

Appendix D

Phase I and II Environmental Site Assessment



FORMER JOHN LEWIS DEPOT, LETCOMBE STREET, READING
(ALSO KNOWN AS JLP MILL LANE)

GEOTECHNICAL AND ENVIRONMENTAL SITE INVESTIGATION
AUGUST 2024



Intended for
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FORMER JOHN LEWIS DEPOT, LETCOMBE STREET, READING (also known as JLP Mill Lane) PHASE I AND II ENVIRONMENTAL SITE ASSESSMENT

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EXECUTIVE SUMMARY

This report presents the findings and conclusions of a combined Phase I and Phase II Environmental Site Assessment (ESA) undertaken at a parcel of land located at Letcombe Street, Reading, RG1 2HN ('the site'). Ramboll UK Limited ("Ramboll") was instructed by John Lewis Plc (the "client"), in accordance with Ramboll's Proposal Ref. Quote 183495, Issue 01, dated 20th May 2024. The work has been undertaken to support a planning application for the site for a proposed Build-to-Rent use.

The main objective of the work was to undertake a desk study, identify potential source-pathway-receptor relationships and to provide an initial characterisation of the site from a ground contamination perspective.

Phase I ESA

The site is currently occupied by a single storey warehouse building situated in the centre of the site, with a customer car park to the west and service yard to the east. The building occupies approximately 50% of the total site area and was previously utilised as a John Lewis Customer Collections Centre. The use of the existing building became surplus to requirements as a customer collection centre in 2021, with its functions having been transferred to the John Lewis department store at Broad Street, Reading. No potentially significant sources of ground contamination were identified from this recent site use.

The earliest historical record of 1879 showed the site to be occupied by militia stores (drill sheds, drill ground) in the centre of the site, with terraced properties in the west and the Reading Baths in the east. By 1900, the militia stores and Reading Baths were no longer labelled on mapping. By the mid-1950s, a factory occupied the central and eastern part of the site and by the mid-late 1960s, the factory was annotated as clothing factory and a tank was present in the north east corner. A garage and dry-cleaning activities were identified in parts of the site. The site had been redeveloped into its current configuration by the mid-late 1980s with a single building labelled as a depot present in the centre of the site and accounting for approximately 40% of the total site area.

A potential for contamination to be present at the site was considered possible, associated with the former site use as militia stores, factories, and the presence of the tank.

The site is considered to be in an area of increased sensitivity with respect to groundwater resources. A Principal Aquifer (Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation) is directly underlying the site with no superficial cover present. The site is not located within a groundwater Source Protection Zone (SPZ); however, there are three groundwater abstractions located within 1 km of the site, including two that are utilised for potable abstractions.

The site is considered to be located in an area of increased sensitivity with respect to surface water receptors due to the proximity of the River Kennet located approximately 100 m north west of the site.

Phase II ESA

An environmental and geotechnical ground investigation was undertaken at the site between the 6th and 16th December 2021 under full time supervision of Ramboll.

Two boreholes were drilled to depths of 20 m below ground (bgl) using cable percussive techniques, alongside five windowless sampling boreholes to a maximum depth of 4 m bgl. Combined ground gas and groundwater monitoring wells were installed in all five boreholes, with one location installed solely for gas monitoring purposes.

Tarmacadam hardstanding (west of the site) and concrete hardstanding (east of the site) was found to be present overlying the Made Ground to a maximum depth of 1.80 m bgl, followed by depths of superficial Taplow Gravels (found in WS02 and WS03) that does not extend across the site and ranges from 0.4 to 2.0 m thick. The Made Ground/Taplow Gravels are underlain by structureless chalk of the

Seaford Chalk Formation. Groundwater was encountered at depths between 2.70 m bgl (BH02) and 3.36 m bgl (BH01).

The main constraint to the work was the presence of a second concrete slab beneath the building that prevented sampling from beneath the building.

Contaminated Land Findings

Visual and olfactory evidence of hydrocarbon contamination was detected in both the Made Ground and natural strata during the investigation, in particular a very strong hydrocarbon odour during the drilling of BH01 and WS02.

Soil and groundwater analytical results were screened against and Ramboll Human Health GAC for commercial end-use. No determinands were noted to exceed the human health pathway via volatilisation.

Asbestos was detected in two out of twelve samples of Made Ground, all within the top 1 m bgl. Following quantification analysis, one sample was measured to be above the laboratory detection limit (<0.001%) at a concentration of 0.253 % (WS08).

Groundwater results were also screened against the relevant GACs for controlled waters, with exceedances noted for groundwater and surface waters relating to petroleum hydrocarbons in BH01 and WS02. Concentrations of heavy metals (copper, nickel and zinc) across the site were also noted at low concentrations that marginally exceeded controlled waters criteria.

The ground gas risk assessment has not identified significant levels of hazardous gases at the site and the site has been classified as Gas Characteristic Situation 1 (i.e., no special gas protection measures required). Further monitoring will be required to confirm this classification or whether basic protection measures are necessary.

Site wide soil and groundwater contamination which could pose a risk to the proposed development was not encountered. The contamination profile identified to date is typical of urban land; however, hydrocarbon impact in the west of the site may require a degree of remediation prior to development. Further investigation and risk assessment should occur in future relating to this impact. This should be undertaken in a staged manner in line with UK land contamination procedures and considering the aims of the UN Sustainable Development Goals (good health and wellbeing, sustainable cities etc.). More detailed recommendations are provided in the conclusion section of this report.

1. INTRODUCTION

1.1 Instruction

This report presents the findings and conclusions of a combined Phase I and Phase II Environmental Site Assessment (ESA) undertaken at a parcel of land located at Letcombe Street, Reading, RG1 2HN ('the site').

Ramboll UK Limited ("Ramboll") was instructed by John Lewis Plc (the "client"), in accordance with Ramboll's Proposal Ref. Quote 183495, Issue 01, dated 20th May 2024. The work has been undertaken to support a planning application for the site for a proposed Build-to-Rent use.

A plan showing the site location and boundary are presented in Figure 1 and 2, respectively (Appendix 1).

1.2 Proposed Development

The proposed development comprises the demolition of the existing building and re-development of the site comprising erection of a new building for up to 215 build to rent residential dwellings (Use Class C3) together with flexible commercial / community space (Use Class E/F1/F2), residents' facilities, landscaping, public realm, amenity space, cycle parking and disabled car parking.

1.3 Objectives

The objective of the work is to further understand the likelihood of ground contamination to be present from desk-based research as part of a Phase I Environmental Review, in addition to undertaking a Phase II Environmental Site Assessment to further characterise the site.

Whilst sustainability and climate change considerations do not form part of the scope of works, where relevant, they have been considered within the text, specifically in relation to the United Nations Sustainable Development Goals (UN SDGs) they are associated with.

Further specific objectives of the Phase II Environmental Site Assessment were to:

- document and interpret the environmental ground conditions encountered;
- assess the potential for risks to both human health and environmental receptors (including controlled waters) based on the data collected;
- carry out a generic quantitative contaminated land risk assessment based on a source-pathway-receptor methodology;
- present a Conceptual site Model (CSM) based on the findings of the ground investigation;
- provide a commentary on contaminated land risks relating to the proposed end use;
- determine the presence and chemical composition of the underlying soil;
- preliminarily investigate the site ground gas and groundwater regime; and
- assess the requirement for further investigation, assessment and/or remedial measures (if required).

2. SCOPE OF WORKS

2.1 Phase I Environmental Site Assessment (ESA)

The scope of the Phase I Environmental Site Assessment (ESA) has included the following:

- review of readily available historic, recent and current Ordnance Survey maps, plans and aerial imagery obtained from a commercial environmental data provider to identify activities which might have led to contamination of soil or groundwater (for example, from industrial processes, chemical/fuel storage activities or waste management or disposal) both on the subject site and on adjacent land (2024 data);
- review of published maps and records on the shallow and deep geology and hydrogeology of the site to assess the vulnerability and sensitivity of groundwater and surface water resources to contamination, if present, and the possible direction of movement off site, if mobile (considered in 2024);
- search of a commercially available database of regulatory information including environmental permits, records and incidents at the site and surrounding area (2024 data);
- review of readily available Local Authority Planning Department records to obtain information on the site's historical uses, planning permissions and associated environmental conditions, where available (2021 information);
- obtain verbal or written information from the Local Authority Environmental Health Department relating to environmental conditions, incidents and known contamination risks and on the Local Authority's Contaminated Land Strategy (2021 information);
- a site walkover inspection that considered (where applicable and information is available) on-site and adjacent land uses, site development history, previous site occupants, visual and olfactory evidence of contamination, hazardous materials and wastes, water supply, use, treatment and discharge arrangements and confirmed the access arrangement for the intrusive works and identifiable constraints that may restrict the coverage of the Phase II ESA (2021); and
- production of a preliminary conceptual site model.

2.2 Phase II Environmental Site Assessment

The scope of works of the Phase II Environmental Site Assessment included the Following (as conducted in 2021):

- the production of a CDM Project Health and Safety Plan;
- the completion of an Unexploded Ordnance (UXO) Desk Study Risk Assessment by an external contractor, Zetica UXO, to confirm the potential to encounter UXO during the works and whether supervision of the works was required. The site was identified as Low Hazard level and no supervision required;
- completion of an underground services clearance exercise by an external contractor (Land Utility Group) to clear all exploratory locations prior to intrusive works;
- hand excavated inspection pits undertaken to a minimum of 1.2 metres below ground level (m bgl);
- drilling of two boreholes (BH01 – BH02) using cable percussive techniques to a maximum depth of 20 m below ground level (m bgl) with ground gas and groundwater monitoring wells installed into each borehole;
- drilling of six windowless sampling boreholes (WS02 – WS08) to a maximum depth of 4 m below ground level (m bgl) with ground gas and groundwater monitoring wells installed into five boreholes;

- dynamic probing from the base of the boreholes to 10 m bgl in WS03 and WS05;
- soil sampling of borehole arisings within Made Ground and natural deposits for environmental testing, with selected samples tested for a range of determinands;
- two rounds of ground gas monitoring;
- groundwater development followed by collection of groundwater samples from five wells; and
- interpretation of the chemical data and a Generic Quantitative Risk Assessment as well as the production of a revised conceptual site model based on the results of the investigation (updated in 2024, otherwise physical work occurred in 2021).

The precise site investigation strategy is discussed in further detail within Section 3.

2.3 General Limitations and Reliance

This report has been prepared by Ramboll exclusively for the intended use by the client in accordance with the appointment letter between Ramboll and the client defining, among others, the purpose, the scope and the terms and conditions for the services. No other warranty, expressed or implied, is made as to the professional advice included in this report or in respect of any matters outside the agreed scope of the services or the purpose for which the report and the associated agreed scope were intended or any other services provided by Ramboll.

In preparation of the report and performance of any other services, Ramboll has relied upon publicly available information, information provided by the client and information provided by third parties. Accordingly, the conclusions in this report are valid only to the extent that the information provided to Ramboll was accurate, complete and available to Ramboll within the reporting schedule.

Ramboll's services are not intended as legal advice, nor an exhaustive review of site conditions and/or compliance. This report and accompanying documents are initial and intended solely for the use and benefit of the client for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts any duty to any third party, unless formally agreed by Ramboll through that party entering into, at Ramboll's sole discretion, a written reliance agreement.

Unless otherwise stated in this report, the scope of services, assessment and conclusions made assume that the site will undergo redevelopment as a build to rent high rise apartment scheme.

The site investigation works were undertaken during a discrete period of time. The findings and conclusions presented in this report are accordingly factually limited by these circumstances and, unless stated otherwise in the report, are preliminary. The field investigations were restricted to a level of detail necessary to meet the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant period of time has elapsed since the sampling took place. The interpretation of the geological and environmental quality conditions is based on extrapolation from point-source data in a heterogeneous environment. Accordingly, more detailed investigation may be appropriate dependent upon the client objectives.

For specific limitations of the Ground Investigation, refer to Section 4.5.

3. PHASE I ESA

Information detailed within the report and utilised by Ramboll as part of this assessment was obtained from several sources, including:

- Envirocheck Report dated November 2021 (see appendix 2);
- British Geological Survey (BGS) Geology of Britain Viewer / BGS Maps Portal;
- EA's Flood Map for Planning; and
- Available online imagery, including Google Earth™ and Google Streetview™.

3.1 Site Description

The site is located to the south of the A329, between Mill Lane and Crossland Road in Reading, approximately 640 m south of Reading train station. The site occupies approximately 0.37 hectares and the centre of the site is located at National Grid Reference SU 71695 73094. The site location is shown in Figure 1 (Appendix 1).

The site is bound by Mill Lane to the north with the A329 beyond, followed by the Riverside and Oracle shopping centres situated to the south and north of the River Kennet respectively. Crossland Road bounds the site to the east and south with mixed residential/commercial properties beyond. The site is bound to the west by Letcombe Street with a Premier Inn beyond. The site is accessed in the north east and south west via Crossland Road.

The site is a broadly rectangular parcel of land, orientated NE-SW and measures approximately 160 m west-east and 20 m north-south. The site is relatively flat at 40 m AOD and slopes upwards slightly to the east. The area to the north of the site, along the A329 and River Kennet is relatively flat before rising towards Reading town centre to the north. The area to the south rises gently towards Christchurch Road further south.

The site comprises a two-storey warehouse building situated in the centre of the site, with a customer car park to the west and service yard to the east. The building occupies approximately 40% of the total site area and was previously utilised as a John Lewis Customer Collections Centre. The site is currently vacant. The use of the existing building became surplus to requirements as a customer collection centre in 2021, with its functions having been transferred to the John Lewis department store at Broad Street, Reading.

3.2 Site History and Surrounds

Ramboll has undertaken a review of historical mapping and aerial imagery obtained from a commercial environmental regulatory database provider, the findings of which are summarised in the following sections.

3.2.1 The Site

The earliest historical record of 1879 showed the site to be developed with a row of terraced properties along the western site boundary; the centre of the site was occupied by a 'drill ground' with accompanying 'drill sheds' adjacent on either side, and collectively annotated as militia stores which extended off site to the north. Several small buildings (collectively labelled as Reading Baths) were present in the north east of the site and extended off site to the north and east. An historic insurance plan dated 1895 identified the militia stores to be occupied by a T. Cook Jnr. And Sons (clothiers).

By the map of 1900, the militia stores and Reading Baths were no longer labelled but buildings remained on site, with the clothiers factory now extending further east. By 1931, the building had extended further east occupying the central area of the site. By 1956, this building was

annotated as a factory and an historic insurance plan dated 1958 identified the site to be occupied by a Burberry's Limited weatherproof clothing factory (that also extended off-site to the north). The majority of the factory building on-site appeared to be factory floorspace and the plan detailed a garage in the north-west of the site and a wet and dry-cleaning facility in the centre north (both occupying ~5% of the site area). By 1967, the factory was labelled as a clothing factory and the square structure in the north east corner was labelled as a tank.

The terraced properties in the west of the site were no longer present by 1973 and by 1990 the site had been developed into its current configuration with a building labelled as a depot in the centre of the site, accounting for approximately 40% of the total site area. Satellite aerial photography of 1999 showed the remaining areas to be in use a car park and yard. No further changes were noted up to the present day.

3.2.2 The Surrounds

The earliest historical record of 1879 showed the surrounding area to be heavily developed with mixed residential and industrial uses. Letcombe Street was present immediately west of the site with a row of terraced properties beyond and a graveyard occupied the area immediately south of the site. To the immediate north the area was occupied by residential properties, a hospital and buildings associated with Reading Baths and with Mill Lane situated beyond. The area to the east was occupied by Reading Baths with residential housing beyond. A gasworks was present approximately 120 m north west of the site (north of the River Kennet). Immediately north of Mill Lane an old water works with an engine house and St Giles Mill were present 55 m north west and 65 m north west of the site, respectively. The Reading Tin Works was present 105 m south east.

By 1912, a tram depot and tramway power station had been developed in the location of the former old water works and St Giles Mill. Tram networks had been developed along Bridge Street (100 m west), London Street (40 m east) and Mill Lane (40 m north). The hospital and Reading Baths were no longer labelled on the map.

By 1931, the gasworks was no longer depicted on the map, and a tram and bus depot had been developed adjacent to the tramway power station. A printing works was present 30 m west.

The tram depot, tramway power station, and tram and bus depot had been replaced with a corporation transport depot by 1957 and the graveyard was no longer present to the south of the site. The factory on site extended off site to the north and remained as such until the 1990s. Several unlabelled works were present 15 m north east, 90 m east, and 25 m north west respectively. Several garages were located 135 m south west, 220 m south, and 145 m north east respectively. The former Reading Tin Works was now labelled as a 'works'. Several tanks (of unknown contents) were present 130 m north west adjacent to the brewery and north of the River Kennet. Another tank (of unknown contents) was located 125 m north east but was no longer depicted on the map of 1961.

By 1968, several tanks were present 55 m, 195 m, and 210 m south east. A police garage was present immediately north east of the site and further works were annotated on the map including printing works 90 m east and 115 m north east, respectively. A metal box works was labelled in the location of the former Reading Tin Works. The garage located 220 m south was annotated as a filling station.

By the late 1980s, the A329 had been developed immediately north of the site and Crossland Road to the south and east. The remaining industrial works, garages and tanks were no longer present and the immediate site surrounds were occupied by mixed light commercial and residential properties.

By 2003, a multistorey car park, cinema and the Oracle Shopping Centre had been developed to the north of the A329. No further significant changes were noted up to the present day with the immediate surrounds occupied by light commercial and residential properties.

3.3 Geology and Hydrogeology

3.3.1 Geology

The BGS 1:10,000 scale (superficial and bedrock) geology maps indicates that the site is underlain by the Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation. Superficial deposits comprising the Taplow Gravel Formation (Sand and Gravel) are present along the southern site boundary.

There are several publicly available BGS borehole records located surrounding the site. The ground conditions described in BGS borehole records in close proximity to the site are summarised in Table 3.1 below.

Table 3.1: Summary of Ground Conditions from BGS Borehole Logs

Stratum	Depth to base (m bgl)	Thickness (m)	Descriptions
Concrete/tarmac	0.3	0.3	-
Topsoil/Made Ground	1.5 – 6.0	1.2 – 5.7	Soft black sandy silt with occasional flint gravel and chalk fragments Soft brown slightly sandy clay with plant stems and brick/pot gravel.
Alluvium (not present in southern borehole records)	3 – 6.0	0 – 4.0	Medium dense light brown and grey SILT with subangular to subrounded chalk flint gravel.
Gravel Deposits	2.45 – 7.9	2.0 – 5.0	Medium dense to dense light brown subangular to rounded fine to medium flint and chalk GRAVEL, with much fine to coarse sand.
Chalk (Grade Dc)	12.0	4.0	White and cream structureless CHALK composed of subangular to rounded gravel to cobble size white highly weathered very weak to weak fragments.
Chalk (Grade Dm)	15.0	3.0	White moderately weathered CHALK. Fractures very closely spaced, infilled up to 15mm with white comminuted chalk. Coarse gravel flint fragments.
Chalk (Grade C)	23.5	8.5	White slightly weathered CHALK, moderately weak. Fractures closely spaced. Marl bands up to 2 mm wide.

Chalk was recorded in all the deep boreholes. There is no evidence of voiding or irregular depth of weathered material within the surrounding BGS logs; the chalk generally becomes less weathered with depth. Some highly disturbed samples where gravel to cobble sized flints were recovered.

The boreholes further from the site show that there is significant variation in the depth to chalk bedrock, as it was encountered at a depth of 3.35 m bgl in SU77SW60, 1.2 m bgl in SU77SW27, and 6.7 m bgl in SU77SW342. The logs indicate that the depth of Made Ground in the area is also highly variable.

Groundwater strikes were recorded at 4.0 m bgl in both SU77SW59 and SU77SW56, whereas groundwater was encountered at 2.5 m bgl in SU77SW57. All groundwater strikes were at depths within the chalk bedrock.

According to the Coal Authority, the site is not located in a Coal Mining Affected Area. The BGS has stated that the site is located in an area where other (non-coal) mining activities are frequent.

3.3.2 Hydrogeology

The chalk bedrock (Lewes Nodular Chalk Formation ((Seaford Chalk Formation)) and Newhaven Chalk Formation) is classified as a Principal Aquifer by the Environment Agency, whereas the superficial deposits comprising the Taplow Gravel Formation (Sand and Gravel) are classified as a Secondary A Aquifer.

There is a Water Framework Directive (WFD) designated groundwater body present beneath the site. The groundwater at the site is part of the Berkshire Downs Chalk Water Body which has been classified as having a 'poor' chemical and 'poor' quantitative rating under the Water Framework Directive classification scheme.

There are currently three licensed groundwater abstractions within 1 km of the site and a further sixteen locations within 2 km of the site. Those within 1km are detailed in Table 3.2 below.

Table 3.2: Summary of Water Abstractions within 2 km of the Site

Licence Holder	Distance/ Direction from Site	Abstraction Source	Purpose of Abstraction
Primark Stores Limited	620 m north west	Thames Groundwater: Cheapside	Drinking, Cooking, Sanitary, Washing, (Small Garden) – Commercial/Industrial/Public Services (Potable water abstraction)
Royal Berkshire Hospital	720 m south east	Thames Groundwater: Royal Berkshire Hospital	Drinking, Cooking, Sanitary, Washing, (Small Garden) – Commercial/Industrial/Public Services (Potable water abstraction)
Private water supply	800 m	-	Private water supply – details unknown (disclosed previously by the EHO – 2021)

The site is not situated within an Environment Agency (EA) designated groundwater Source Protection Zone (SPZ).

Based on available information, it is considered that groundwater in the Chalk bedrock (Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation (undifferentiated) – Chalk) is a potentially sensitive receptor due to its Principal Aquifer designation. Furthermore, there are three groundwater abstractions located within 1 km of the site, including two that are utilised for potable abstractions.

3.4 Chalk Cavities

The desk-based Cavity Occurrence Assessment produced by Stantec for the site concluded the following in terms of natural or man-made chalk cavity risk:

- *An assessment of the site has been undertaken regarding the potential for solution features to have formed in the geology, geomorphology and hydrogeology setting. This has taken into consideration the wider spatial area factors pertaining to solution feature hazards resulting in a rating of MODERATE for the presence of solution features being present in the chalk surface and MODERATELY HIGH for the presence of chalk subsurface solution features at depth.*
- *On the basis of the site history, geology, hydrogeology and geomorphology, the potential for past chalk mining to have occurred at the site is considered to be VERY LOW.*

3.5 Surface Water and Flooding

The nearest surface water feature is an inland river located approximately 85 m north west of the site. The river branches off the River Kennet located approximately 100 m north west. The EA currently classifies this section of the River Kennet (Lower Kennet) as being of 'moderate' ecological quality and not classified on chemical quality under the Water Framework Directive classification scheme.

The site is located within the Kennet Surface Water Operational Catchment Zone and the River Kennet is located approximately 100 m north west of the site at its nearest point.

There is one licensed surface water abstraction within 1 km of the site, located approximately 95 m north west of the site. The abstraction is from St Giles Stream and used for 'Lake and Pond Throughflow'.

According to the EAs fluvial and tidal flood map for planning, the site is located in Flood Zone 1 (low probability). This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1% in any year).

According to the EA Flood Map for Surface Water which presents the theoretical potential for flooding from pluvial sources (i.e. flooding caused by rainwater exceeding capacity of drainage systems), the site is located in an area of low flooding probability. This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of pluvial flooding (1% to 0.1% in any year).

The only surface water abstraction within 1km of the site is from the St. Giles Stream at the Oracle Centre, Reading located approximately 95m north-west that is used for throughflow associated with an amenity lake at a shopping centre.

The site is considered to be located in an area of increased sensitivity with respect to surface water receptors due to the proximity of the River Kennet located approximately 100 m north west of the site. However, the River Kennet appears to have sheet-piled walls along this section that limits the potential for groundwater to be in direct continuity with the waterbody.

3.6 Ecological Receptors

There are no statutory designated ecological receptors located within a 2 km radius of the site.

3.7 Environmental Database

The information presented in Table 3.3 below has been obtained from a review of a proprietary environmental database procured by Ramboll relating to the site and surrounding land.

Table 3.3: Summary of Relevant Environmental Records

Data Type		Distance				Relevant Records within 250 m of the Site
		On Site	<250 m	250 m-500 m	500 m-1 km	
Contaminated Land Register enquiries		0	0	0	0	None
Pollution incidents		0	13	34	90	Nearest incident is located approximately 50 m west and involved the spillage of oils in 1993 and classified as a minor incident. Twelve further incidents within 250m all of a minor nature and relating to release of oils.
Prosecutions or enforcement actions		0	0	0	0	None
Recorded landfill sites		0	0	0	0	None
Licensed waste management facilities		0	0	0	2	None
Environmental Permits	Part A(1)	0	0	0	0	None
	Part A(2)	0	0	0	0	None
	Part B	0	1	1	0	Nearest is located 185m east as a crematoria. Petrol filling stations located 580m east and 730m south-west.
Control of Major Accident Hazards Sites (COMAH)		0	0	0	0	None
Fuel stations		0	0	0	6	None
Contemporary trade directory entries		0	36	-	-	Nearest is listed as B & T Business Machines located 25m north-east for equipment servicing and manufacture purposes.
Registered radioactive substances		0	0	0	3	Information on certain radioactive substance authorisations is not publicly accessible
EA discharge consents		0	8	7	18	Nearest relates to a brewery located 130m distant (revoked). All within 250m of the site are revoked.
Radon affected area (Y/N)		N	-	-	-	N/A
Designated ecological sites		0	0	0	0	None

3.8 Local Authority Information

An environmental information request was submitted to the Reading Borough Council in 2021 which responded with the following information relating to the site:

- The site has been identified by the Council for future investigation under the Council's Contaminated Land Strategy due to the historic potentially contaminative uses as a militia store and factory. The Council consider the site as low risk under its current commercial use, and there is no schedule set for the investigation of the site.
- The Council does not have any records of any intrusive investigations at the site or in the near vicinity.
- No current or historic landfills located within a 250 m radius of the site.
- No elevated indoor radon gas concentrations have been identified by the Council within buildings on or within 100 m of the site, therefore radon protection measures are not required in the buildings on site or within 100 m.
- The Council does not have any records of current or former nuisance issues at the site or adjoining properties.
- A private water supply is present approximately 800 m from the site; however, the Council are unable to provide further details due to Regulation 12 (5) (a) of the Environmental Regulations 2004.
- No Part A(2) or Part B Environmental Permits issued to the site or adjoining properties.

3.9 Planning Department

An information request was submitted to the planning department at Reading Borough Council which identified the following applications of interest relating to the site:

- 83/TP/0821- Dem. majority of factory. refurb. remainder for light ind. use, car parking & lorry access.
- 84/TP/0216 - Storage and facilities, temporary offices with supporting gantry over existing temporary offices.
- 93/00520/FD - Use of existing building for b8 storage & distribution.
- 96/00692/FD - Erection of warehouse with customer collection facilities ancillary car park and servicing area.

The planning team searched the decision notices for the applications for mention of site investigations and there were none identified. Documents related to the planning applications are not available for review on the Councils online planning portal.

3.10 Proposed Development

The proposed development comprises the demolition of the existing building and redevelopment of the site comprising erection of a new building for up to 215 build to rent residential dwellings (Use Class C3) together with flexible commercial / community space (Use Class E/F1/F2), residents' facilities, landscaping, public realm, amenity space, cycle parking and disabled car parking. It is assumed that soft landscaping and paved areas will form the external areas at the site.

3.11 Potential Sources of Contamination

3.11.1 Current Site Uses

The site is currently vacant and the use of the existing building became surplus to requirements as a customer collection centre in 2021, with its functions having been transferred to the John Lewis department store at Broad Street, Reading. No significant sources of contamination are considered to be present resulting from the recent or current activities on site.

3.11.2 Historic Site Uses

Based on available information the potential for contamination to exist from historic uses of the site cannot be ruled. Potential historic sources of contamination include:

- Previous site use as militia stores, a factory (unknown use), a clothing factory and the presence of a tank in the north east corner. An historic insurance plan dated 1958 identified the site to be occupied by a Burberry's Limited weatherproof clothing factory (that also extended off-site to the north). The majority of the factory building on-site appeared to be factory floorspace and the plan detailed a garage in the north-west of the site and a wet and dry-cleaning facility in the centre north (both occupying ~5% of the site area).
- There is the potential for a range of contaminants to be present on-site including asbestos from former building demolitions, fuels and oils, chlorinated solvents given the reference to wet and dry-cleaning activities, and it cannot be ruled out that perfluorinated compounds may be present given the weatherproof clothing activities may have extended into the 1980s.
- Nearby historical uses including garages, printing works, unspecified works, metal (tin) works, tramways, transport depot, and the presence of numerous tanks (of unknown contents).

In general terms the urban location of the site reduces the environmental sensitivity, although groundwater (a Principal Aquifer) is expected to be present on-site as a relatively shallow waterbody there is limited potential for this to be in direct continuity with the nearby River Kennet that is sheet-piled along this section. There are also no identified sensitive abstraction points in the near vicinity.

3.12 Ramboll Conclusion

To support the planning application Ramboll has undertaken further site investigation that is discussed in the following sections.

4. SITE INVESTIGATION STRATEGY

The site investigation strategy was to provide an initial characterisation of the site to support a future planning application.

Note that the site investigation strategy was prepared in 2021 prior to the identification of the weatherproof clothing activities on-site and therefore PFAS testing was not included at that time. This is a data-gap and additional testing is recommended in future once the on-site building is demolished given the additional information provided in the Phase I mapping in 2024.

4.1 Preliminary Conceptual Site Model (CSM)

The preliminary conceptual site model is a simplified representation of the environmental and geotechnical conditions at the site, and in the vicinity of the site, and is used to initially identify potentially sensitive receptors and potential pollutant linkages. Information obtained during the Ramboll site investigation, described in the following sections of this report, is then used to refine and update this preliminary conceptual model.

Table 4.1: Preliminary Conceptual Site Model

Potential Sources of Contamination • Made Ground: the type and composition of the Made Ground is unknown. • Residual / historical contamination relating to the former land-use including militia stores, factories and an unspecified tank. • Electrical sub-station located off-site of the north east corner. • Current site use as car parking: potential for small-scale leakages of fuels and oils. • Ground gases: potential generation of ground gases associated with the unknown composition of the underlying Made Ground. • Off-site sources: industrial land uses including various works, depots, garages, warehouses, substations, and numerous unspecified tanks. Potential contaminants may include Heavy metals, Organics, Inorganics, Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAHs), Volatile Organic Carbons (VOCs, including chlorinated VOCs), Semi-volatile Organic Carbons (SVOCs), Phenols, Sulphate, Sulphides, Asbestos containing material (ACM), Polychlorinated Biphenyls (PCBs), Solvents and Petrol Additives (e.g., MTBE).
Geology The site is underlain by the Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation. Superficial deposits comprising the Taplow Gravel Formation (Sand and Gravel) are present along the southern site boundary. Made Ground of varying thickness is likely present on the site.
Hydrogeology According to the EA, the chalk bedrock underlying the site is classified as a Principal Aquifer. The superficial deposits comprising the Taplow Gravel Formation, present along the southern site boundary, are classified as a Secondary A Aquifer. The groundwater at the site is part of the Berkshire Downs Chalk Water Body which has been classified as having a 'poor' chemical and 'poor' quantitative rating under the Water Framework Directive classification scheme. There are three groundwater abstractions located within 1 km of the site, including two that are utilised for potable abstractions; however, the site is not situated within an Environment Agency designated groundwater Source Protection Zone (SPZ) and none of the abstractions are within 500m. Overall, the site is considered to be of high environmental sensitivity and vulnerability in terms of groundwater, due to the presence of a Principal Aquifer directly underlying the site.

Table 4.1: Preliminary Conceptual Site Model

Hydrology There are no surface water features located on the site. The nearest surface water feature is an inland river located approximately 85 m north west of the site; the river branches off the River Kennet located approximately 100 m north west. The River Kennet appears to be sheet piled through this section limiting the potential for groundwater influx. The site is located within the Kennet Surface Water Operational Catchment Zone and the River Kennet is located approximately 100 m north west of the site at its nearest point. The EA currently classifies this section of the River Kennet (Lower Kennet) as being of 'moderate' ecological quality and a 'fail' on chemical quality under the Water Framework Directive classification scheme. There is one licensed surface water abstraction within 1 km of the site, located approximately 95 m north west of the site. The abstraction is from St Giles Stream and used for 'Lake and Pond Throughflow'. According to the EAs fluvial and tidal flood map for planning, the site is located in Flood Zone 1 (low probability). This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1% in any year). Overall, the site is considered to be of low-moderate environmental sensitivity in terms of surface water due to the River Kennet located approximately 100 m north.			
Potential Receptors to Contamination (if Present)			Receptor Present?
Human Health	On-site	The proposed development comprises a mixed-use high-rise residential apartment scheme with accompanying commercial at ground level and undercroft car parking.	Yes
	Off-site	Offsite receptors include mixed residential and light commercial properties present to the east, south, and west of the site, in addition to commercial properties (Riverside and Oracle shopping centres) to the north.	Yes
Water Environment	On-site	The Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation is a Principal Aquifer. The Taplow Gravel Formation (Sand and Gravel) is a Secondary A Aquifer.	Yes
	Off-site	Groundwater: The site is located on a Principal Aquifer. Groundwater flow direction is unknown.	Yes
		Surface Water: The nearest surface watercourse is an inland river located approximately 85 m north west.	Yes
Ecological Receptors	On-site	There are no statutory designated ecologically sensitive sites present on-site.	No
		Areas of soft landscaping may potentially be included within the final design plans for the proposed development.	Yes
	Off-site	There are no statutory designated ecologically sensitive sites within a 2 km radius of the site.	No
Built Environment	On-site	The proposed site use is for residential and commercial use.	Yes

4.2 Site Investigation Works

A summary of the intrusive works is provided below:

Table 4.2: Summary of Intrusive Works

Item	No.	Comments
Utilities Clearance Survey	Item	Before proceeding with intrusive works, the specialist underground service clearance contractor Land Utility Group confirmed the absence of underground services at each location, with borehole locations being located at least 1.5 m away from identified services or known underground features (such as underground water supply pipes or gas supplies).
Cable Percussion Boreholes	2 No.	Two boreholes (BH01 and BH02) were drilled to depths of up to 20.00 m below ground level (bgl). BH02 was initially proposed to 35.00 m and BH01 to 25.00 m but due to flint gravels both boreholes refused at 20.00 m bgl after significant efforts to progress beyond this depth. Both boreholes were installed for ground gas and groundwater monitoring purposes. Wells were of an appropriate construction for the ground conditions encountered. The well designs are detailed within the borehole logs presented in Appendix 2.
Dynamic Windowless Sampling Boreholes	5 No.	Five boreholes (WS02, WS03, WS05, WS06 and WS08) were drilled to depths of up to 4 m below ground level (bgl). Three boreholes were installed for ground gas and groundwater monitoring purposes, whereas WS03 was installed solely for ground gas monitoring. WS01, WS04 and WS07 were attempted internally but failed on obstructions or a second concrete slab at depth of approximately 0.5 m bgl. Ramboll did not attempt to break through this for H&S reasons. Wells were of an appropriate construction for the ground conditions encountered. The well designs are detailed within the borehole logs presented in Appendix 2.
Soil Sampling and Analysis	12 No.	Samples were collected for environmental and geotechnical purposes. During the site investigation, soil samples were recovered from each exploratory hole location and screened on-site using a handheld photo-ionisation detector (PID) for the presence of volatile organic compounds. Up to three soil samples from each sampling location were submitted for selected laboratory analysis. Selected soil samples were analysed for a predetermined suite of contaminants (see Section 3.4), designed to be reflective of the site's historic uses.

Table 4.2: Summary of Intrusive Works

Item	No.	Comments
Groundwater Sampling and Analysis	7 No.	Groundwater was encountered in five of the six installed monitoring wells (WS03 was installed for gas monitoring purposes only, at a depth above the groundwater level). An oil/water interface probe was used to check for free-phase hydrocarbons and resting groundwater levels were monitored. The monitoring wells were developed, with a minimum of three well volumes purged and allowed to recover prior to sampling. A round of groundwater sampling was undertaken on 16th December 2021, five groundwater samples were analysed for a suite of contaminants designed to be reflective of the site's historic uses (see Section 3.4). Additional groundwater samples were collected from WS02 and BH01 on 17th January 2022 for re-sample purposes due to previously detected Total Petroleum Hydrocarbon (TPH) concentrations.
Gas Monitoring	2 No.	Two rounds of ground gas monitoring were undertaken on the 16 th December 2021 and 17 th January 2022, using a portable gas analyser (GFM 430 Series) and a PhoCheck Tiger photo-ionization detector (PID).
Waste Disposal	Item	All soil arisings were stored in dedicated waste drums during the investigation. Where visual or olfactory evidence of contamination was encountered, the arisings were stored in a separate drum. Purged groundwater along with general waste generated during the works were also stored in dedicated drums during the investigation. A representative sample of the waste was submitted for chemical testing and was characterised for waste disposal purposes waste (i.e. hazardous or non-hazardous waste). Once characterised, the wastes (soil, water and general waste) were collected by Acorn Waste, who (under appropriate consignment notes) arranged for disposal to a suitably licenced facility.

The borehole locations are presented in Figure 3 (Appendix 1). The locations and associated rationale are summarised in Table 4.3 below.

Table 4.3: Exploratory Hole Rationale

Exploratory Hole	Rationale	Depth achieved (m bgl)	Installed as Monitoring Well?
BH01	To preliminarily investigate the superficial and bedrock geology and groundwater conditions in the west of the site. To complete in-situ testing and gain samples to perform laboratory testing to determine characteristic soil parameters adequate for foundation option appraisal. To understand depth of weathered chalk and provide a comparison to BH02 for stratigraphy of site.	20.00	Yes

Table 4.3: Exploratory Hole Rationale

Exploratory Hole	Rationale	Depth achieved (m bgl)	Installed as Monitoring Well?
BH02	To preliminarily investigate the superficial and bedrock geology and groundwater conditions in the west of the site. To complete in-situ testing and gain samples to perform laboratory testing to determine characteristic soil parameters adequate for foundation option appraisal. To understand depth of weathered chalk and provide a comparison to BH01 for stratigraphy of site. Broadly targeted the former wet and dry-cleaning activities.	20.00	Yes
WS01	To determine shallow soil and groundwater conditions in the north east corner of the warehouse footprint and to provide general coverage. Location not drilled to depth.	n/a	n/a
WS02	To determine shallow soil and groundwater conditions on the northern site boundary and to provide general coverage. Broadly targets the former garage activities in the north-west of the site.	4.00	Yes
WS03	To determine shallow soil and groundwater conditions on the western site boundary and to provide general coverage.	4.00	Yes
WS04	To determine shallow soil and groundwater conditions in the west of the warehouse footprint and to provide general coverage. Location not drilled to depth.	n/a	n/a
WS05	To determine shallow soil and groundwater conditions in the east of the site and to provide general coverage.	4.00	Yes
WS06	To determine shallow soil and groundwater conditions on the northern site boundary and to provide general coverage. Broadly targeted the former wet and dry-cleaning activities.	4.00	No
WS07	To determine shallow soil and groundwater conditions in the east of the warehouse footprint and to provide general coverage. Location not drilled to depth.	n/a	n/a
WS08	To determine shallow soil and groundwater conditions in the vicinity of the former tank and current electricity sub-station in the north east corner of the site.	4.00	Yes

4.3 Monitoring Well Installation

Two boreholes and three window sample boreholes were installed as gas and groundwater monitoring wells with 50 mm HDPE slotted pipe set in a gravel filter pack with a plain pipe bentonite seal above and below. One window sample borehole (WS03) was installed solely for gas monitoring purposes.

Table 4.4: Summary of Monitoring Installations

Borehole ID	Installation Type	Response Zone (m bgl)	Ground Level (m AOD)	Response Zone (m AOD)	Stratum at Response Zone
BH01	50 mm Gas/Groundwater Monitoring Standpipe	2.00 – 5.50	39.50	37.50 – 34.00	Chalk Bedrock
BH02	50 mm Gas/Groundwater Monitoring Standpipe	2.00 – 10.00	38.84	36.84 – 28.84	Chalk Bedrock
WS02	50 mm Gas/Groundwater Monitoring Standpipe	2.00 – 4.00	39.64	37.64 – 35.64	Chalk Bedrock
WS03	50 mm Gas/Groundwater Monitoring Standpipe	1.00 – 2.00	39.50	38.50 – 37.50	Made Ground
WS05	50 mm Gas/Groundwater Monitoring Standpipe	1.00 – 4.00	39.23	38.23 – 35.23	Chalk Bedrock
WS08	50 mm Gas/Groundwater Monitoring Standpipe	1.00 – 4.00	39.14	38.14 – 35.14	Chalk Bedrock

4.4 Laboratory Chemical Analysis

The laboratory chemical analysis was undertaken by i2 Analytical as specified by Ramboll. Laboratory chemical analysis of soil/groundwater samples was selected based on the site history and the potentially contaminative uses, as summarised in Table 4.5 below:

Table 4.5: Summary of Analytical Strategy

Analytical Suite	Rationale	No. of soil samples submitted	No. of groundwater samples submitted
Total Petroleum Hydrocarbons Carbon Working Group (TPH CWG) including BTEX	Typically associated with fuels and oils.	12	7
Total cyanide, phenols	Typically associated with historical industrial sites and brownfield land	12	7
Asbestos Screen	Typically associated with Made Ground.	12 (2 quantification analysis)	N/A
Asbestos Quantification	Where asbestos was detected during the screening, samples were scheduled for quantification analysis.	2	N/A
Metals (including arsenic, beryllium, boron, calcium (waters only), cadmium, chromium, chromium – hexavalent, chromium III, copper, lead, magnesium (waters only), mercury, nickel, selenium, vanadium, zinc	Typically associated with brownfields sites historically used for industrial purposes.	12	7

Table 4.5: Summary of Analytical Strategy

Analytical Suite	Rationale	No. of soil samples submitted	No. of groundwater samples submitted
Water soluble sulphate (SO ₄)	Typically associated with Made Ground.	12	7
Ammoniacal Nitrogen (as N)	Typically associated with organic contamination.	N/A	7
Polycyclic Aromatic Hydrocarbons (PAH) – Speciated (EPA 16)	Typically associated with fuels and oils.	12	7
Volatile Organic Compounds (VOC) and Semi-Volatile Organic Compounds (SVOC)	Typically associated with fuels and oils.	4	7
Polychlorinated Biphenyls (PCBs) – 7 Congeners	Associated with electrical equipment. Samples collected from WS06 and WS08, in vicinity of the electricity sub-station in the north of the site.	2	0
Total hardness (as calcium carbonate – CaCO ₃)	Used to characterise the soils and derive assessment criteria for some metals.	N/A	7
Total Organic Carbon (TOC)	Used to determine the proportion of organic matter in a sample.	4	N/A

4.5 Limitations to the Investigation

The ground investigation was limited by the following factors:

- Internal windowless sampling boreholes (WS04 and WS07) were not successfully drilled. The coring team from Borehole Solutions Ltd cored through the concrete slab flooring of the warehouse at the locations; however, the window sampling team from Dynamic Sampling Ltd encountered an obstruction at approximately 0.5 m bgl at both locations. The obstruction was thought to be a second concrete slab. WS01 was cancelled due to insufficient overhead clearance for the drilling rig.
- The two deeper boreholes drilled with the cable percussion rig did not achieve the targeted depths of 35 m bgl in BH02 and 25 m bgl in BH01. This was due to the presence of flints in the Chalk bedrock which led the cable percussive method to refuse at 20 m bgl. This should be taken into account for any future ground investigations in order to improve recovery at depth.

5. SUMMARY OF GROUND INVESTIGATION FINDINGS

5.1 Ground Conditions

Ground conditions identified during this site investigation are summarised in Table 5.1 below. The information provided below is a summary of both the windowless sampling boreholes and cable percussion boreholes. The findings were generally consistent with published data as presented in Section 2.3. A full lithological description is recorded on the logs, which are provided as Appendix 2.

Table 5.1: Summary of Ground Conditions

Strata	Range of Depth to Base of Strata (m bgl)	Range of Depth to Base of Strata (m AOD)	Approx. Average. Thickness (where encountered) (m)	Typical Description (s)
Tarmacadam and Concrete Hardstanding	0.05 – 0.24	39.54 – 38.60	0.16	Tarmacadam surfacing overlying the Made Ground is present in the west of the site, whereas concrete hardstanding is present in the east.
Made Ground	0.30 – 1.80	38.93 – 37.70	0.90	Made Ground (i.e. anthropogenic material deposits) was present at all drilling locations, generally comprising a dark grey / brown sandy gravel with brick, concrete, asphalt, flint and rare metal and plastic.
Taplow Gravel Formation (Sand and Gravel) WS02 and WS03	3.220 – 3.440	36.330 – 36.24	0.440 – 2.000	Dark reddish brown slightly clayey gravelly fine to coarse SAND. Gravel is angular to sub-angular fine to coarse of flint and chalk. Or Light grey to brown very sandy angular to sub-angular fine to medium GRAVEL of flint and occasional chalk. Sand is fine to coarse.
Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation	Base not proven	Base not proven	0.60 – 19.20 encountered max thickness not proven	Structureless chalk composed of cream white gravelly SILT. Gravel is low density, weak to medium strength, cream white with black specks, sub-rounded to angular. Flint gravels are fine to coarse, sub-angular to very angular. Or Structureless chalk composed cream white silty sub-rounded to angular GRAVEL. Gravel is low density, weak to medium strength, white with brown specks. Flint gravels are fine to coarse, sub-angular to very angular. Occasional cobbles of flint.

Evidence of dissolution features or infilled cavities was not observed during the ground investigation.

5.2 Groundwater Observations

The depth to resting groundwater level was recorded during Ramboll's gas monitoring/ groundwater sampling round on 16th December 2021 and also during the second gas monitoring round undertaken on 17th January 2022.

Table 5.2: Summary of Groundwater Observations

Borehole ID	Borehole Level (m AOD)	Depth to groundwater (m bgl)	Depth to Groundwater (m AOD)	Inferred Horizon Containing Groundwater ¹
BH01	39.50	3.30 – 3.36	+36.20 - +36.14	Chalk bedrock
BH02	38.84	2.70 – 2.76	+36.14 - +36.08	Chalk bedrock
WS02	39.64	3.00 – 3.34	+36.64 - +36.30	Chalk bedrock
WS03	39.50	DRY	DRY	n/a
WS05	39.23	3.05 – 3.11	+36.18 - +36.12	Chalk bedrock
WS08	39.14	2.94 – 3.00	+36.20 – +36.14	Chalk bedrock
Notes: 1 The inferred horizon has been identified by comparing the resting groundwater levels against the exploratory hole logs and monitoring well design. 2 data from 16 th December 2021 presented first in depth to groundwater columns				

Groundwater flow has been contoured (see figure 4 and 5, Appendix 1) and flows broadly to the north across the site, further indicating the site is not in continuity with the nearby river.

5.3 Field Evidence of Contamination

5.3.1 Drilling Observations

Visual and olfactory evidence of contamination was detected within the Made Ground and natural deposits during the site investigation as summarised in table 5.3 below. The general presence of demolition materials (asphalt, brick, concrete etc) were found within the Made Ground.

Soil headspace screening for volatile organic compounds was recorded using a photo-ionisation detector (PID) for selected soil samples. Elevated PID concentrations were recorded in WS02 with concentrations of 35.40 ppm at 3.50 m bgl, and 274.60 at 3.90 m bgl. In BH01, a PID concentration of 43.20 was recorded in a sample from 3.20 m bgl. The full list of PID results can be found within the borehole logs in Appendix 2.

Table 5.3: Summary of Contamination Observations

Borehole ID	Depth of observation (m bgl)	Stratum	Observation
BH01	4.00 – 6.50	Chalk	Brownish grey discolouring in chalk
	3.50 – 9.50	Chalk	Strong hydrocarbon odour (diesel), decreasing in strength with depth.

Table 5.3: Summary of Contamination Observations

Borehole ID	Depth of observation (m bgl)	Stratum	Observation
WS02	3.40 – 4.00	Chalk	Strong hydrocarbon odour (diesel) and grey discolouring in the chalk.
WS06	0.40 – 0.50	Made Ground	Black staining and 'sooty' odour.
WS08	0.40 – 0.70	Made Ground	Black staining and 'sooty' odour.

5.3.2 Groundwater Sampling Observations

During groundwater sampling on 16th December 2021, olfactory evidence of hydrocarbon contamination was noted in two locations; however, no free-phase hydrocarbons were detected using an oil-water interface meter. A strong hydrocarbon (diesel) odour was noted in WS02 and a hydrocarbon odour (diesel) was also noted in BH01. No visual evidence of contamination (such as a sheen on groundwater) was recorded.

5.4 Results of Laboratory Chemical Analysis

Laboratory certificates of chemical analysis are provided in Appendix 3.

5.4.1 Soils

A general description of the soil analytical data is provided below:

- Asbestos was detected in two of the twelve soil samples analysed; the samples where asbestos was identified were then scheduled for additional quantification analysis:
 - In WS05, amosite (loose fibres) was identified in a sample collected from 0.25 m bgl, the asbestos content was reported at <0.001% (laboratory detection limit - LDL); and
 - In WS08, chrysotile (hard / cement type material and loose fibres) was identified in a sample collected from 0.50 m bgl, the asbestos content was reported at 0.253 %.
- Heavy metals (except for chromium VI, and selenium) were identified above the LDL in the majority of soil samples.
- PAHs were identified above the LDL in six of the twelve soil samples obtained.
- Aliphatic petroleum hydrocarbons lighter than C10 were not identified in any of the samples. Aliphatic petroleum hydrocarbons heavier than the C10 were identified in four of twelve samples, with a maximum total aliphatic concentration (C5-C35) of 120 mg/kg in WS07.
- Aromatic petroleum hydrocarbons lighter than the C10 fraction were not identified in any of the samples. Aromatic hydrocarbon fractions heavier than C10 were detected in five out of twelve samples with a maximum total aromatic hydrocarbon concentration (C5-C35) of 560 mg/kg in WS08.
- The following determinands were not detected above the laboratory detection limit in any samples: VOCs, SVOCs, BTEX compounds, PCBs, cyanide, phenols.
- pH of the soils tested ranges from 8.5 – 9.0 (6 samples).
- Total Sulphate as SO₄ in soil samples range from 0.03 – 0.10 % which places the soil in ACEC Class AC-1.
- Organic Matter ranges from 0.1 – 3.4 %.
- Water soluble nitrate (2:1) as N all fell below the LDL of 2 mg/l.
- Carbonate as CaCo³ ranged from 48 to 96 %.

- Only two samples had detectable levels of magnesium ranging from 5.1 – 5.5 mg/kg of water soluble magnesium and 2.5 – 2.7 mg/l of leachate equivalent.

In general, the above analytical results do not indicate significant or widespread contamination within soils at the site. The analytical results are discussed in further detail within the risk assessment of the soil analytical results in Section 5.2.

5.4.2 Groundwater

A general description of the groundwater analytical data is provided below:

- Heavy metals (except for beryllium, chromium VI) were identified above the LDL in the majority of samples.
- Aliphatic petroleum hydrocarbons lighter than the C6 fraction were not identified in any of the samples. Aliphatic petroleum hydrocarbons heavier than the C6 fraction were identified in two of the five locations (BH01 and WS02), with a maximum total aliphatic concentration (C5-C35) of 670 µg/l in BH01.
- Aromatic petroleum hydrocarbons lighter than the C10 fraction were not identified in any of the samples. Aromatic petroleum hydrocarbons heavier than the C10 fraction were detected in two of the five sampling locations (BH01 and WS02), with a maximum total aromatic hydrocarbon concentration (C5-C35) of 220 µg/l in BH01.
- The following determinands were not detected above the laboratory detection limit in any samples: PAHs, VOCs, SVOCs, BTEX compounds, cyanide or phenols.
- 2 No. BRE aggressivity tests were completed on groundwater samples from BH01 and WS02, the Total Sulphate as SO₄ in these samples was 109 mg/l and 2.36 mg/l respectively. The pH of these samples was 7.2 and 7.7 respectively. These results place the location in ACEC Class AC-1.

The above analytical results do not indicate significant or widespread impact to the underlying groundwater and are not untypical for a site in an urban context. The Generic Quantitative Risk Assessment associated with these detected substances is presented in Section 5.3.

5.5 Summary of Gas Monitoring Results

Two rounds of gas monitoring were undertaken on 16th December 2021 and 17th January 2022. The two rounds were undertaken at times of high atmospheric pressure (~1033 mb). Gas flow rates were measured at all monitoring boreholes and Ramboll recorded the range in flow rates until a steady state was reached. The key findings from the monitoring are detailed below:

- Flow rates: flow rates were recorded below 0.1 litres/hr at all locations during both monitoring rounds.
- Methane: methane was not detected above the instrument detection level (<0.1 % v/v) at all locations during both monitoring rounds.
- Carbon dioxide: carbon dioxide was measured above the instrument detection level (<0.1 % v/v) at all locations except WS02 and WS05 during round 1, with a maximum concentration of 4.6 % v/v recorded in WS03. In round 2, carbon dioxide was measured above the instrument detection level (<0.1 % v/v) at all locations with a maximum concentration of 4.4 % v/v in WS03 and a minimum concentration of 0.1 % v/v in WS05.
- Oxygen: oxygen levels were recorded to be below 18 % v/v at a single location during round 1, with a concentration of 15.9% v/v recorded in WS03. In round 2, concentrations were recorded below 18% v/v in three locations, with concentrations of 16.1 % v/v in WS03, 16.6 % v/v in BH02 and 17.7% v/v in BH01.

- Carbon monoxide: carbon monoxide was not detected above the instrument detection level (<1 ppm) at all locations during both monitoring rounds.
- Hydrogen sulphide: hydrogen sulphide was not detected above the instrument detection level (<1 ppm) at all locations during both monitoring rounds.
- Volatile organic compounds – VOCs: during the ground gas monitoring a photo-ionisation detector (PID) was used to screen for the potential presence of VOCs within the monitoring wells. PID readings were recorded above the instrument detection limit (<0.1 ppm) at every location except for BH02 during round 1. Elevated concentrations of 192.4 ppm, 19.7 ppm and 10.4 ppm were detected in WS02, BH01 and WS08 in round 1. During round 2, concentrations of 8.6 ppm and 2.8 ppm were detected in WS02 and BH01 respectively, whereas VOCs were not recorded above the instrument detection limit (<0.1 ppm) in WS03 and WS05.
- Lower explosive limit - LEL: LEL readings were not recorded above the lower instrument detection limit (<0.1 %) at all locations during both monitoring rounds.

Further details regarding the significance of these measurements are presented in Section 5.4. The full set of ground gas data is presented in Appendix 5.

6. CONTAMINATED LAND RISK ASSESSMENT

6.1 Introduction

An initial assessment of the environmental risks are presented in this section based on the available information from this Site Investigation.

Given the presence of certain analytes above the LDL (as detailed in Section 4), a Generic Quantitative Risk Assessment (GQRA) was undertaken to determine whether potential significant risks might be posed to identified receptors by these substances.

The assessments followed key Environment Agency guidance (i.e. Land Contamination Risk Management (LCRM), 2020), where a GQRA is the main starting point for assessing contaminated land risks at a site.

A GQRA involves comparing analytical data with Generic Assessment Criteria (GAC) to establish if 'exceedances' of said criteria are present or not. GAC were derived using largely general, non-site-specific assumptions regarding the characteristics and behaviour of sources, pathways and receptors. These assumptions were conservative within a defined range of conditions and drew upon published criteria for soils and water. If a concentration exceeds a GAC value this does not necessarily mean that a significant risk is present, more detailed evaluation of the exposure situation could be completed, or the risk may be mitigated by the nature of the development.

The risk assessment is based on the proposed use of the site as apartment blocks whereby the site will be entirely covered in hardstanding apart from potential small areas of soft landscaping such as planters.

The various risk assessments undertaken are detailed in the following sections.

6.2 Summary of Potential Future Risks to Human Health

Human Health Receptor – Soils

The analytical soil results were compared to current Ramboll Generic Assessment Criteria (GAC) for commercial end-use to be protective of human health. The commercial GAC has been selected as the proposed development currently comprises commercial use at ground level, with plant rooms, reception and building amenity space and no residential apartments proposed at ground level. This also assumes that limited areas of soft landscaping will be present in external areas and that no plants will be grown for consumption purposes. The results of the screening are summarised in Table 6.1 below. The full screening results are presented in Appendix 4.

The following determinands were not detected above the method reporting limits and therefore are not included in the table below:

- Heavy Metals: chromium VI and selenium
- BTEX/MTBE (benzene, ethylbenzene, toluene, xylene-m, xylene-o, xylene-p and methyl tert-butyl ether)
- TPH Aliphatic: C5-6, C6-8, C8-10
- TPH Aromatic: C5-7, C7-8, C8-10
- VOCs / SVOCs
- PCBs
- Cyanide
- Phenols

Table 6.1: Summary of Soil Analytical Results

Determinand	Conc. Range (mg/kg)	Location of Max. Conc.	Ramboll GAC for Commercial End-use (mg/kg)	No. and Location of Exceedance
Heavy Metals				
Arsenic (C4SL)	1.6 - 38	WS03	640	0
Beryllium	<LDL - 4.6	WS03	12	0
Boron	<LDL - 4.9	WS04	240000	0
Cadmium (C4SL)	<LDL - 0.4	WS08	410	0
Chromium (III)	1.6 - 24	WS02	8600	0
Copper	3.5 - 300	WS03	68000	0
Lead - (C4SL)	2.8 - 840	WS03	2300	0
Mercury (inorganic)	<LDL - 2.9	WS03	1,100	0
Nickel	1.3 - 55	WS03	980	0
Vanadium	2.4 - 61	WS03	9000	0
Zinc	15 - 300	WS08	730000	0
Polycyclic Aromatic Hydrocarbons (PAH)				
Acenaphthene	<LDL - 1.8	WS08	75000	0
Acenaphthylene	<LDL - 9.3	WS08	76000	0
Anthracene	<LDL - 20	WS08	520000	0
Benzo(a)anthracene [3]	<LDL - 55	WS08	170	0
Benzo(a)pyrene [3] - C4SL	<LDL - 42	WS08	76	0
Benzo(b)fluoranthene [3]	<LDL - 47	WS08	45	0
Benzo(ghi)perylene [3]	<LDL - 25	WS08	3900	0
Benzo(k)fluoranthene [3]	<LDL - 22	WS08	1200	0

Table 6.1: Summary of Soil Analytical Results

Determinand	Conc. Range (mg/kg)	Location of Max. Conc.	Ramboll GAC for Commercial End-use (mg/kg)	No. and Location of Exceedance
Chrysene [3]	<LDL - 33	WS08	350	0
Dibenz(ah)anthracene [3]	<LDL - 6.8	WS08	3.5	0
Fluoranthene	<LDL - 100	WS08	23000	0
Fluorene	<LDL - 6.6	WS08	60000	0
Indeno(123-cd) pyrene [3]	<LDL - 24	WS08	510	0
Naphthalene (C4SL)	<LDL - 1.5	WS08	880	0
Phenanthrene	<LDL - 74	WS08	22000	0
Pyrene	<LDL - 84	WS08	54000	0
Total Petroleum Hydrocarbons (TPH)				
TPH Aliphatic C10-12	<LDL - 1.4	WS07	6100	0
TPH Aliphatic C12-16	<LDL - 7.3	WS08	43000	0
TPH Aliphatic C16-21	<LDL - 24	WS08	NC	N/A
TPH Aliphatic C21-35	<LDL - 89	WS07	NC	N/A
TPH Aromatic C10-12	<LDL - 8.6	WS08	11000	0
TPH Aromatic C12-16	<LDL - 35	WS08	35000	0
TPH Aromatic C16-21	<LDL - 220	WS08	29000	0
TPH Aromatic C21-35	<LDL - 300	WS08	29000	0
Asbestos				
Asbestos Screen	<LDL - 0.253 (% weight)	WS08	Detect	2 (WS05 @ 0.25 m, WS08 @ 0.50 m)

Table 6.1: Summary of Soil Analytical Results

Determinand	Conc. Range (mg/kg)	Location of Max. Conc.	Ramboll GAC for Commercial End-use (mg/kg)	No. and Location of Exceedance
Notes: NC – No criteria available LDL – Laboratory detection limit [3] Benzo(a)pyrene used as surrogate marker for certain PAHs				

Asbestos

Asbestos was detected in two of twelve soil samples analysed. The samples where asbestos was identified were scheduled for additional quantification analysis and the details are presented within Table 6.2 below.

Table 6.2: Asbestos Identified

Sample	Asbestos Type	Sample Matrix	Quantification (% weight of sample)
WS05: 0.25 m	Amosite	Loose Fibres	< 0.001 (Reporting Limit – RL)
WS08: 0.50 m	Chrysotile	Hard / Cement Type Material and Loose Fibres	0.253

The samples where asbestos was detected were collected from within the shallow Made Ground. It is anticipated that the majority of the shallow Made Ground will likely remain during the enabling works at the site other than shallow excavations for services or ground beams etc may remove some of the soil. For this reason, further consideration must be taken to protect workers during the construction phase of the development and manage the excavations and disposal of asbestos impacted soils (as encountered).

Hard-standing surfacing will cover the majority of the open areas on the proposed development, thus blocking any potential future exposure linkage to asbestos.

Inorganics

Inorganic substances were not detected above the GAC in any of the Made Ground or Natural Ground obtained during this site investigation. Several heavy metals were detected above laboratory detection limits, but none that exceeded the commercial GAC.

Organics

Polycyclic aromatic hydrocarbons (PAHs) were identified at concentrations above the LDL in six of the twelve soil samples obtained, but none that exceeded the Ramboll GACs.

Benzo(a)pyrene has been used as the surrogate marker for benzo(a)anthracene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenzo(ah)anthracene and indeno(123-cd)pyrene. As such current guidance infers that the concentrations of benzo(a)pyrene be used within the risk assessment to determine if a potential risk exists for the above-mentioned PAHs.

The maximum PAH concentrations were all recorded in a sample obtained from WS08 at 0.5 m bgl. In WS08, benzo(b)fluoranthene (47 mg/kg) and dibenzo(ah)anthracene (6.8 mg/kg) were detected at concentrations above their respective GACs of 45 mg/kg and 3.5 mg/kg respectively; however, benzo(a)pyrene was detected at a concentration of 42 mg/kg which is below the Ramboll GAC of 76 mg/kg.

Aliphatic and aromatic petroleum hydrocarbons lighter than C10 fraction were not identified in any samples, whilst aliphatic petroleum hydrocarbons heavier than the C10 were identified in four out of twelve samples, and aromatic hydrocarbon fractions heavier than C10 were detected in five out of twelve samples. The majority of maximum TPH concentrations were detected in the sample obtained from WS08, except for aliphatic C10-12 and aliphatic C21-35 where the maximum concentrations were detected in WS07. The elevated TPH concentrations in WS08 correspond with slightly elevated PAH concentrations discussed previously.

The slightly elevated concentrations are likely to originate from the localised black staining and 'sooty' odour observed at the depth where the sample was collected.

Human Health Receptor - Groundwater

The analytical groundwater testing results were compared to current GAC relating to the protection of human health via the volatilisation pathway.

No determinants within groundwater samples were detected at concentrations in excess of the respective volatilisation GAC.

A detailed summary of the results of the Generic Human Health QRA is provided in Appendix 4.

Construction Workers

This report and the generic assessment criteria (GAC) consider long term and chronic risk to humans based on defined exposure scenarios set out in the Contaminated Land Exposure Assessment (CLEA) model. In some cases contaminants may also pose acute hazards to workers at a site, or a worker's exposure scenario may differ from the scenarios considered when deriving the GAC. This is outside the scope of this assessment and will need to be considered separately.

6.3 Summary of Potential Risks to Controlled Waters

The analytical groundwater results were compared to the current GAC relevant to the protection of the underlying Lewes Nodular Chalk Formation (Seaford Chalk Formation) and Newhaven Chalk Formation (Principal Aquifer) and the nearby surface water receptors (River Kennet).

The results of the screening are summarised in Table 6.3 below, a detailed summary of the results of the Generic Controlled Waters QRA is provided in Appendix 4.

The following determinands were not detected above the LDL and therefore are not included in the table below:

- Heavy Metals: beryllium and chromium VI
- BTEX/MTBE (benzene, ethylbenzene, toluene, xylene-m, xylene-o, xylene-p and methyl tert-butyl ether)
- TPH Aliphatic: C5-6, C21-35
- TPH Aromatic: C5-7, C7-8, C8-10, C16-21, C21-35
- VOCs/SVOCs (including PAHs)
- Cyanide
- Phenols

Table 6.3: Summary of Groundwater Analytical Results

Determinand	Conc. Range (µg/l - unless stated otherwise)	Location of Max. Conc.	Ramboll Controlled Waters GAC – Groundwater (µg/l – unless stated otherwise)	Ramboll Controlled Waters GAC – Surface Waters (µg/l – unless stated otherwise)	No. and Location of Exceedance
Other Analysis					
Ammoniacal Nitrogen as N	<LDL – 0.062 (mg/l)	WS02	1.27 (mg/l) – (B)	0.75 (mg/l, moderate status))	0
Hardness - Total	26.6 – 494 (mg CaCO ₃ /l)	BH01	NC	NC	N/A
pH	7.2 – 7.9 (pH)	WS02	NC	NC	N/A
Sulphate as SO ₄	2360 – 109000	BH01	250000 – (A)	400000 – (C)	0
Heavy Metals					
Arsenic	0.53 – 7.47	WS08	7.5	50 – (C)	0
Boron	0.012 – 0.32 (mg/l)	BH01	1 (mg/l)	2000 – (C)	0
Cadmium	<LDL – 0.03	WS02	5	0.25	0
Calcium	9.6 – 180 (mg/l)	BH01	NC	NC	N/A
Chromium	0.7 – 8.7	WS05	50	4.7 – (C)	1 – WS05
Chromium III	<LDL – 8.7	WS05	50	4.7 – (C)	1 – WS05
Copper	4.4 – 7.1	WS08	2000	1 (bioavailable) – (C)	7 – BH01 (x2), BH02, WS02 (x2), WS05 and WS08
Lead	<LDL – 0.3	WS02/WS05	10	1.2 (bioavailable)	0
Magnesium	0.63 – 8.0 (mg/l)	BH01	NC	NC	N/A
Mercury	LDL – 0.06	BH01	1	NC	0

Table 6.3: Summary of Groundwater Analytical Results

Determinand	Conc. Range (µg/l - unless stated otherwise)	Location of Max. Conc.	Ramboll Controlled Waters GAC – Groundwater (µg/l – unless stated otherwise)	Ramboll Controlled Waters GAC – Surface Waters (µg/l – unless stated otherwise)	No. and Location of Exceedance
Nickel	1.9 – 8.2	BH02	20	4 (bioavailable)	4 – BH01 (x2), BH02 and WS02.
Selenium	<MRL – 3.4	WS05	10	NC	0
Vanadium	0.5 – 7.3	WS08	NC	60 - (C)	0
Zinc	7 – 340	WS02	23.1 – (B)	10.9 (bioavailable) - (C)	4 – BH02, WS02 (x2), and WS08
Total Petroleum Hydrocarbons (TPH)					
TPH Aliphatic C6-C8	<MRL – 130	BH01	10	10	2 – BH01 and WS02
TPH Aliphatic C8-C10	<MRL – 540	BH01	10	10	2 – BH01 and WS02
TPH Aliphatic C10-C12	<MRL - 45	WS02	10	10	1 – WS02
TPH Aliphatic C12-C16	<MRL - 91	WS02	10	10	1 – WS02
TPH Aliphatic C16-C21	<MRL - 95	WS02	10	10	1 – WS02
TPH Aromatic C10-12	<MRL - 170	BH01	10	10	3 – BH01 (x2) and WS02
TPH Aromatic C12-16	<MRL - 50	BH01	10	10	3 – BH01 (x2) and WS02

Table 6.3: Summary of Groundwater Analytical Results

Determinand	Conc. Range (µg/l - unless stated otherwise)	Location of Max. Conc.	Ramboll Controlled Waters GAC – Groundwater (µg/l – unless stated otherwise)	Ramboll Controlled Waters GAC – Surface Waters (µg/l – unless stated otherwise)	No. and Location of Exceedance
Notes: <u>Controlled Waters GAC – Groundwater (GW)</u> Drinking Water Directive (Standards) - Directive 98/83/EC on the Quality of Water Intended for Human Consumption. In the absence of the above, the following criteria has been used: (A) - Drinking Water Directive (Indicator Parameters) - Directive 98/83/EC on the Quality of Water Intended for Human Consumption. (B) - WFD Threshold Values (TVs) for 'Good Status', GW Impacts of SW (Max TV) - Schedule 5, The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. <u>Controlled Waters GAC – Surface Waters (SW)</u> WFD 'Good' Standard, Inland Surface Water AA – (Annual Average) - 2013/39/EU: Priority Substances in the Field of Water Policy Directive / 2008/105/EC: Environmental Quality Standards in the Field of Water Policy Directive In the absence of the above, the following criteria has been used: (C) – EA Permitting Standards (England), Freshwater AA EQS - The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 Total Petroleum Hydrocarbons have been screened against The Water Supply (Water Quality) Regulations 1989 (Withdrawn). NC – No criteria N/A – Not applicable LDL – Laboratory detection limit					

Controlled Waters – Principal Aquifer

The following determinands were detected above the relevant GACs for the suitable protection of the underlying Principal Aquifer:

- Zinc was detected above the LDL in all locations across the site. In WS02, zinc was detected at concentrations of 31 µg/l and 340 µg/l (re-sample) exceeding the relevant GAC of 23.1 µg/l. The concentration of 340 µg/l recorded in the resample is considered isolated and not representative of the overall zinc concentrations at the site.
- Aliphatic hydrocarbons were detected above the LDL in two locations in the west of the site: BH01 and WS02. In WS02, exceedances of the GAC at 10 µg/l were recorded for the following: TPH Aliphatic C6-C8, C8-C10, C10-C12, C12-C16 and C16-C21. In BH01, exceedances were recorded for TPH Aliphatic C6-C8 and C8-C10. The two wells were resampled on 17th January 2022 and aliphatic hydrocarbons were not detected.
- Aromatic hydrocarbons were detected above the LDL in two locations in the west of the site BH01 and WS02. Exceedances of the GAC at 10 µg/l were recorded for TPH Aromatic C10-C12 and C12-C16 in both BH01 and WS02. The same exceedances were noted in the resample collected from BH01 on 17th January 2021, with concentrations of 170 µg/l (C10-C12) and 50 µg/l (C12-C16) compared to a GAC of 10 µg/l.

The elevated TPH concentrations correspond with observations recorded during the drilling of the boreholes; strong hydrocarbon (diesel) odours were noted during the drilling of BH01 and WS02 and during subsequent monitoring/sampling rounds.

No further determinands were detected at concentrations in excess of their respective GAC.

Controlled Waters – Surface Waters

The following determinands were detected above the relevant GACs for the protection of surface waters as a receptor:

- Chromium and chromium III were detected at a concentration of 8.7 µg/l in the groundwater sample from collected from WS05 compared to the GAC of 4.7 µg/l. No further exceedances of the GAC were noted and the concentrations detected were only very slightly above the GAC.
- Copper was detected above the LDL in all samples, and at concentrations exceeding the GAC of 1 µg/l. The maximum concentration of 7.1 µg/l was recorded in WS08, and is considered fairly typical for an urban area. The elevated copper concentrations detected were consistent across the site and it is likely these concentrations are associated with the poor background groundwater quality in the wider area.
- Nickel was detected above the LDL in all samples, with four samples exceeding the GAC of 4 µg/l. The maximum concentration of 8.2 µg/l was recorded in BH02, which is only marginally above the GAC. Similar to the copper concentrations discussed previously, it is likely these elevated nickel concentrations are associated with the poor background groundwater quality in the wider area.
- Zinc was detected above the LDL in all locations across the site with exceedances of the GAC at 10.9 µg/l recorded in four samples. The concentrations only marginally exceeded the screening criterion, except for in WS02 where a concentration of the 340 µg/l was detected. The concentration of 340 µg/l is considered isolated and not representative of the overall zinc concentrations at the site.
- Aliphatic and aromatic hydrocarbons were screened against the same GAC (10 µg/l) for both groundwater and surface water receptors, therefore the exceedances noted above are the same for surface waters and groundwater.

- No further determinants were detected at concentrations in excess of their respective GAC.

6.4 Summary of Potential Risks to Future Built Environment

A detailed summary of the results of the generic built environment risk assessment is provided in Appendix 5.

6.4.1 Gas Risk Assessment

In classifying the ground gases on site, reference has been made to CIRIA C655¹ and BS8485². The Gas Screening Value (GSV) / Site characteristic hazardous gas flow rate (litres of gas/hour) is the product of the maximum gas concentration (% v/v) and the maximum measured borehole (steady state) gas flow rate (l/hr). A GSV was calculated on a location-by-location basis, utilising the maximum gas concentration (methane or carbon dioxide) and maximum steady state gas flow rate taken from all of the monitoring rounds.

No flow was recorded at all locations during the monitoring rounds and a maximum gas concentration of 4.6 % v/v carbon dioxide was detected at WS03 during round 2. The results from the gas monitoring programme characterise the site as Characteristic Situation 1 (CS1) and therefore no special protection measures would be required if this was consistently achieved over further rounds.

Oxygen levels were recorded to be below 18% v/v on four occasions during the monitoring rounds. The depleted oxygen in the shallow ground needs to be considered during the development phase due to the risks to construction workers if confined spaces such as excavations are created. Workers should be notified of the risks from ground gases and depleted oxygen levels, with mitigation measures put in place.

CIRIA C665 indicates that where carbon dioxide typically is greater than 5 % v/v and /or methane is typically greater than 1 % v/v, consideration should be given classifying the site as a minimum of CS2, where gas protection measures would be required. The maximum concentration of carbon dioxide recorded to date is 4.6 % v/v. CS2 would require basic gas protection measures including a well-constructed floor slab and a ground gas resistant membrane.

The two monitoring rounds to date have been undertaken during high atmospheric pressure. Further monitoring under falling or low atmospheric pressure (<1000 mb – worst case scenario conditions) is recommended.

6.4.2 Water Supply Pipework

Buried water supply pipes can be at risk from permeation and accelerated deterioration from certain contaminants. The results of this investigation should be used by the appropriate party during future construction activities to determine the material selection requirements for future water supplies i.e. the architect.

6.5 Post Investigation Conceptual Site Model

The site is currently occupied by a single storey warehouse building with a service yard and car parking areas. The site is proposed for redevelopment comprising a build to rent high rise apartment scheme, with commercial at ground level and undercroft parking.

¹ CIRIA Report C665

² Code of practice for the characterization and remediation from ground gas in affected development – BS8485:2007.

The post investigation CSM with potential pollutant linkages is presented in Table 6.4 below and has been formulated based on data obtained by Ramboll and the nature of the proposed development.

Table 6.4: Revised Conceptual Site Model

Source	Pathway	Receptors	Confirmed Risk (?)	Pollutant Linkage No.
Asbestos in shallow Made Ground	Inhalation of dust and asbestos fibres	Human health – future site users	Future Residential Users Low –The proposed development will comprise a large building footprint, with areas of hard standing and minimal 'clean' newly installed soft landscaping areas, thus severing or removing any potential future exposure linkage	PL1
Chromium / Chromium III detected at a concentration of 8.7 µg/l in WS05 compared to the relevant GAC of 4.7 µg/l.	Vertical migration of contaminated groundwater in aquifer	Groundwater – Principal Aquifer	Low – concentration does not exceed the DWS but is marginally above the EQS. The concentration is isolated with no other exceedances noted at the site. Groundwater does not flow towards the River Kennet directly.	PL2
	Lateral migration of contaminated groundwater to off-site watercourses	Surface Water – River Kennet approximately 100 m north west		
Ground gases	Inhalation of hazardous ground gas	Human health - future site users and the built environment	Future Residential Users / Built Environment Low to moderate - further monitoring required to verify whether basic protection measures are necessary. The proposed development will comprise a large building footprint and areas of hard standing with minimal soft landscaping areas.	PL3
Low concentrations of heavy metals in groundwater across the site (copper, nickel and zinc).	Vertical migration of contaminated groundwater	Groundwater – Principal Aquifer	Low – the concentrations marginally exceed the relevant GACs, except for zinc where a concentration of 340 µg/ was detected compared to the EQS of 10.9 µg/l on one	PL4

Table 6.4: Revised Conceptual Site Model

	to deep aquifer		occasion. This is isolated and not considered significant.	
	Lateral migration of contaminated groundwater to off-site watercourses	Surface Water – River Kennet approximately 100 m north west	On a site wide basis the concentrations of heavy metals are low and are likely a reflection of the poor-quality groundwater in the wider urban area.	PL4
Total petroleum hydrocarbons (TPH) identified in groundwater at concentrations above the GAC (10 µg/l) in two locations in the west of the site, BH01 and WS02.	Vertical migration of contaminated groundwater to deep aquifer	Groundwater – Principal Aquifer.	Moderate – the maximum total aliphatic and aromatic hydrocarbon concentrations were recorded at 670 µg/l and 160 µg/l both in the sample collected from BH01 which are above the GAC at 10 µg/l.	PL5
	Lateral migration of contaminated groundwater to off-site watercourses	Surface Water – River Kennet approximately 100 m north west	BH01 and WS02 were resampled, and aliphatic hydrocarbons were not detected in either sample, with aromatic hydrocarbons only being detected in BH01 albeit at a slightly highly concentration of 220 µg/l. Groundwater flow is not directly towards the River Kennet. In the second monitoring round TPH was not detected in WS02 (northern boundary) or other downgradient boreholes, whereas TPH was detected in BH01 (south of WS02). This demonstrates that the migration of the contamination is limited and it is localised. The extent of the hydrocarbon contamination on site is not fully defined, albeit is generally at low concentrations. Further delineation investigation and risk assessment is recommended. Future piling activities associated with the proposed development have the potential to	PL5

Table 6.4: Revised Conceptual Site Model

			create a pathway for the migration of contaminants deeper into the aquifer. A Foundation Works Risk Assessment is recommended.	
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PL1 – Asbestos was identified in two of twelve samples collected from the Made Ground: WS05 at 0.25 m bgl and WS08 at 0.50 m bgl. No other detections of asbestos were noted within the Made Ground. The asbestos content within the sample collected from WS08 was recorded at 0.253 % and was present in the form of hard cement type material. Further sampling of the Made Ground may be required to prove/disprove that this detection as an isolated exceedance. Further consideration must be taken to protect workers during the construction phase of the development.

PL2 - An elevated concentration of chromium / chromium III was identified in one of the five groundwater monitoring wells that was sampled, in WS05 in the east of the site. The concentration is isolated and only very marginally above the stringent EQS screening criterion.

PL3 – The ground gas assessment has not identified significant levels of hazardous gases at the site and the site has been classified as Gas Characteristic Situation 1 (i.e., no special gas protection measures required); however, moderate carbon dioxide concentrations of 4.6 and 4.4 % v/v were recorded in WS03 during rounds 1 and 2 respectively. Slightly elevated concentrations of carbon dioxide, together with depleted oxygen levels pose a risk to workers when activities are undertaken in confined spaces, for example excavations for utility routes. CIRIA C665 indicates that where carbon dioxide typically is greater than 5 % v/v consideration should be given classifying the site as a minimum of CS2, where gas protection measures would be required. To date, monitoring has been undertaken during periods of high pressure, it is recommended that further monitoring under falling or low atmospheric pressure (<1000 mb – worst case scenario conditions) is undertaken which will assist in further characterising the ground gas regime at the site.

PL4 – Concentrations of heavy metals (copper, nickel and zinc) were identified in groundwater across the site. Copper and nickel were at concentrations marginally exceeding the stringent screening criteria of the EQS but not DWS, whereas zinc concentrations measured in two samples collected from WS02 exceeded both EQS and DWS.

PL5 – Aliphatic and aromatic hydrocarbons were detected in groundwater samples collected from BH01 and WS02 in the west of the site. Further delineation investigation and controlled waters DQRA is likely to be necessary to confirm whether remediation is required or not.

7. DEVELOPMENT CONSIDERATIONS

7.1 Mitigation and Remediation

Notable ground contamination within the Made Ground was limited to the asbestos detections in two locations. Mitigation against the concentrations of asbestos within soils can be managed through the construction and design of the proposed development where it is managed in accordance with the requirements of this section.

Petroleum hydrocarbons were detected within groundwater at BH01 and WS02 in the west of the site, with the highest concentrations recorded in BH01. The contamination is relatively modest in concentration and it may be possible to demonstrate through delineation, additional risk assessment and a foundation works risk assessment that remediation is not required. Further sampling should take place to delineate the impact including beneath the building and to close any relevant data-gaps or further monitoring requirements identified in this report.

A Remediation Strategy should be completed specific to the proposed development and include remedial measures to mitigate the risks identified above.

7.2 As-Yet-Unidentified Contamination

Based on the available information the site does not appear to be significantly contaminated; however, it has not been possible to sample beneath the building and given that asbestos and hydrocarbon impact have been identified outside of the current building footprint there is a potential for similar areas of impact to be present beneath the building. Further investigation should take place beneath the building footprint in future.

As with any site investigation given the constraints and nature of the borehole sampling from small diameter positions it cannot be discounted that further hot spots of contamination may be present between sampling points, beneath the building's footprint or that 'unexpected finds' may be encountered during earthworks, which could require management during redevelopment (this is the case for any brownfield land). A watching brief should be followed during the earthworks on-site by an appropriately experienced environmental consultant to identify and provide advice on the management of such finds.

7.3 Re-use Of Materials on Site

Where the re-use of soils at the site takes place, such as during a cut and fill exercise (if applicable), this would need to be documented within a Materials Management Plan (or other suitable regulatory mechanism allowing waste soil re-use as may apply at the time of the construction work), following the CL:AIRE guidance "Definition of Waste: Development Industry Code of Practice". There is a four-point test for the re-use of material:

- **Protection of human health and the environment** - suitable risk assessments must be in place to demonstrate that the re-use of materials is acceptable.
- **Suitability of use without further treatment** - should the contaminated soils need treating then they may still be re-used (under an appropriate authorisation).
- **Certainty of use** - there should be a justifiable reason for re-use rather than just avoiding waste disposal.
- **Quantity of Materials** - only the quantities required for the specific use should be used.

Assuming that these four points can be satisfied by providing suitable risk assessments and within the design of the development, it should be possible to re-use materials on site (if required).

7.4 Acute Human Health Risks during Development Activities

This report and risk assessment is not an appraisal of risks to ground development workers, and the site should be treated as a brownfield site. Future development workers should be provided with the results of this assessment.

Construction workers should be prepared to use appropriate personal protective equipment during construction work, to prevent contact with contaminated soils and potentially hazardous gases, vapours and dust that might be present. Dust suppression measures should be employed at the site if contaminated materials are exposed during construction, to prevent off-site migration of contaminants via this pathway. Also note that asbestos fibres are present in soils and are discussed separately further below.

7.5 Waste Disposal

Waste Classification of on-site soils has not been completed as part of this assessment. Ramboll recommend that the soil chemical data obtained within this report be used in addition to further soil samples obtained in the future to assess the suitability of soils for re-use and or waste disposal. There is the potential that some soil removal and disposal will be required as part of the proposed development works and in creating new service runs. The review of current data and future sampling and analysis should be undertaken to determine the appropriate waste disposal route. An asbestos fragment was recorded at a concentration above the hazardous waste threshold and therefore some soil may need to be disposed as hazardous waste. As with any brownfield site the management and segregation of waste soils will lead to lower disposal costs (if required).

7.6 Asbestos in Soils Management

Asbestos was detected in two out of twelve Made Ground soil samples, from two locations (WS05 and WS08). Asbestos in the form of cement type material was identified in the sample obtained from WS08 at 0.5 m bgl. The asbestos content was reported as 0.253%, above the laboratory detection limit (LDL) of <0.001%.

Based on this initial data in Ramboll's professional opinion the works in this area would be classed as non-licensed under the Control of Asbestos regulations 2012 and associated CAR-Soil guidance (July 2016). This would require the client to undertake the work using trained and competent workers in accordance with a Plan of Work and using appropriate control measures to prevent exposure and the spread of asbestos.

Additional soil sampling in the Made Ground could be beneficial to establish if the asbestos fragment is isolated or not. If no further asbestos containing material is found and the asbestos fibres in soil concentrations are <0.001% in concentration, it is likely that the work would not be classed as non-licensed work (but precautions would still be required even if trace fibres are present – see below).

If the work is non-licensed or outside of CAR there will still be a need to implement asbestos management measures given the presence of fibres in the soil and nearby third-party property. This will need to comprise basic controls and mitigations such as:

- daily independent air monitoring conducted around the site during disturbance and removal of the soil to provide quantitative data with respect to fibre suppression mitigation measures;
- dust suppression using water/ mist spray will be required where there is a potential for dusty soil to be generated during the excavation and loading process (rainfall or wet ground may naturally control this risk); and
- appropriate PPE should be used at all times including:
 - semi-disposable respirators – EN405 with P3 filter;

- washable safety boots or a dedicated pair of safety boots; and
- personal decontamination facilities.

Should unexpected Asbestos Containing Materials (ACM) be encountered, such as friable material, insulation board or asbestos lagging, the impacted area should be fenced off, appropriate signage installed, and an assessment of the material made by a competent and trained person (potentially by Ramboll) who will advise on the next steps.

8. CONCLUSIONS AND RECOMMENDATIONS

Ramboll's desk study identified a potential for contamination on-site given the historic use as a militia ground and clothing factory with a tank identified in the north-east, a preliminary conceptual site model (CSM) was developed and a site investigation was designed based on the CSM to provide an initial characterisation of the ground conditions. This occurred in 2021 and there is a need to close-out data gaps identified in this report and undertake further monitoring.

Below the hardstanding, the site is underlain by Made Ground of approximately 0.9 m thickness, followed by depths of superficial Taplow Gravels (found in WS02 and WS03 only) that does not extend across the site and ranges from 0.4 to 2.0 m thick. The Made Ground / Taplow Gravel is underlain by structureless chalk of the Seaford Chalk Formation, the base of which was not proven. The chalk was recovered as gravelly silt to silty gravel with gravel of chalk and flint. Flint is fine to coarse with occasional cobbles.

8.1 Contaminated Land

Asbestos was detected in two Made Ground soil samples from the east of the site, with one sample at a concentration of 0.253 % measured above the hazardous waste threshold.

Petroleum hydrocarbons were detected in groundwater in BH01 and WS02 in the west of the site, exceeding the GAC for groundwater and surface waters. Further delineation and risk assessment should be undertaken relating to the impact and it cannot be discounted that soil and groundwater remediation may locally be required prior to piling through this area. Concentrations of heavy metals (copper, nickel and zinc) were detected in groundwater across the site, which are reflective of the general urban nature of the site.

Ground gas monitoring has been undertaken and has classified the site as Characteristic Situation 1 (no special gas protection measures required). Further monitoring will be required to confirm this classification.

Overall, the contamination is expected to be manageable in the context of the proposed development.

8.2 Next Steps

In general terms, based on the available information, the site is very typical of urban city centre land. Ramboll consider the site will be suitable for a proposed Built to Rent use with a commercial ground floor subject to the following actions that align with the staged approach to ground contamination assessment set out in the Environment Agency's Land Contamination Risk Management guidelines:

- Further delineation of the petroleum hydrocarbon and asbestos contamination should be undertaken ideally once the existing building has been demolished. Further risk assessment will then be required to define the remedial requirements.
- Prior to development a remediation strategy should be prepared, considering the ground conditions and setting out the proposed mitigation for the identified risks, including, but not limited to, capping, landscaping, gas protection (if required), targeted soil and groundwater remediation (subject to the findings of the additional investigation and RA) and appropriate material selection and installation (water pipes, gas protection etc.).
- A Foundation Works Risk Assessment should be undertaken.
- A waste assessment has not been undertaken as part of this scope; Ramboll can provide a Preliminary Waste Assessment, however the contractor will need to assess waste prior to loads being removed from site.

- The findings of the preliminary ground-gas risk assessment found the site to be classified as CS1 (i.e., no gas protection measures required); however, the monitoring has been undertaken during periods of high atmospheric pressure. Further gas monitoring under falling or low atmospheric pressure (<1000 mb, i.e., worst case scenario conditions), or a period of continuous monitoring should be undertaken. Further monitoring and a more detailed risk assessment may assist to confirm that gas protection measures are not required.
- Where topsoil may be required for proposed soft landscaped areas, it is recommended that the soil is imported and verified as being free from asbestos and other contaminants.
- It is recommended that a watching brief is implemented during ground works to identify any unforeseen ground conditions or localised contamination hotspots (e.g., concentrated pockets of contamination, asbestos or hydrocarbons). If previously unforeseen contamination is identified, the risk assessment should be updated accordingly.
- Consideration of the presence of asbestos will be required when planning the development earthworks and ensuring a Plan of Work and controls are in place. The work is expected to be non-licensed based on the findings to date, trial pitting under controlled conditions into this area would be beneficial to confirm the licensing requirements.
- Prior to demolition or major refurbishment works of the existing buildings a pre-demolition asbestos survey should be completed (in accordance with HSG 264, 2012), and asbestos materials removed for disposal at a suitable licensed facility prior to demolition taking place.

APPENDIX 1 FIGURES

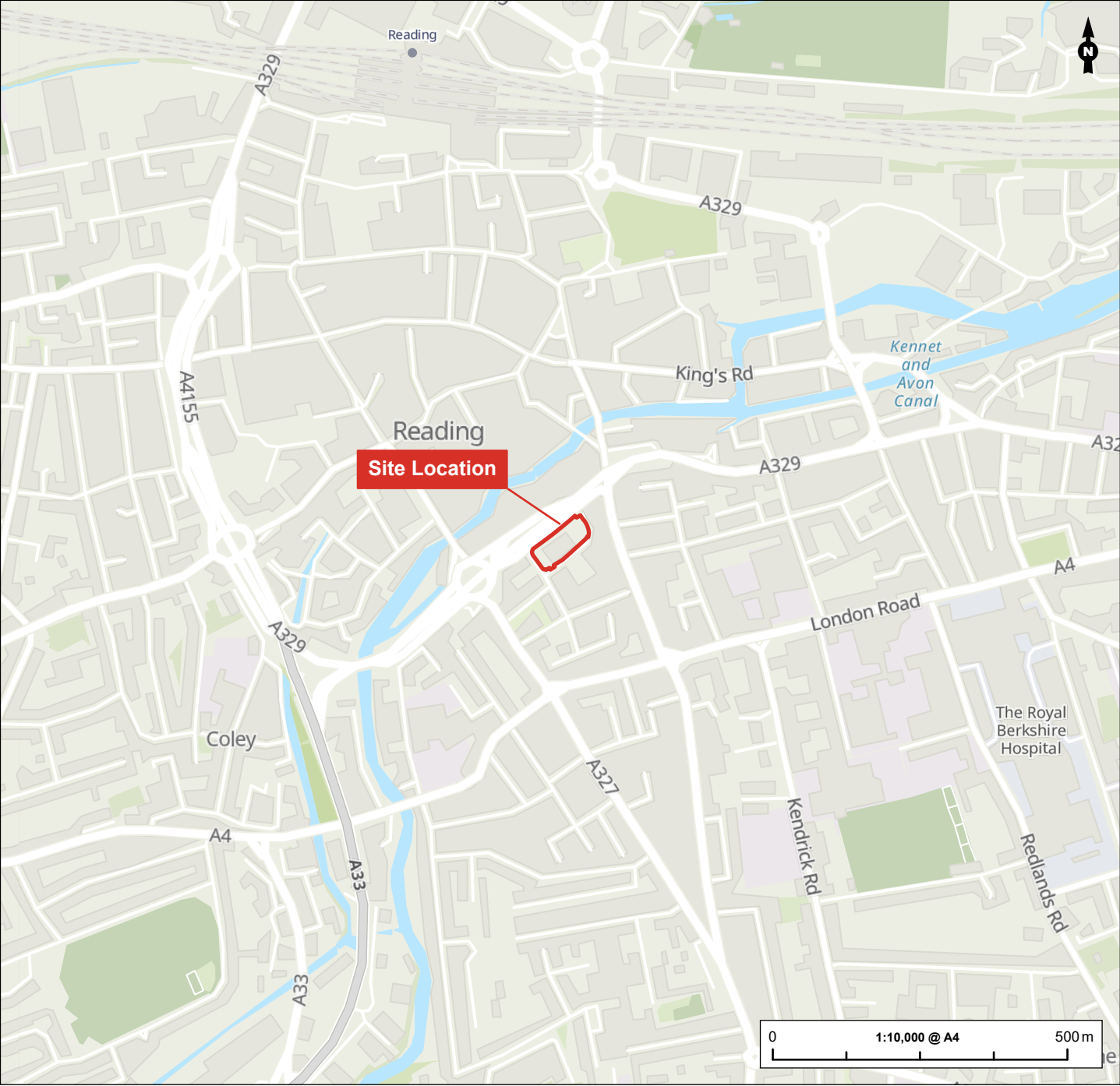
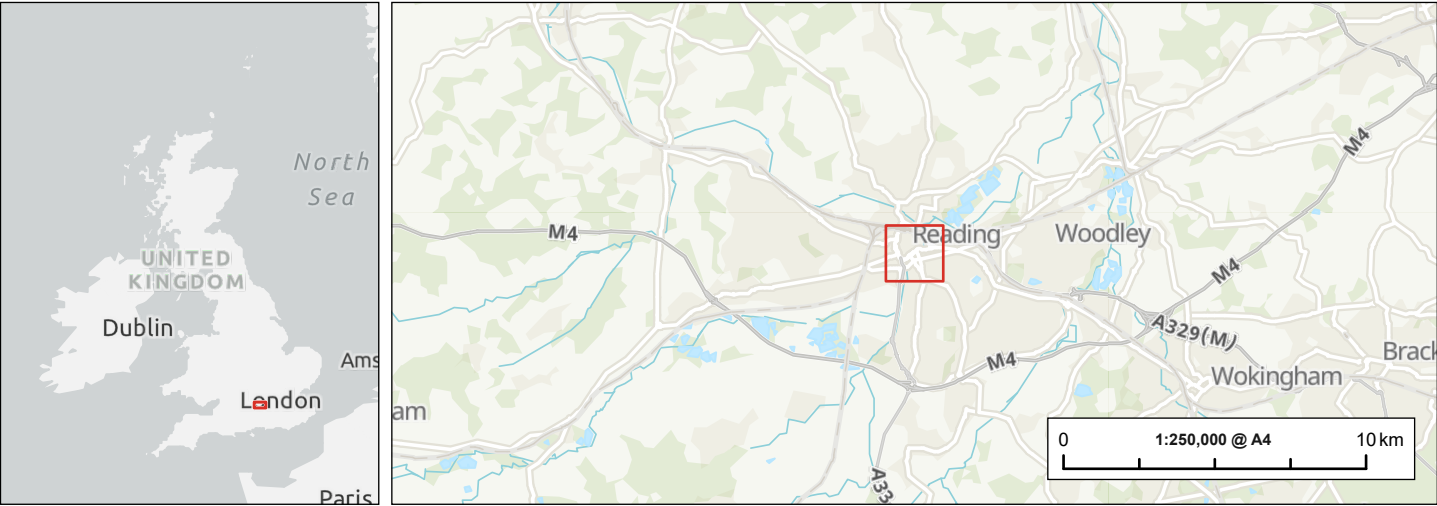


	Figure Title Site Location	Project Name Former John Lewis Depot, Letcombe Street, Reading (also known as JLP Mill Lane)	Date May 2024	
	Client John Lewis Plc	Project No./Filery ID 1620017037 / REH2024N02370	Prepared By CT	Figure No. 1
			Scale As Shown	Revision 1.0



Legend

Site Boundary

Figure Title
Site Layout

Project Name
Former John Lewis Depot,
Letcombe Street, Reading (also
known as JLP Mill Lane)

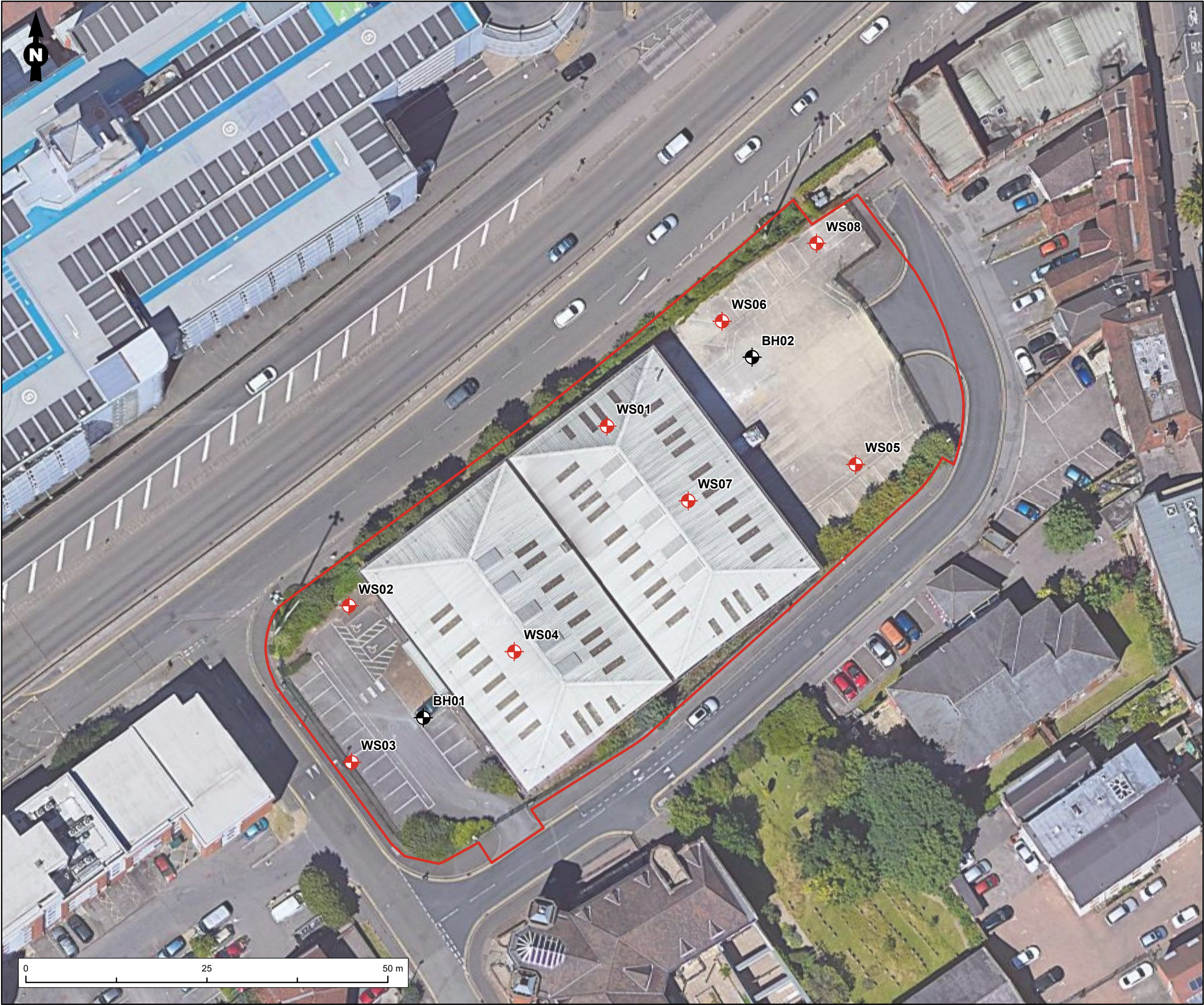
Project No./Filey ID
1620017037 / REH2024N02370

Date	Figure No.	Revision
May 2024	2	1.0

Prepared By	Scale
CT	1:1,000 @A4

Client
John Lewis Plc





Legend

Site Boundary

Borehole

Window Sample

Figure Title

Borehole Plan

Project Name

Former John Lewis Depot, Letcombe Street, Reading (also known as JLP Mill Lane)

Project No./Filery ID

1620017037 / REH2024N02370

Date

May 2024

Figure No.

3

Revision

1.0

Prepared By

CT

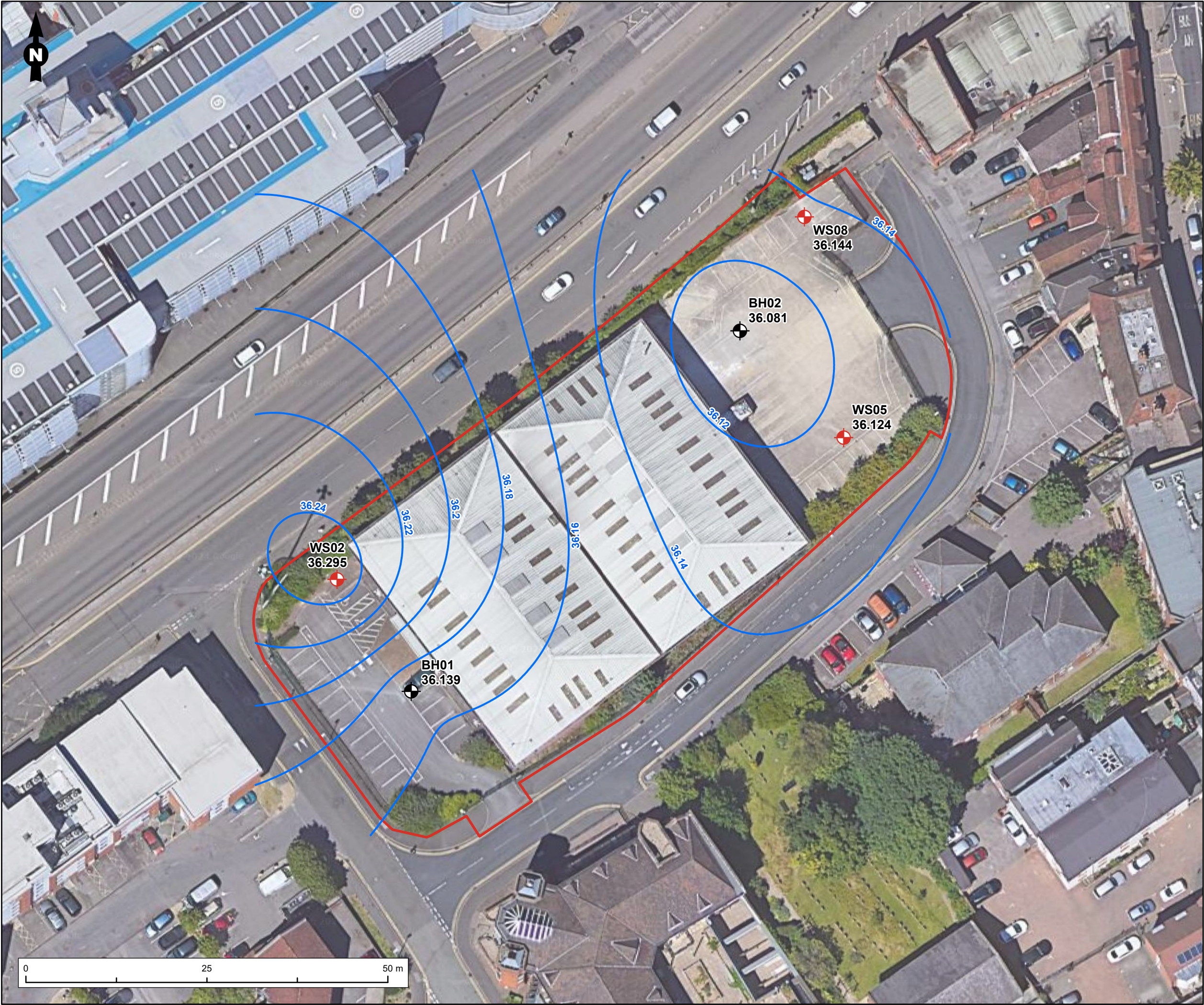
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Client

John Lewis Plc

RAMBOLL



Legend

Site Boundary

Borehole

Window Sample

Groundwater Level (m AOD)

Figure Title
Interpolated Groundwater Levels
December 2021

Project Name
Former John Lewis Depot, Letcombe
Street, Reading (also known as JLP
Mill Lane)

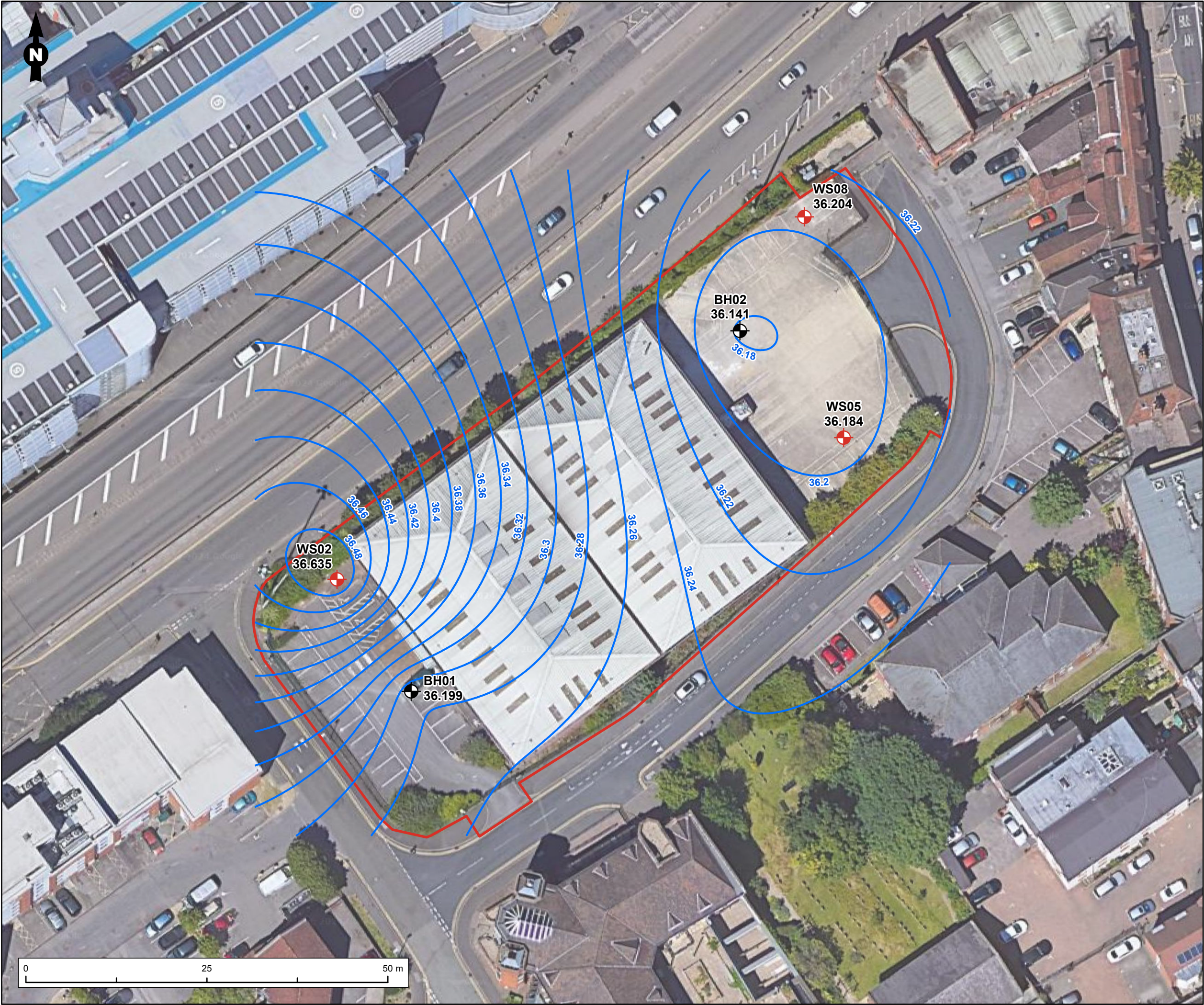
Project No./Filey ID
1620017037 / REH2024N02370

Date	Figure No.	Revision
May 2024	4	1.0

Prepared By	Scale
CT	1:500 @A3

Client
John Lewis Plc





Legend

- Site Boundary
- Borehole
- Window Sample
- Groundwater Level (m AOD)

Figure Title
Interpolated Groundwater Levels
January 2022

Project Name
Former John Lewis Depot, Letcombe
Street, Reading (also known as JLP
Mill Lane)

Project No./Filery ID
1620017037 / REH2024N02370

Date May 2024	Figure No. 5	Revision 1.0
Prepared By CT	Scale 1:500 @A3	

Client
John Lewis Plc

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