BROWNFIELD SOLUTIONS LTD

GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

SHURGARD UK LTD

Oldfield Road, Hampton

Phase I & II Geo-Environmental Assessment Report

CO/M5478/12423

September 2023

EXECUTIVE SUMMARY	
Location and Brief Site Description	The site is located off Oldfield Road, Hampton, TW 12 2HS. It is situated approximately 5 Km west of Kingston upon Thames town centre, centred on National Grid Reference 513148, 169753 as shown on the Site Location Plan, Drawing No. M5478/01. At the time of the intrusive investigation the site comprised an existing office building and storage facility with associated hardstanding car park in the south and west of the site. The site is active and occupied.
Ground Conditions	Generalised ground conditions from the ground investigation comprise (top down): • Made ground encountered from ground level to between 0.70m and 1.30m bgl. • Natural strata encountered from 0.70mbgl to between 3.00m and 4.40m bgl. • Solid geology encountered from 3.00m bgl to 25.00m bgl. • Groundwater recorded between 0.88m and 12.00m bgl.
Human Health - Soils Contamination	Testing of the made ground at the site did not reveal any exceedances of heavy metals, PAHs, petroleum hydrocarbons, BTEX or MTBE compounds. Chrysotile and Amosite fibres (loose fibres) have been detected in four samples of made ground across the site. On quantification analysis the asbestos level within the four samples was between <0.001% and 0.007% mass and classified as being trace levels..
Controlled Waters – Surface and Groundwater Contamination	The risk to Controlled Waters are considered to be generally low, and no further action is required.
Ground Gas	Ground gas monitoring has revealed a maximum peak carbon dioxide concentration of 9.80%v/v and methane concentrations of 0.1%v/v. The gas monitoring is completed, and ground gas protection measures are not required based on the following rationale: • Based on the GSVs alone, the site falls into CS1 classification. • The "worst case" data has been plotted on a ternary diagram, which indicates the carbon dioxide concentrations are likely due to microbial respiration, where there is no requirement to increase the characteristic situation simply because the carbon dioxide concentration exceeds 5%. • Representative flows are below the limit of detection in all locations on all visits. • The majority of the installations were placed within naturally occurring gravelly sand. • No credible off-site gas source has been identified within the desk study assessment.
Outline Remedial Strategy	The above are considered to pose a risk to human health and remedial measures may be required in the form of a cover system in soft landscaping areas to mitigate the risk. Further intrusive works are recommended in the area of the existing building footprint to confirm the ground conditions and further assess the risks to human health.
Waste	Waste classification for the made ground and superficial strata at the site has revealed the soils to be non-hazardous.
Foundations and Floor Slabs	Piled foundations are considered a suitable option for the site. Preliminary pile calculations indicate that, an allowable load of 350kN may be achieved for a 450mm diameter circular concrete pile at a depth of 15m bgl, increasing to 480kN for a 18m pile. Further intrusive investigation is recommended to confirm ground conditions and obtain data for detailed piled design. Suspended floor slabs are recommended. However, ground bearing floor slabs may be adopted, providing the criteria are met.
Concrete Classification	DS-1 and DS2, and ACEC Class AC- 11s and AC-2 conditions generally prevail within the made ground and superficial deposits. Total potential sulphate values within the London Clay Formation indicate that pyrite may be present within the strata. However, further data would need to be obtained in order to determine the concrete classification for this material.
Highways Design	Based on Table 5.1 from DMRB IAN 73/06 Rev 1 equilibrium CBR values of 5% are likely to be achieved in undisturbed natural granular soils and 2.5-3% for natural clays soils for pavement design purposes, unless proven otherwise by in-situ testing at formation level by a specialist geotechnical engineer. Equilibrium CBR values are likely to be 2% within the made ground.
Sustainable Drainage Systems (SUDS)	Drainage to soakaways is considered potentially suitable for this site.
Further Work	The following further works will be required to progress to the construction phase: • Demolition Asbestos survey. • Further intrusive investigations – Post demolition, including Cable Percussive boreholes and Window sampling to confirm ground conditions within the existing building footprint. • Detailed foundation design by a structural engineer

EXECUTIVE SUMMARY	
	• Design of Remedial Strategy and confirmation with the Local Authority. • Implementation of the Remedial Strategy and verification of the remedial works

This executive summary should be read in conjunction with the full report, reference CO/M5478/12423 and not as a standalone document. Report template version 4.2.

PROJECT QUALITY CONTROL DATA SHEET

Site Name:	Oldfield Road, Hampton		
Document Name:	Phase I & II Geo-Environmental Assessment Report		
Reference:	CO/M5478/12423		
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	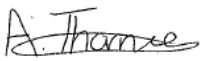	
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CONTENTS

CONTENTS

DRAWINGS

Drawing Number	Rev	Title
UK00-Hampton-UM Plan-SK04	-	Proposed Development Layout Plan
M5478/01	-	Site Location Plan
M5478/02	-	Site Features Plan
M5478/03	-	Exploratory Hole Location Plan

APPENDICIES

Appendix	Title
Appendix A	BSL Methodology and Guidance

APPENDICIES	
Appendix	**Title**
Appendix B	Historical Maps
Appendix C	Geo-Environmental Data Report
Appendix D	UXO Screening Map and Detailed UXO Desk Study
Appendix E	Exploratory Hole Logs
Appendix F	Chemical Testing Results
Appendix G	Geotechnical Testing Results
Appendix H	Monitoring Results
Appendix I	Waste Assessment Report

1.0 INTRODUCTION

1.1 Context

This report describes a Phase I and II Geo-Environmental Assessment carried out by Brownfield Solutions Limited (BSL) for Shurgard UK Ltd on a site off Oldfield Road, Hampton and has been completed in general accordance with the following guidance:

- Environment Agency guidance - Land Contamination: Risk Management (LCRM).
- BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites.
- BS5930: 2015+A1:2020 Code of Practice for Ground Investigations.
- BS EN 1997-1:2004+A1:2013 Eurocode 7. Geotechnical design. General rules plus UK National Annex.
- BS EN 1997-2:2007 Eurocode 7 Geotechnical design. Ground investigation and testing plus UK National Annex.
- NHBC Standards. Chapter 4.1: Land Quality - Managing Ground Conditions.

Definitions of terms and acronyms used within this report is presented in Section 13.0.

1.2 Proposed Development

The proposed development is for commercial end use comprising a four storey self-storage facility, as well as a basement level, assumed to be steel framed as shown on the Basement to Third Floor Plans, drawing No. UK00-Hampton-UM Plan-SK04 provided to BSL by the client.

1.3 Objectives and Scope

The objectives of this report are to determine the geo-environmental setting and ground conditions of the site, highlighting potential risks and areas of concern that may govern the development under the current planning regime.

The Phase I section is intended to meet the requirements of a Preliminary Investigation as defined in BS10175:2011+A2:2017, whilst the factual and interpretive Phase II sections are produced in general accordance with the recommendations for a Tier 2 Generic Quantitative Risk Assessment as described in LCRM guidance. This assessment is also intended to fulfil the requirements of a Ground Investigation Report (GIR) as detailed in BS EN 1997-2:2007.

The scope of works comprises a Desk Study and site walk-over, with a review of the site, surroundings, historical uses and environmental setting in order to develop a preliminary Conceptual Site Model (CSM).

Following the Desk Study, an exploratory intrusive investigation was undertaken to confirm the findings of the preliminary CSM and risk assessment and meet any objectives that had not been satisfied. The exploratory investigation was undertaken using window sampling, cable percussive drilling, ground gas and groundwater monitoring, laboratory chemical and geotechnical testing, with reporting on the findings.

1.4 Limitations

This assessment has been prepared in accordance with the relevant current legislative framework, guidance and risk assessment methodology as outlined in Appendix A. BSL is not liable for any subsequent changes in the guidance and legislation.

The findings and opinions conveyed via this report are based on information obtained from a number of sources as detailed within this report, BSL have assumed this information is correct and reliable.

Nevertheless, BSL cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

BSL have used reasonable skill, care and diligence for the investigation of the site and the production of this report. There may be other conditions prevailing on the site which are outside the scope of work and have not been highlighted by this assessment and therefore have not been considered by this report. Responsibility cannot be accepted for such site conditions not revealed by the assessment.

This report has been prepared for the sole use and reliance of the Client, Shurgard UK Ltd. No other third parties may rely upon or reproduce the contents of this report without the written permission of Brownfield Solutions Ltd (BSL). If any unauthorised third party comes into possession of this report, they rely on it at their own risk and BSL do not owe them any Duty of Care.

The investigation carried out on the site has been conducted to provide the best information on the ground conditions within site access and budgetary constraints. The inherent variation of ground conditions allows only for definition of the actual conditions at the locations and depths of exploratory locations at the time of the investigation. Different ground conditions may exist that have not been identified within this investigation.

The recommendations in this report assume that ground levels will remain as existing, unless stated otherwise within the report. If there is to be any re-profiling (e.g. to create development platforms or flood defences) then the recommendations may not apply.

The groundwater results described are only representative of the dates on which they were recorded, and levels may vary seasonally (e.g. due to changes in weather).

This assessment has been based on the proposed planning layouts provided. Any subsequent change to the planning layout may have an impact on the validity of recommendations made within this report. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

Although every effort has been made to position exploratory holes in the least sensitive areas of the site, exploratory hole positions were located approximately as part of this investigation and no guarantee can be given as to their accuracy. Consideration should be given to the possibility that exploratory holes excavated as part of this investigation and indeed any previous ground investigation work by others may be encountered beneath or within the influence of individual foundations. BSL cannot be held responsible for structural failures caused by the location of foundations of any form of structure within the influence of exploratory holes.

Where it has not been possible to reasonably use an EC7 compliant investigation technique, a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon engineering experience, local precedent where applicable and relevant published information.

The chemical testing carried out for this report was not scoped to comply with the requirements of the water supply company and further work may be required, unless otherwise stated.

Notwithstanding site observations concerning the presence or otherwise of archaeological issues, asbestos-containing materials (ACM) or invasive weeds (e.g. Japanese knotweed), this report does not constitute a formal survey of these potential issues.

Asbestos in structures was not covered in this report. It should be noted that an asbestos demolition survey will be required prior to any demolition of structures. If asbestos is present in soils, these will need to be dealt with in accordance with the Control of Asbestos Regulations (CAR) 2012.

The site plans enclosed in this report should not be scaled off. Any site boundary line depicted on plans does not imply legal ownership of land.

Any recommendations made in this report should be confirmed with the Regulatory Authorities prior to implementation to ensure compliance.

2.0 THE SITE

2.1 Location

The site is located off Oldfield Road, Hampton, TW12 2HS. It is situated approximately 5 Km west of Kingston upon Thames town centre, centred on National Grid Reference 513148, 169753 as shown on the Site Location Plan, Drawing No. M5478/01.

2.2 Site Description

The main site features and potential issues identified are detailed below and are shown on the Site Features Plan, Drawing No. M5478 /02.

Feature	Description
Site Area	0.31 hectares.
Site Access	Access to the site is gained off Oldfield Road to the south.
Current Land Use and Site Features	The site comprises an existing office building and retail storage facility with associated hardstanding car park in the south and west of the site. Numerous manhole covers were noted in the site, denoting possible drainage/sewers. A railway line was noted abutting the northern boundary of the site. A number of skips are present on-site, filled with general waste and cardboard/plastic. Electrical meter boxes are present along Oldfield Road in the south-west of the site. A wooden patio in poor condition is present to the south of the yard area, in the centre of the site.
Potential Sources of Gross Contamination	No potential sources of gross contamination were noted on site. Some apparent coal-type material was encountered along the northern boundary of the site, possibly from charcoal fires. Several containers of various cleaning materials were noted on pallets in the east of the site, adjacent to the entrance of the warehouse.
Vegetation	There are sporadic mature/semi-mature trees across the site.
Topography	The site is generally flat.
Site Boundaries	Low brick walls with wrought iron fencing atop encloses the site to the south and west. The north of the site is bound by chain-link fencing, while the east is bounded by wood fencing and steel palisade fencing. Palisade fencing also encloses the yard area on-site, in the centre east of the site.
Surrounding Area	The site is set within a mixed commercial and residential area, bordered by a railway line to the north, a supermarket to the east and residential properties to the south, west and further east of the site.

3.0 GEO-ENVIRONMENTAL SETTING

3.1 Historical Setting

A review of the available historical Ordnance Survey Maps and satellite imagery has been conducted, with the pertinent issues that may have affected the site, or its environs, summarised below. The Historical Maps are presented in Appendix B. A review of the historical industrial data within the geo-environmental data report has also been undertaken below, the report is presented in Appendix C.

Notable features within 110m of the site boundary have been presented. Any features that have potentially been infilled will be considered up to 250m from the site boundary.

Feature	Distance	Years Present	Description
Coal Yard	Onsite	1934 - 1973	A coal yard was noted centred on site associated with the railway lines, constructed between the mapping of 1938 and 1956-1957. It was redeveloped between 1957 and 1971 when the railway connection in the north was removed. It was last noted on the 1973-1977 map of the site, when redevelopment into the current development took place.
	40m NW	1956 - 1957	A coal yard was present, labelled from the 1956 map of the area and was last noted in 1957-1962 map, redeveloped into housing by 1971.
Railway Sidings	Onsite	1912 - 1971	This was first noted north of the site on the earliest large-scale mapping from 1865. Expansion of the railway network by 1912 included construction of a terminus running through the north of the site, ending at a Goods Shed to the east of the site. it is assumed this was to ease offloading of goods at the goods shed. This off-shoot remained until demolition between 1957 and 1971. The main railway lines have remained north of the site until present day.
	2m N	1871 - Present	
Nursery	5m W	1971 - 1977	An existing hall was redeveloped into a nursery between the mapping of 1957 and 1971, present until it was redeveloped into residential housing by the map of 1992.
	80m N	1895 - 1965	This was observed to be present in the 1895 map of the site. It was expanded between 1899 and 1912. In 1957 surveyed map, it was renamed Station nursery. It was last noted in the 1965 surveyed map, redeveloped in to residential housing by 1971.
Goods Shed	10m E	1912 – 1965	It was first noted in the 1912 surveyed map of the site. It is assumed to be used for storage and transport of coal and other goods. Between 1965 and 1971 the goods shed was demolished, replaced with a large unlabelled structure.
Sawmill	70m SE	1934	A former institute was relabelled *'Saw Mill'* on the 1934 map only, redeveloped into an engineering works by the next map of 1956-1957 (see below).
Engineering works	70m SE	1956 – Present.	It was first noted in the 1956 surveyed map where the Sawmill was formerly noted. In the 1989 surveyed map, it was relabelled *'Works'*. The building is currently being used as a car showroom based on satellite imagery.
	110m E	1956 – 1970	Although the building was first noted on the 1934 map, the engineering works was first labelled on the 1956 surveyed map of the site. Between 1957 and 1971, the works was relabelled *'Garage'*.
Garage	110m E	1970 - 2003	This was first noted in 1970 surveyed map, when the engineering works was relabelled. By 1992, the garage was split into two uses, with the garage occupying the north of the structure, and *'Works'* occupying the south. This layout remained up until and including the latest large-scale mapping from 2003. Recent satellite imagery indicates the garage/works were demolished to make way for residential development circa 2018/2019.
Electricity Sub stations	20m NE	1989 - Present	An electricity substation was first noted in the 1989-1992 map of the site. It appears to still be in use.

	40m SE	1971 - 1977	An electricity substation was first recorded on the 1971-1973 map. It was last noted on the 1977 surveyed map.

In summary, the map evidence indicates that the site has been in use between 1934 and 1977 as a coal yard. It is currently used as a retail office building and storage facility. An electrical substation first noted in 1989 is still present 20m north east of the site.

The majority of the site is surrounded by residential and commercial developments, with historic and current off site features including railway siding, nursery, goods shed, garage and electricity substation.

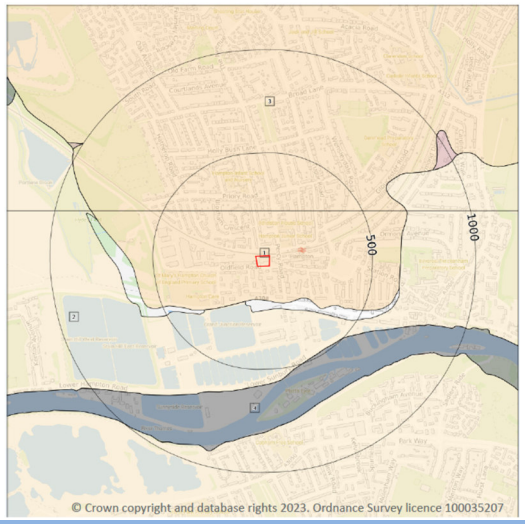
3.2 Published Geology

The following publications of the British Geological Survey (BGS) were examined in respect of the geology underlying the site:

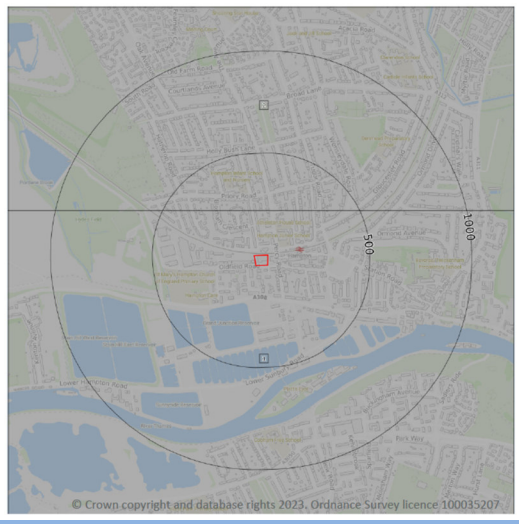
- British Geological Survey (BGS) 1:50,000 Scale Geological Map Sheet EW 270 South London. Solid and Drift Edition.
- BGS Geology of Britain Map Viewer.
- BGS GeoIndex Onshore.
- Geo-Environmental Data Report.

Extracts of the 1:10,000 geological mapping from the Geo-Environmental Data Report are presented below for reference:

BGS 1:10 000 Superficial Geology



BGS 1:10 000 Solid Geology



Made Ground
BGS mapping does not display any made ground deposits on site, however based on the historical mapping and the development that has taken place, made ground deposits are likely to be present.

Superficial Deposits
The site is indicated to be underlain by Taplow Gravel Formation. This stratum typically comprises sand and gravel.

Solid Geology
The deeper solid geology is indicated to be part of the London Clay Formation, which typically comprises clay.

No faults are shown on or within an influencing distance of the site.

3.3 BGS Boreholes

There are no BGS exploratory hole records within a relevant distance of the site (assumed as an approximate 50m radius).

3.4 Mining and Mineral Extraction

The site is outside the area of a designated coalfield or brine extraction area and the Law Society and Coal Authority state a mining search is not required.

3.5 Hydrogeology

Based on the inferred geology, a summary of the Environment Agency aquifer designations is presented in the table below:

Stratum	Coverage	Aquifer Designation
Taplow Gravel Member	Full Site	Principal Aquifer. This is Geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale.
London Clay Formation	Full Site	Unproductive Strata. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

A summary of the pertinent hydrogeological features within the Geo-Environmental Data Report are provided below:

Feature	Distance (m) & Direction	Details
Nearest Active Groundwater Abstraction	1183m E	Licence No: 28/39/31/0172 Details: General Use Relating To Secondary Category (Medium Loss) Direct Source: THAMES GROUNDWATER Point: HAMPTON POOL BOREHOLE Name: HAMPTON POOL LIMITED Annual Volume (m3): 15,000 Max Daily Volume (m3): 200 Original Application No: WRA/6220 Original Start Date: 02/04/1997
Nearest Active Potable Groundwater Abstraction	491 SE	Licence No: 28/39/M/0002 Details: Potable Water Supply - Storage Direct Source: THAMES SURFACE WATER - NON TIDAL Point: RIVER THAMES AT M2 HAMPTON INTAKE T22 Name: Thames Water Utilities Ltd Annual Volume (m3): 665,388,000 Max Daily Volume (m3): 5,455,000 Original Start Date: 10/10/1966
Source Protection Zones	-	None within 500m.

3.6 Hydrology

A summary of the pertinent hydrological aspects within the Geo-Environmental Data Report are provided below:

Feature	Distance (m) & Direction	Details
Nearest Watercourse	242 SW	Grand Junction Reservoir
Nearest Surface Water Abstraction	-	None within 2000m.
Closest Active Licenced Discharge Consent	405m SE	Effluent Type: TRADE DISCHARGES - PROCESS EFFLUENT - WATER COMPANY (WTW) Permit Number: TEMP.3060 Permit Version: 2 Receiving Water: River Thames Status: TEMPORARY CONSENTS (WATER ACT 1989, SECTION 113) Issue date: 25/09/2009 Effective Date: 01/01/2010

The British Geological Survey indicate there is a potential for groundwater flooding at the subject site, with a high-risk rating along the northern boundary of the site, and moderate to moderate-high across the site itself.

No further consideration of flood risk is undertaken in this report. Specialist flood risk advice should be sought with regards to drainage and flooding

3.7 Landfill and Waste Management Sites

There are no landfill sites recorded within 500m.

There is one recorded historic landfill within 500m, recorded 491m west at Kempton Park Gravel Pit, Sunbury, registered to Greenham Sand and Ballast Company Limited, stated to accept inert household, wastes, first recorded in December 1968 and last recorded in December 1981.

There are no current waste management sites recorded within 250m of the site.

There are no historical waste management sites recorded within 500m of the site.

3.8 Environmental Regulatory Data

A summary of the relevant environmental aspects, both on site and within 500m of the site contained in the Geo-Environmental Data Report, are presented in the table below:

Entry	On-site	0 – 50m	50 – 250m	Details
Recent Industrial Land Uses	1	1	14	The industrial land use on site is for office building and storage facility. The other three uses within 100m of the site are an electricity substation (16m NE), vehicle service centre (86m SE) and radio mast (99m E). Of the remaining 12, 4 No. pertain to electrical substations.
Current or Recent Fuel Stations	0	0	1	The entry is 121m east of the site and is noted to be obsolete.
Licensed Industrial Activities (Part A(1))	0	0	0	-
Licensed Pollutant Release (Part A(2)/B)	0	0	0	-
Radioactive Substances	0	0	0	-
Pollution Incidents (EA/NRW)	0	0	0	-

The site is within 500m of an active COMAH site (situated 167m to the south) related to a water treatment works, operated by Thames Water Utilities Ltd. BSL recommends the Local Authority is contacted at the earliest opportunity to ascertain any potential planning constraints.

In regard to the entries identified above, only electricity substation is considered to be of significant relevance to be carried forward to the preliminary CSM. No other entries require further consideration.

3.9 Radon

Information from the environmental database report indicates the property is in an area where <1% of properties are above the Action Level for radon, and therefore radon protective measures are not required in accordance with BRE Report 211 'Radon – Guidance on protective measures for new buildings' 2023 Edition.

3.10 UXO Risk

In accordance with CIRIA Report C681, BSL have reviewed non-specialist UXO data for the site using the online Zetica Bomb Risk Mapping data.

There is no indication of former military use from the Phase I Assessment. The map indicates the site to be in an area where the bomb risk is high. A copy of the map is presented in Appendix D.

Since the site is considered to be at high, a UXO Desk Study was instructed which determined the risk to be low, and a summary of the relevant points is below.

A summary of the relevant points from the detailed UXO Desk Study completed by 1ST Line Defence (reference DA18413-00) is presented below:

- There is a low risk from German UXBs, incendiaries and bomblets.
- There is a low risk from Allied AAA ordnance.
- There is a negligible risk from other Allied military ordnance.
- The overall risk is low.
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works was recommended.

4.0 DESK STUDY SUMMARY AND RISK ASSESSMENT

4.1 Introduction

The risk posed by any contaminants in soil or groundwater will depend on the nature and level of the source, the probability of exposure occurring, the potential pollution pathway and the likely effects on the receptors.

A contaminant is defined as a substance that has the potential to cause harm, a risk is considered to exist if such a substance is present at sufficient concentrations to cause harm and if a pathway is present through which a receptor could be exposed to the contaminant.

The following sections discuss the identified potential on-site and off-site sources, and any pollution that could impact receptors via the pathways associated with the proposed development. Pollution linkages are assessed which may represent a risk to human health and/or controlled water receptors from the information gained from the desk study searches. The assessment has been carried out on a qualitative basis and aims to produce a complete and comprehensive Preliminary Conceptual Site Model.

Three potential impacts exist for any given site and all three need to be considered in the qualitative risk assessment, these are:

- On-site impacts.
- The site impacting its surroundings.
- Off-site sources impacting the subject site.

4.2 Potential Contaminative Sources

On-Site
From the information obtained during the desk study the following sources have been identified by the desk study which may affect the redevelopment of the site for commercial end use:

- Made ground associated with the historic site uses.
- Coal yard.
- Railway sidings.

Off-Site
The following off-site sources have been identified by the desk study which may affect the redevelopment of the site.

- Nursery (closest 5m W).
- Goods shed (10m E).
- Electricity substation (closest 20m NE).
- Sawmill (70m SE).
- Engineering works (closest 70m SE).
- Garage (110m SE).

The Sawmill located 70m south east of the site was only noted in the 1934 surveyed map of the site. It was subsequently redeveloped to engineering works. Given the short operational time, lack of likely significant contamination and significant time since redevelopment, the saw mill is not considered to be a significant source.

Associated Contaminants

The contaminants commonly associated with the potential sources of contamination identified are tabulated below:

Contaminative Sources	Department of the Environment Industry Profile or Other Source	Commonly Associated Contaminants
On Site		
Made Ground	-	Heavy metals, polycyclic aromatic hydrocarbons (PAHs), asbestos, ground gases (carbon dioxide and methane).
Railway Sidings	Railway Land Engineering works-Railway.	Heavy metals, polycyclic aromatic hydrocarbons (PAHs), asbestos.
Coal yard	Railway Land.	Petroleum hydrocarbons (TPHs), polycyclic aromatic hydrocarbons (PAHs), asbestos
Off Site		
Nursery	-	Heavy metals, organic chemicals, pesticides, herbicides.
Goods shed	-	Petroleum hydrocarbons (TPHs), polycyclic aromatic hydrocarbons (PAHs), asbestos.
Electricity substation	Electrical Works.	PCBs
Engineering works	Railway Land Engineering works-Railway.	Heavy metals, polycyclic aromatic hydrocarbons (PAHs), asbestos.
Garage	Road vehicle fuelling, service and repairs.	Heavy metals, petroleum hydrocarbons (TPHs), polycyclic aromatic hydrocarbons (PAHs), asbestos.

4.3 Pathways

A pathway is defined as a medium by which a contaminant comes into contact with, or otherwise impacts a receptor.

At this stage the potential contaminants identified above are considered to present potential risks to site end users and controlled waters through the following pathways:

Potential Pathways	
Pathways in respect to Human Health	• Ingestion of contaminated soils. • Dermal contact with contamination. • Inhalation of dusts. • Inhalation of gases or vapours in both indoor and outdoor air.
Pathways in respect to Controlled Waters – Surface water	• Surface run-off /over land flow. • Drainage discharge. • Base flow from groundwater.
Pathways in respect to Controlled Waters – Groundwater	• Leaching of mobile contamination into groundwater via the unsaturated zone. • Migration of perched groundwater in any permeable soils or along existing or proposed service runs. • Migration into the saturated zone and flow through the Principal Aquifer and the Unproductive Aquifer underlying the site.
Pathways in respect to Property/structures/water pipes	• Direct contact with substances deleterious to building materials and potable water supply pipelines.

Potential Pathways	
	• Migration of ground gases (methane) into confined spaces (explosion and damage to property).

4.4 Receptors

The identified receptors are listed below:

- Commercial end users (human health).
- Structures/Property/potable water supply pipes.
- Nearest watercourse. Grand junction reservoir (Controlled waters).
- Superficial Aquifer. Taplow gravel member (Controlled waters).

Under current UK health and safety legislation, employers are required to carry out their own appropriate site-specific risk assessments and mitigation to protect employees. It has been assumed that any future construction works onsite will be undertaken in compliance with these requirements. Therefore, construction workers have not been specifically considered as part of this assessment.

4.5 Preliminary Conceptual Site Model

The information obtained in the previous sections has been used to compile a Preliminary CSM. The identified potential contaminants and receptors have been assessed in the table below as to whether a plausible source-pathway-receptor pollutant linkage for the proposed end use of the site exists. The risk classification has been estimated in accordance with information in the BSL Guidance and Methodology in Appendix A.

The Preliminary CSM's are presented in the tables overleaf, any assessed risk above moderate will possibly require further action.

Human Health						
Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk	Justification
On site Made Ground Metals, PAH's, asbestos	Root uptake, ingestion, direct contact, inhalation of dusts	End-users	Low likelihood	Medium	Moderate / Low	Made ground associated with the previous development is likely to be present, although no significant development of the site appears to have occurred over time. Both the current site and proposed development are/will be surfaced predominantly with hardstanding, which will break some of the pathways to site end users, however areas of soft landscaping are proposed around the perimeter of the site, and therefore pathways may still be present. Given the previous use as a coal yard, pervasive contaminants may be present in soils related to historic coal storage, however the coal yard was demolished circa 50 years ago, and therefore significant degradation of organic contaminants is likely to have occurred. The recent site use as a retail storage facility is unlikely to be significantly contaminative. Based on the assessment above, the risk is considered to be moderate/low.
On site Made Ground Metals and organic contamination	Migration into/chemical attack of water supply pipelines	Water Pipelines / End users	Low likelihood	Medium	Moderate / Low	Contaminants within the soil/groundwater could potentially attack the clean potable water supply pipe, contaminants should be assessed to determine the correct pipe material and level of precautions required. The risk is considered moderate/low. Further assessment will be required to confirm the risk.
On site Made Ground Ground Gas (carbon dioxide and methane)	Migration into confined spaces, inhalation and asphyxiation/ explosion	End-users	Unlikely	Severe	Moderate / Low	The Geo-environmental Data Report noted the absence of any significant made ground thickness, however, due to previous use of the site, it is possible that limited made ground may be present and therefore there is a potential for contaminants to be present within made ground. The made ground is expected to be limited in thickness and extent and therefore a significant source of ground gas is considered to be unlikely. However, given the severity of ground gas in relation to migration into buildings, explosion and asphyxiation is considered to be severe, the risk at this stage is considered to be moderate/low.
On site Coal yard Metals, PAH's, asbestos	Root uptake, ingestion, direct contact, inhalation of dusts	End-users	Unlikely	Medium	Low	Contaminants associated with the previous use of the site as coal yard between 1934 and 1977 may be present within made ground soils underlying the site. Immobile contaminants such as asbestos and coal are unlikely to be widespread and will be limited to the made ground soils. The development is proposed to include a basement level which will remove the majority of the made ground soils and contaminants within the soils. Mobile contaminants associated with coal yards include PAHs. These are likely to have degraded over time. The pathways to

Human Health						
Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk	Justification
						end-users are limited to the areas of soft landscaping and therefore the risk is considered low..=
On site Railway sidings Metals, PAH's	Root uptake, ingestion, direct contact, inhalation of dusts	End-users	Low likelihood	Medium	Moderate / Low	A railway siding was noted on and adjacent to the site from 1912 and is still present. In the early 1900s, the railway siding transported materials to a goods shed adjacent to the site, and transported coal during the late 1900s. It is assumed that localised spillages of materials occurred over time when loading and unloading occurred. The contaminants associated with the coal yard are generally persistent, and immobile, and therefore may still be present in soils. The presence of hardstanding will generally block pathways for contaminants, but pathways through landscaping are still present. As well as this, construction of the basement is likely to lead to the majority of shallow made ground soils being removed from site and therefore there is a low likelihood that a contaminative event would occur. The risk is considered to be moderate/low.
Off site Goods shed. Metals, PAH's, asbestos	Root uptake, ingestion, direct contact, inhalation of dusts	End-users	Unlikely	Medium	Low	The goods shed was present between 1912 and 1977 and is likely to be used for storage and transport of coal and other materials. Contaminants associated with railway lines and the goods transported are likely from leaks/spills of materials being transported over time. These contaminative events are likely to be rare and sporadic however, involving low volumes of material. It is unlikely that contamination from these rare events would have migrated on to site in significant quantities. Therefore, the risk is considered to be low.
Off site Electricity Substation PCBs	Ingestion, direct contact, inhalation of dusts	End-users	Unlikely	Medium	Low	The predominant contaminant of concern related to electricity substations is PCBs. The mobility of this contaminant is low, and any volumes present are likely to be small. The nearest substation was constructed recently, following the ban on PCBs, and therefore is unlikely to contain this contaminant. In addition, the proposed development will be covered predominantly in hardstanding which will break the majority of pathways to site end users. The risk is considered to be low.
Off site Nursery Metals and organic contamination	Root uptake, ingestion, direct contact, inhalation of vapours	End Users	Unlikely	Medium	Low	The nursery was noted 5m west of the site between 1956 and 1977. The nursery is unlikely to be significantly contaminative, and was redeveloped circa 50 years ago, and therefore any potential contaminants are likely to have degraded. The risk is considered to be low

Human Health						
Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk	Justification
Off site Engineering Works Metals, PAH's, asbestos	Ingestion, direct contact, inhalation of dusts	End Users	Unlikely	Medium	Low	The engineering works was noted 70m south east of the site. Records from satellite imagery noted its current use as car showroom. The mobility of its associated contaminants is limited. Furthermore, the proposed development with its associated hardstanding will break any potential pathway to site end users. The risk is considered to be low.
Off site Garages Metals and organic contamination	Ingestion, direct contact, inhalation of dusts	End Users	Unlikely	Medium	Low	The garage was noted 110m south east of the site. The garage appears to only have been demolished circa 5 years ago, and therefore although some contaminant degradation will have occurred, it's not likely to be significant. However, any spills are likely to be localised and some attenuation would have occurred. The garage is south-east of the site, and it is thought that groundwater flow is likely to be south towards the River Thames rather than towards the site. Furthermore, the proposed development with its associated hardstanding will break the majority of potential pathways to site end users. The risk is considered low.

Controlled Waters						
Potential Source	**Potential Pathway**	**Potential Receptor**	**Likelihood**	**Severity**	**Level of Risk**	**Justification**
Made Ground PAH's, Metals	Overland flow / migration through saturated zone	Grand junction reservoir 242m away (Surface waters)	Unlikely	Medium	Low	It is considered contaminants associated with the made ground and other past industrial uses are unlikely to impact the Grand Junction reservoir. The thickness of the made ground is unlikely to be significant. Though the site is underlain with permeable strata, the site is predominantly surfaced in hardstanding and will remain so, this will limit leaching to the underlying soils. Due to the distance of the site, it's likely that any contaminants will have attenuated prior to reaching the reservoir. Therefore, a low risk is posed to the reservoir from the made ground.
	Leaching through unsaturated zone / Migration through saturated zone	Principal Aquifer (Groundwater)	Low likelihood	Medium	Moderate / Low	Some mobile contaminants may have been used in the site's history, but the predominant contaminants of concern associated with the former railway siding/coal yard are likely to be relatively immobile. However, the site is indicated to be underlain by permeable strata which permits leaching through unsaturated zone. The site is currently surfaced predominantly in hardstanding and will remain so. The nature of the development will reduce leaching through placement of a building with a larger footprint and a formal surface water drainage system, which will further reduce potential for contamination. By virtue of the development taking place, this should contribute to an overall "betterment" of groundwater quality. The risk is currently assessed as moderate/low subject to intrusive investigation.
	Migration through saturated zone	Unproductive Aquifer (Groundwater)	Unlikely	Mild	Very Low	The site is underlain by permeable strata which permits leaching through unsaturated and saturated zone into the bedrock aquifer. However, the site is currently surfaced predominantly in hardstanding and will remain so. The bedrock aquifer is unproductive, and not likely to be a sensitive receptor. The nature of the development will reduce leaching through placement of a building with a larger footprint and a formal surface water drainage system, which will further reduce potential for contamination. By virtue of the development taking place, this should contribute to an overall "betterment" of groundwater quality.

Human Health Risk – Summary
Based on the preliminary CSM and the current use of the site, the overall risk from land contamination at the site is considered to be **low to moderate/low** for a redeveloped site. This would need to be confirmed by appropriate intrusive investigation, testing and assessment.

A potential on-site gas source has been identified associated with the made ground associated with historic site use. The preliminary CSM considers the sources to be a moderate/low risk to site end users and property.

In accordance with CIRIA C665 and as set out in Appendix A of this report, the gas generation potential is considered to be very low. The sensitivity of the development is low on account of the proposed commercial use.

In line with current guidance, it is recommended that ground gas monitoring should comprise 4 visits over a 2month period.

Controlled Waters Risk - Summary
Based on the preliminary CSM, BSL believes the overall risk to controlled waters at the site is considered to be very **low to moderate/low** for the following reasons:

- No significant contamination is anticipated on site.
- contaminant degradation prior to reaching the reservoir due to distance and age of contaminants.
- There are no of groundwater abstractions within 1000m.
- There are no surface water abstractions within 2000m.
- The nearest portable (sensitive) water abstraction is nearly 500m away.
- The site is underlain by permeable strata which permits lateral and vertical contaminant migration. through the saturated zone
- The bedrock aquifer is not considered to be sensitive (unproductive aquifer).
- The site does not lie within 500m of an SPZ.

The above assessed level of risk will need to be confirmed by intrusive investigation and quantitative risk assessment.

5.0 PRELIMINARY GEOTECHNICAL ASSESSMENT

5.1 Hazard Identification

Potential geotechnical hazards based on the expected ground conditions are listed below:

- Made ground of unknown nature; if placed in a non-engineered manner may cause excessive settlement of foundations, highways and infrastructure.
- Presence of obstructions/basements in the ground from historical developments (e.g relict foundations) causing difficulties with excavations or penetrative works (e.g. piling).
- Attack of buried concrete by aggressive ground conditions; the site may contain unknown made ground and potentially sulphate bearing soils.
- Shrink / swell of clay; settlement / heave of foundations when located within the influence of trees and vegetation.
- Shallow groundwater/groundwater rise resulting in difficulties with excavations due to trench collapse.

The above identified geotechnical hazards will need to be considered as part of further investigations and assessments.

5.2 Foundation Design

The proposed development will comprise a four storey self-story facility, assumed to be steel framed. The type of foundation solution should be informed by an onsite intrusive investigation to confirm the ground conditions and obtain geotechnical parameters for preliminary design. Intrusive investigation should also obtain data to allow appropriate concrete classification in accordance with BRE SD1 and for preliminary highways/pavement design.

5.3 Sustainable Drainage Systems (SuDS)

Drainage to SuDS is a potentially viable option for the site, given the indicated presence of permeable Taplow Gravel Member, subject to the depth to the groundwater and test results.

This would need to be confirmed by an onsite intrusive investigation to confirm ground conditions and infiltration rates. Testing should be carried out in general accordance with BRE Digest 365 “Soakaway design” and CIRIA C753 “The SuDS Manual”.

5.4 Other Development Constraints

A formal survey of asbestos within structures is not covered in this report. It should be noted that an asbestos demolition survey will be required prior to any demolition of structures. If asbestos is present in soils, these will need to be dealt with in accordance with the Control of Asbestos Regulations (CAR) 2012.

No invasive species have been noted during the walkover, however it would be prudent to undertake a specialist survey prior to any works on site.

There are known services on site, these may need to be disconnected prior to any construction activities. Telecom services and Sewer are concentrated on western section of the site. Electricity and gas services enter the southern part of the site. Unidentified services are located in the western section of the site in north-south and northwest-south directions. GPR services are located in the western section in the northwest-southwest direction and also in the eastern section of the site in a north-south direction.

6.0 METHOD OF INVESTIGATION

6.1 Objectives

To confirm the risks to the identified receptors and confirm the ground conditions in respect to the identified geotechnical and geo-environmental risks, an appropriate intrusive investigation was undertaken as per the recommendations of the Phase I Desk Study Assessment.

The aim of the fieldwork was to:

- Investigate ground conditions on the site and the potential need for detailed investigation.
- Install standpipes to allow future monitoring.
- Assess the potential contamination on the site and obtain samples for contamination screening.
- Assess the potential impact of any contamination on controlled waters.
- Obtain geotechnical information on the ground conditions at the site for preliminary foundation design and preliminary pavement design purposes.
- Provide an assessment of the geo-environmental risks associated with redevelopment of the site.

6.2 Site Works

The following site works have been undertaken as part of the intrusive investigation between the dates of 14th and 17th August.

Method	No.	Range Depths (m bgl)	Purpose
Window sample boreholes – Tracked WS rig	10	0.25 – 5.00	Establish general ground conditions on site. Allow Standard Penetration Tests (SPTs) to be carried out and obtain samples for contamination and geotechnical and testing. Installation of ground gas and water monitoring wells.
Cable percussive boreholes	3	1.20 – 25.00	Assess deeper ground conditions, carry out SPTs. and obtain samples for contamination and geotechnical and testing. Installation of ground gas and water monitoring wells.
Dynamic Cone Penetration Testing (DCP)	1	5.00	Obtain parameters on soils strengths and densities used as a follow on from window sampling where shallow refusals were encountered.

BH02 was terminated at 1.20m bgl due to the possibility of a service as indicated by strong signals using a cable avoidance tool.

WS04 was drilled to 2.00m bgl at which depth there was an SPT refusal. Dynamic probe testing was carried out from the base of the borehole to 5.00m bgl as a follow on from the window sample borehole.

WS02, WS03, WS03A, WS03B, WS05, and WS08 were terminated at depths ranging from 0.25m to 1.10m bgl due to concrete obstructions within the hand dug pits.

No exploratory holes were able to be positioned within the existing building footprint and therefore, this investigation is limited, and further intrusive works are recommended to confirm ground conditions in this area, and to allow for a more complete assessment of risks.

Exploratory hole locations are shown on Drawing No. M5478/03, attached. The approximate locations of the exploratory holes are indicated on the Exploratory Hole Location Plan, Drawing No M5478/03. The exploratory hole logs are presented in Appendix E.

The exploratory holes were logged by an experienced geo-environmental engineer in general accordance with the following guidance:

- BS 5930:2015+A1:2020 Code of Practice for Site Investigations.
- BS EN 14688-1:2018 Geotechnical Investigation and Testing – Identification and classification of soil.

6.3 Sampling Strategy

Representative samples were taken from exploratory holes at regular intervals to assist in the identification of the soils and to allow subsequent laboratory testing. They were stored and transported in general accordance with BS 10175:2011+A2:2017.

The type of sample was dependent upon the stratum and the purpose of analysis in accordance with current environmental and geotechnical guidance. The distribution of samples taken across the site is recorded on the exploratory logs.

Investigatory hole locations were determined by reference to the conditions identified in the preliminary risk assessment. Certain specific features such as railway sidings were targeted for specific investigation, but a reasonably even spacing was used for the remainder of the site. No specific sampling statistics or grid were utilised in this instance.

6.4 Laboratory Testing

As part of the initial assessment for potential contamination of the site, selected samples were taken for the purpose of chemical contamination testing.

In the absence of particularly contaminative processes on site and the lack of visual evidence of potential hydrocarbon impaction representative soil samples were screened for the following general suite of determinands at a UKAS approved laboratory:

Determinand	No of Samples
BSL Default Soil Suite: Arsenic, Cadmium, Chromium (III), Chromium (VI), Copper, Nickel, Mercury, Lead, Zinc, Selenium, speciated polycyclic hydrocarbons (PAH 16), water soluble sulphate (2:1 Extract), soil organic matter (SOM) and pH.	8
Petroleum Hydrocarbons (TPH CWG) inc BTEX and MTBE.	3
Asbestos Screen.	8
Asbestos Quantitative Analysis.	4
Total Organic Carbon (TOC).	8
Waste Acceptance Criteria (WAC).	3

The Chemical Laboratory Testing Results are presented in Appendix F.

Representative disturbed samples were obtained for all soil types encountered. Selected samples were scheduled for testing at an approved laboratory in accordance with BS 1377 'Method of Test for Soils for Civil Engineering Purposes' and BS EN ISO 17892- Parts 1-12:2018 'Geotechnical investigation and testing. Laboratory testing of soil'.

The following tests were scheduled for geotechnical purposes:

Description	No of Samples
Natural Water Content.	8
Plasticity Index Analysis.	8

Description	No of Samples
SD1 BRE Full Suite.	6
Determination of One-Dimensional Consolidation properties.	2
Determination of Undrained Shear Strength in Triaxial Compression.	3

The Geotechnical Laboratory Testing Results are presented in Appendix G.

6.5 Monitoring

Ground gas and ground water monitoring standpipes were installed in four boreholes and subsequently four monitoring visits were undertaken out of four proposed as part of the current scope, in line with the recommendations of CIRIA C665. All gas monitoring was undertaken using either a GA5000 or GFM436 infrared gas meter with integral electronic flow analyser.

Flow measurements on each standpipe (l/hr) were taken. Measurements of the percentage volume in air (%v/v) of oxygen (O_2), carbon dioxide (CO_2) and methane (CH_4) were recorded in addition to the percentage Lower Explosive Limit (%LEL) of methane (Note: 100% LEL equates to 5% by volume), the atmospheric pressure (mb) and average temperature during the visit (°C).

Standpipes were constructed in general accordance with the relevant guidance. A summary of the installation construction is presented in the table below:

Location	Internal Diameter Pipe	Response Zone (m bgl)	Targeted Strata	Purpose
BH01	50mm HDPE	1.50 – 4.50	Gravelly sand	Ground Gas
BH03	50mm HDPE	1.00 – 3.00	Gravelly sand	Ground Gas
WS01	35mm PVC	1.50 – 2.80	Gravelly sand	Ground Gas
WS04	35mm PVC	0.50 – 1.00	Made Ground	Ground Gas
WS06	35mm PVC	1.00 – 2.80	Clay / Sand	Ground Gas

The gas monitoring visits recorded peak and steady state conditions. Peak results are those that occur on opening the valve on the borehole tap. Steady state conditions are those that occur a period of time afterwards when the initial (accumulated) gases have been purged from the borehole.

Ground gas monitoring results are presented in Appendix H of this report.

7.0 GROUND CONDITIONS

7.1 Summary

A brief summary of the ground conditions encountered is presented in the table below:

Stratum	Range Depths - Top (m bgl)	Range Depths - Base (m bgl)	Range Thickness' (m)	Brief Description
Made Ground	0.00	0.25 – 1.30	0.25 – 1.30	Asphalt/concrete, over gravelly sand, over slightly gravelly slightly sandy clay.
Natural Superficial Strata	0.70 – 1.30	3.00 – 4.40	2.00 – 3.20	Gravelly SAND OR Silty / sandy CLAY over gravelly SAND
Solid Geology	3.00 – 4.50	5.00 – 25.00	2.00 – 20.50	London CLAY

Details are provided in the logs in Appendix E and the individual strata are described in the sections below.

7.2 Made Ground

Made Ground – Topsoil
Made Ground topsoil was encountered within WS06 and WS08 from ground level to between 0.50m and 1.20m bgl, generally comprising dark brown slightly sandy clay with occasional organic matter, rootlets and anthropogenic inclusions of gravel sized brick and concrete alongside plastic and timber fragments.

Made Ground – General
Made ground was encountered within all the exploratory holes across the site and was observed from ground level to depths between 0.70m and 1.30m bgl.

Hardstanding surfacing of concrete was present across the southern section of the site and recorded 0.19m thick. Rebar was encountered in the concrete in WS01. Asphalt was encountered across the western section of the site and recorded between 0.09m and 0.10m thick.

The composition of the made ground beneath the concrete was fairly consistent across the site and represented demolition material comprising gravelly sand and slightly gravelly slightly sandy clay with varying amounts of concrete and brick.

7.3 Natural Superficial Strata

The natural strata underlying the site was generally medium dense gravelly sand interpreted to be part of Taplow Gravel Member with varying amounts of soft to firm silty clay as minor constituents. The sand was found to be loose (N=8) from 1.00m to 2.00m in WS06.

NATURAL CLAY ABOVE THE SAND IN BH02, BH03, WS03, WS06, WS07. DESCRIBE IT.

7.4 Solid Geology

Dark brown clay interpreted to be part of London Clay Formation was encountered across the site from depths between 3.00m and 4.50m bgl to the base of the boreholes (maximum depths of 25.00m bgl). Soft clay was encountered between 3.00m and 6.00m bgl.

7.5 Groundwater

No groundwater was encountered within the sand and gravel formation during site works; however, it was observed to be wet.

The depths to groundwater and locations present during site works are shown in the table below:

Location	Depth During Site Works (m)	Comments
BH01	12.00	Small seepage
BH03	11.70	Small seepage

NGW – No Groundwater Encountered

Within installed standpipes, post site works monitoring has revealed the following depths to groundwater:

Location	Depth During Monitoring Period (range) (m)	
	Min	Max
Overall min/max	0.91	2.38
BH01	2.41	2.30
BH03	2.41	2.21
WS04	0.91	0.83
WS06	2.58	2.38
WS01	2.56	2.21

7.6 Observations

Contamination
During the works undertaken by BSL, observations for both visual and olfactory evidence of contamination were undertaken. No visual or olfactory evidence of contamination was observed at the site. Groundwater did not display any visual or olfactory signs of potential contamination.

Stability of Boreholes
Casing was required to prevent collapse with the granular materials during drilling of cable percussive boreholes.

Obstructions
There are numerous obstructions throughout the made ground on site. The obstructions identified are summarised in the table below:

Location	Depth (m bgl)	Comments
WS02	0.40	Concrete
WS03	1.10	Concrete.
WS03A	1.10	Concrete.
WS03B	0.25	Concrete.
WS05	0.60	Concrete.
WS08	1.20	Concrete.

8.0 TEST RESULTS

8.1 Geotechnical Laboratory Testing

Plasticity Index Analysis
Plasticity index results ranged between 24% and 49%. Associated water contents ranged between 14.6% and 30.3%.

After modification of particle size in accordance with BRE 240 the modified plasticity indices are in the range 16% to 49% indicating the cohesive soils to be of low to high volume change potential.

Undrained Shear Strength – Quick Undrained Triaxial
The results of the tests are shown in the table below:

Location	Depth (m)	Shear Strength (kPa)	Undrained Shear Strength to EC7
BH01	7.5	83	High
BH01	10.50	167	Very High
BH03	9.00	110	High

One Dimensional Consolidation Properties
The one-dimensional consolidation properties were as follows:

Location	Depth (m)	Mv Range (m^2/MN)	Cv Range (m^2/yr)	Compressibility at Approx Over-Burden Pressure
BH01	7.5	0.04 – 0.13	0.57 - 67	Low to Medium
BH03	9.00	0.038 – 0.12	1.1 - 29	Low to Medium

8.2 Aggressive Ground Conditions – Geotechnical Chemical Testing

The test results for the assessment of aggressive ground conditions are presented in Appendix G. The results are summarised and assessed within Section 9.8 of this report.

8.3 In Situ Geotechnical Testing

In Situ Standard Penetration Tests
Standard Penetration Tests (SPTs) were carried out within the window sample and cable percussive boreholes at regular 1.0m to 1.5m intervals. The results of the individual blows and the N-values are recorded on the Exploratory Hole Logs in Appendix E.

All SPT N values are uncorrected. Density and strength descriptors are reported in accordance with the guidelines stated in BS 5930:2015+A1:2020, incorporating requirements of BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and BS EN ISO 14689-1:2003.

8.4 Geo-Environmental Testing

Chemical Laboratory Testing
The chemical test results for soils, are presented in Appendix F. The results are summarised and assessed within Section 10.0 of this report.

Ground Gas Monitoring

Ground gas monitoring installations have been monitored on two occasions to date out of four visits scheduled. The results are presented in Appendix H and are summarised and assessed within Section 10.6 of this report.

9.0 GEOTECHNICAL ASSESSMENT

9.1 Ground Model Summary

The site is currently occupied by an office building with a storage facility with its associated car parking space and hardstanding.

The ground conditions can be summarised as below (top down):

- Made ground generally comprising concrete and asphalt over slightly gravely slightly sandy clay from ground level to between 0.70m and 1.30 mbgl.
- Natural superficial deposits comprising generally medium dense to dense gravelly SAND and typically soft to firm slightly sandy slightly silty CLAY proven to depths between 0.60m and 4.40 mbgl. The sand was found to be loose (N=8) in WS07 at 3m bgl.
- Solid geology comprising London Clay Formation proven to depths ranging between 3.00m and 25.00m bgl. Soft clay was found in BH01, BH03, WS06, and WS07 at depths between 3.00m and 6.00m bgl.
- Groundwater levels ranging between 11.70m and 12.00m bgl during site works.
- Post site works monitoring levels ranged between 0.88m and 2.45m bgl.

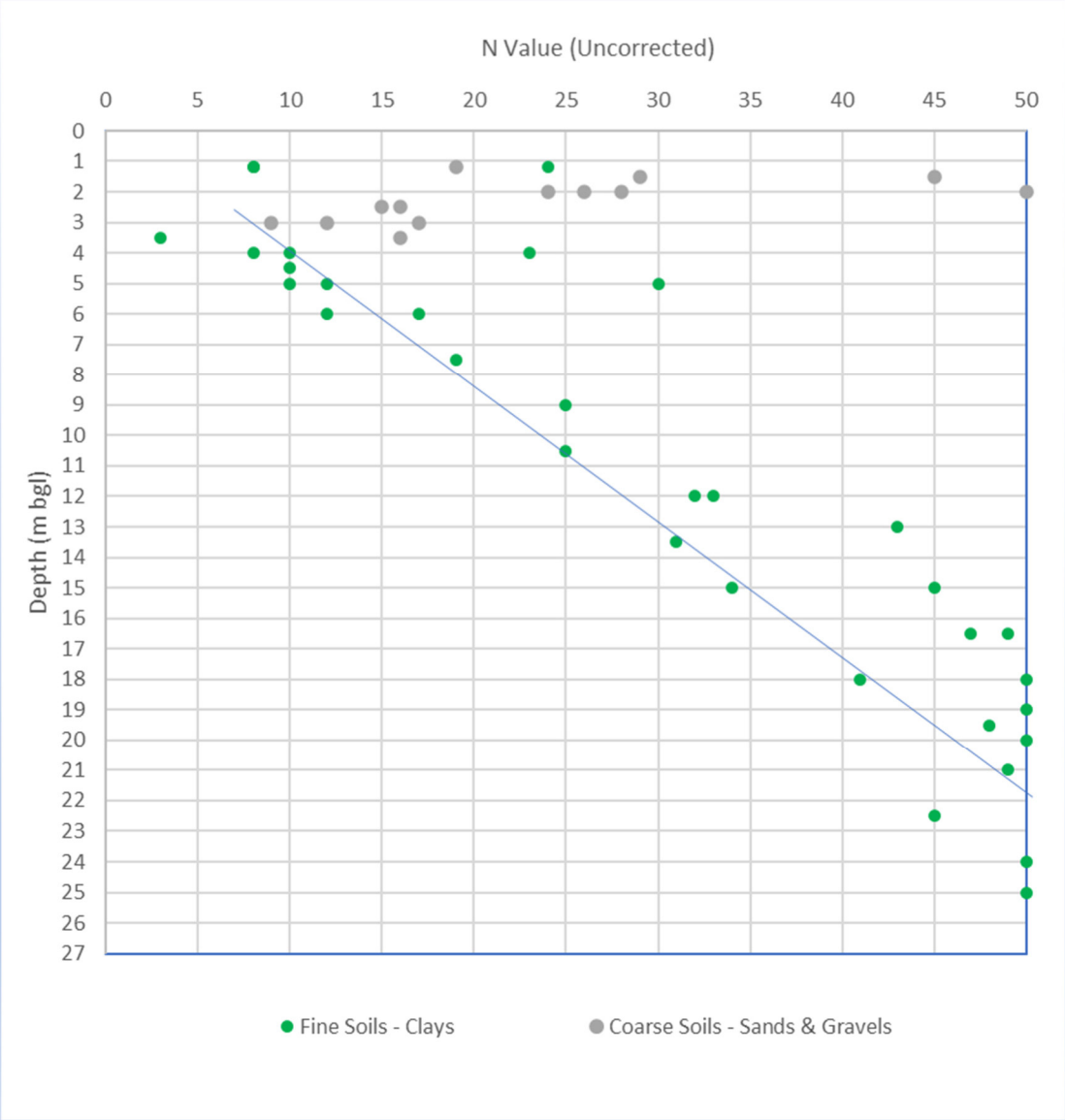
There are numerous concrete and asphalt obstructions throughout the made ground that will need removal during enabling works.

9.2 Design Soil Parameters

The relevant test results from the prior section have been evaluated to derive geotechnical soil parameters for the site.

The angle of shearing resistance (ϕ') of the granular (coarse) soils has been derived from the uncorrected SPT N value data and the correlation of Peck (1967).

A depth (m bgl) vs SPT N value graph is also provided below to provide a profile of all material types underlying the site.



The above graph shows a general increase in soils strengths as depth increases.

9.3 Foundations

The development will comprise a four storey self-storage facility with basement assumed to be steel framed and is considered to be classed as Geotechnical Category 2 in accordance with Eurocode 7.

Preliminary design by calculation has been undertaken to determine the design resistance of the bearing strata in the following section. Note that the made ground, present to depths down to 1.30m bgl, is not considered to be a suitable bearing stratum.

No proposed structural loads were available at the time of writing, therefore the following recommendations are provisional and should be reviewed at the detailed design stage

This assessment is based on the existing ground levels and does not take into consideration any cut/fill exercise, which should be considered at the detailed design stage.

In view of the construction of a basement beneath the entire building footprint, shallow foundations are not considered suitable, and therefore, pile calculations have been undertaken.

Piles should be extended through the made ground and the superficial deposits. Depending on the structural loadings and design requirements, piles will likely utilise a combination of skin friction and end-bearing resistance, transferring the majority of the load to the underlying clay deposits through skin friction.

Displacement piles such as driven pre-cast concrete or tubular steel piles, or replacement techniques such as bored piles with the use of casing or continuous flight auger (CFA) piles are all considered potentially suitable piling solutions for this site, with either pre-cast or cast in situ ground beams spanning between piles to support masonry walls.

The choice of piling system and the detailed design of piles are beyond the scope of this report and should be undertaken by a piling specialist. However, as a guide, preliminary calculations were undertaken for a circular concrete pile, taking into account shaft resistance, end bearing resistance and the effects of negative skin friction. The preliminary allowable loads for various pile diameters and lengths are shown in the table below. Please note, in the absence of detail on the proposed basement depths, these pile calculations have been undertaken assuming piles will extend to existing ground levels.

Profile	Pile Diameter (mm)	Pile Length (m)	Allowable Load (kN)
Generalised Soil Profile	300	10.00	130
		15.00	220
		18.00	300
	450	10.00	210
		15.00	350
		18.00	480

The above does take into consideration the effects of pile groups or the self-weight of the pile.

A large portion of the site was not investigated during this phase due to the presence of an existing building. Therefore, it is recommended that further intrusive works are conducted to inform pile design.

Information gained from this ground investigation should be assessed by an experienced piling contractor such that appropriate piles are selected and designed given the site conditions that have been encountered.

Whilst detailed design is beyond the scope of this report, the following should be taken into consideration during the detailed design stage by a suitably competent contractor/engineer:

- Piles should extend a minimum of five pile diameters into the bearing stratum to fully mobilise end-bearing resistance and shaft resistance.
- Higher allowable loads than those listed in the table above could be achieved by increasing the diameter of the piles or by using pile groups.
- As groundwater was observed during the boring of the intrusive holes and monitoring, temporary casing may be required for bored piles.
- Bored piles through coarse soils will likely result in loosening, with resultant reduced shaft friction.
- Discussions should be made with the pilling contractor regarding the suitability of driven piles due to the levels of disruption to the adjacent residential and commercial properties.
- CFA piles are likely to be a suitable alternative to driven piles to reduce noise levels, although there will be additional costs associated with disposal of excess soils.

- The construction of a basement structure should also be taken into account for foundation and pile design.
- The piling work should be undertaken in accordance with BS EN 12699:2015 'Execution of Special Geotechnical Work - Displacement piles', and also relevant standards associated with manufacturing the piles.
- In accordance with Eurocode 7 it would be prudent to verify the compressive resistance of the strata and the pile design should by static load testing on working piles 1.5 times the characteristic load on more than 1% of working piles. This will provide an accurate strength of the end bearing stratum.

Other Foundation Options

Other foundation solutions such as controlled modulus columns, vibro stone columns etc. could be considered as an alternative to piled foundations, subject to liaison with specialist contractors.

9.4 Building Near Trees

The clay soils on site are of high volume change potential. Where piles encounter cohesive strata in the vicinity of existing, proposed or recently removed trees, foundations should be adjusted in full accordance with BRE 298. All foundations should be deepened below roots of greater than 5mm diameter during excavations for footings.

Where foundations are constructed on clay soils within the influencing distance of trees including proposed planting, the upper section of the pile (to the recommended minimum founding depth) should be sleeved or over bored to allow for clay volume change. Bored, cast-in-place piles are well suited to counteracting heave. Driven piles are less well suited to counteracting heave and are difficult to install in stiff desiccated clay without excessive noise and vibration.

Where foundations are constructed on cohesive soils, special precautions will be required in respect to trees. General guidance is given in NHBC Ch. 4.2.

9.5 Floor Slabs

Given the thickness of made ground present (generally >600mm), suspended floor slabs should be adopted at the site in accordance with LABC standards.

Given that a basement construction is proposed for the development, the ground conditions beneath the floor slab may be variable. Therefore, to reduce differential settlements a suspended floor slab is recommended.

For granular soils, a minimum ventilation void of 150mm should be provided below the underside of precast concrete suspended floors.

For buildings where suspended construction is structurally inappropriate, a hardcore thickness in excess of 600 mm may be employed below a ground bearing slab providing it is designed and supervised by an appropriately qualified engineer.

Ground bearing slabs may be adopted providing the following criteria are satisfied:

- Any other compressible or unsuitable materials (topsoil containing vegetation and organic matter, including tree roots, are excavated and either improved or removed and replaced with suitable materials.
- The foundation depth (such as due to the influence of trees) is less than 1.5m.

- It is demonstrated that desiccation in cohesive soils is not present.
- Any fill beneath the slab is suitable, well-compacted granular material placed in an appropriate thickness in accordance with a suitable specification (e.g. NHBC Standards) designed and supervised by an appropriately qualified engineer, with the end performance validated.
- The slab is adequately reinforced.
- Regular construction joints and ties are provided to allow for differential settlement.

The final floor slab design should be of sufficient thickness and sufficiently reinforced to accept the envisaged applied loads, without unacceptable total or differential movement.

Vertical elements within the structure, such as columns and walls will need to be isolated from the ground bearing slab in order to allow for the slab to expand against them without resulting in cracking.

9.6 Site Preparation and Construction

The existing structures will need to be demolished and relict foundations/infrastructure grubbed out. Topsoil and subsoil should be removed from beneath all proposed buildings and hardstanding areas.

There are a number of services crossing the site. To allow remediation and construction, all services will need to be disconnected and any suspected dead services are confirmed as dead by testing.

Instability of excavations through natural soils is not anticipated provided they are not exposed to adverse weather conditions for any substantial period of time. Instability of the made ground should be allowed for. All excavations should be carried out in accordance with CIRIA Report 97 'Trenching Practice'.

Excavation depths should generally be readily achieved using conventional plant (JCB or similar) although high specification plant (tracked 360^{o} or similar) is recommended to maintain the build programme. Breaking equipment may also be required locally to penetrate old foundations associated with former construction.

Recorded post site works groundwater levels ranged between 0.91m and 2.45m bgl and therefore will be encountered within likely excavation depths. Based on the exploratory hole logs and monitoring, it is considered that methods such as sump pumping are likely to be sufficient to deal with anticipated flows. Further guidance is provided in CIRIA C750 "Groundwater Control: Design and Practice". It should be noted that groundwater levels will vary seasonally and the timing of construction may influence requirements.

9.7 Basement Construction

A basement structure is proposed beneath the majority of the proposed building. Depths to the base of the structure are not currently known to BSL.

Based on the proposed development layout, the excavations for the basement will likely encounter made ground down to approximately 1.30m bgl, overlying sands to a maximum depth of between 3.00m and 4.40m, in turn overlying stiff clays.

The following points need to be considered in the design and construction of the basement:

- The method of excavation of materials within the basement.
- Temporary and permanent support of the excavation.
- Groundwater levels, control and water proofing of basement sidewalls/base.
- Active pressures from groundwater and the surrounding earth acting on the sidewalls/base.
- Potential settlement of adjacent structures or infrastructure due to ground deformation or dewatering.

- Differential settlement between the basement structure and other foundations or floor slab elements.
- Cut and fill requirements across the wider site.
- Floor heave/settlement.

Embedded retaining walls could be utilised for the construction of the basement using temporary support, where one advantage is that they could be incorporated into the foundation design for the proposed structure. This could include either a contiguous or secant piled wall or a diaphragm wall.

The selection of the type of embedded retaining wall, will depend on a range of factors such as environmental constraints, including noise and vibration, as well as cost.

Alternatively, sheet piled walls could be utilised or the basement retaining walls could be constructed within an open excavation. However, the sides of the excavation would need to be sufficiently battered and supported for safety, and the available space on site may preclude this option.

Retaining walls which are incorporated in the design of the basement will need to be designed by an engineer, taking into account the ground conditions and the serviceability requirements of the scheme. Specialist advice should be sought on all aspects of the construction.

Methods of water proofing basements and below ground structures are detailed in BS 8102 (2009), "Code of practice for protection of below ground structures against water from the ground".

Any water from excavations should be treated either prior to construction or during the operation of the site in accordance with a Remedial Specification and discharged in accordance with the relevant permits and licences.

Temporary support (if adopted) should be designed in accordance with BS 5975 "Code of practice for temporary works procedures and the permissible stress design of falsework".

The design of the basement should also take into account ground gas protection measures, although ventilation within the basement may negate the requirement of these measures. A full assessment will be made upon completion of the ground gas monitoring programme.

If the materials excavated from the basement are to be re-used elsewhere on site, then an earthworks specification will be required to ensure the appropriate management and reuse of the existing soils. This may also need to be undertaken in accordance with a Materials Management Plan (MMP) under the CL:AIRE Code of Practice.

9.8 Concrete Classification

The soluble sulphate and pH test results have been assessed in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005. The Design Sulphate (DS) classification and the Aggressive Chemical Environment for Concrete (ACEC) classification are presented in the table below.

For the purposes of this assessment, the made ground and natural strata is considered to be relatively permeable, therefore the groundwater has been classed as mobile. However, within the relatively impermeable London Clay Formation, the groundwater has been classed as static.

Stratum	No. Samples	Characteristic SO_4 (g/l)	Characteristic pH	DS Class	ACEC Class
Made Ground	2	0.498	7.5	DS1	AC-1
Natural Superficial Strata – Taplow Gravel Member	1	0.0666	8.3	DS1	AC-1

Stratum	No. Samples	Characteristic SO_4 (g/l)	Characteristic pH	DS Class	ACEC Class
Solid Geology - London Clay	2	0.521	8.2	DS2	AC-2s

Based on the above, the results of laboratory pH and sulphate content, alongside the BRE full suite tests, indicate that sulphate class DS-1 and DS2, and ACEC Class AC-1s and AC-2 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005.

Total potential sulphate values within the London Clay Formation indicate that pyrite may be present within the strata. However, further data would need to be obtained in order to determine the concrete classification for this material.

The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site-specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

9.9 Highways

Based on Table 5.1 from DMRB IAN 73/06 Rev 1 equilibrium CBR values of 5% are likely to be achieved in undisturbed natural granular soils and 2.5 to 3% for natural clays soils for pavement design purposes, unless proven otherwise by in-situ testing at formation level by a specialist geotechnical engineer. Equilibrium CBR values are likely to be 2% within the made ground.

Where the CBR is found to be less than 2%, the sub-grade is unlikely to be suitable for both the trafficking of site plant and as a permanent highway foundation without improvement of the soils.

To achieve the required design CBR value, improvement works should be carried out in accordance with DMRB IAN 73/06 Rev 1 Chapter 5 and may include proof rolling, excavation and re-engineering / replacement of weaker soils, the inclusion of a geogrid or use of stabilisation techniques such as the addition of hydraulic binders (e.g. cement/lime).

Based on the fines content of the soils, they are considered to be frost susceptible, therefore highway construction should be a minimum thickness of 450mm to mitigate against the risk.

Care should be taken to ensure the stratum at formation level is protected against inclement weather, as this is likely to lead to surface deterioration and a decrease in soils strengths.

9.10 Site Drainage

The use of soakaways within the natural ground may be feasible at the site due to the presence of permeable strata underlying the site. This would be subject to the results of in-situ testing in accordance with BRE Digest 365 'Soakaway Design' 2016 and CIRIA C735 "The SUDS Manual".

10.0 GEO-ENVIRONMENTAL RISK ASSESSMENT

10.1 Introduction

The samples were tested for an assessment of the chemical contamination that may pose a risk to human health. The results were examined with reference to a selection of guidance documents as detailed in Appendix A. In this case the LQM/CIEH S4ULs and DEFRA C4SLs / commercial end use have been adopted as Tier 1 generic screening values.

The apparent exceedance of the relevant screening value is taken as indicating further detailed assessment or remedial action is required.

A summary assessment sheet is presented in Appendix F alongside the chemical test results. Results are discussed in detail in the sections below.

10.2 Soils Test Results and Risk Assessment – Human Health

Metals
No metals have been detected above the adopted screening criteria.

Asbestos
The locations where asbestos has been detected in the made ground, alongside the results of quantification (where carried out) are summarised in the table below:

Exploratory Hole	Depth (m)	Asbestos ID	Concentration by Weight (%)
BH01	0.50	Chrysotile loose fibres	0.007
WS03B	0.25	Amosite loose fibres	<0.001
BH03	0.70	Chrysotile loose fibres	<0.001
WS07	0.40	Chrysotile loose fibres	<0.001

Asbestos above trace levels was recorded within the north of the site, likely associated with the historical use of the site. No visual evidence of asbestos contamination was noted during the investigation, which was undertaken by an engineer with asbestos awareness and NNLW qualifications. *Poly Aromatic Hydrocarbons (PAHs)*
No PAHs have been detected above the adopted screening criteria.

Total Petroleum Hydrocarbons (TPH CWG)
No petroleum hydrocarbons have been identified above the adopted screening criteria.

BTEX and MTBE
No BTEX or MTBE compounds have been identified above the adopted screening criteria.

10.3 Summary – Human Health Risk Assessment

Based on the testing and assessment undertaken, there are no determinands above the relevant assessment criteria.

Chrysotile and Amosite asbestos fibres have been detected in four samples to date, with one sample quantified above trace levels (0.007%). However, there is a large gap in the investigation due to the limitations with the existing building.

. The above poses a risk to human health and will require further consideration. Further intrusive investigations are recommended to confirm the ground conditions, and attempt to delineate the location(s) of elevated asbestos concentrations.

10.4 Controlled Waters Risk Assessment

Groundwater or surface water testing has not been carried out based on the preliminary CSM risk assessment as the site is not considered to pose a significant risk to controlled waters for the following reasons:

- No significant gross or mobile contamination has been identified on site in soils based on the results obtained as a potential indicator of groundwater contamination.
- Following development of the site, the continued high percentage of hard covering will limit infiltration and subsequent migration of any residual contamination to Controlled Waters.
- For the made ground, the preparation of samples for leachability analysis has not been undertaken as this is an aggressive methodology and provides theoretical values which are unlikely to be representative of existing site conditions, real site leaching concentrations will be reduced significantly from that indicated by the laboratory testing, furthermore this would not be representative of post construction conditions, which will significantly reduce infiltration.
- The concentrations of leachable substances that could emanate from the site will be subject to dilution and dispersal during transport and so the risks will reduce with distance from the site and into the identified surrounding water bodies.
- The site does not lie within 500m of an SPZ.

10.5 Permanent Ground Gas and Vapours Results

A total of four ground gas monitoring visits have been carried out between the dates of 17th August and 2nd October 2023. Results are summarised in the table below:

	CH_4 (%)		CO_2 (%)		O_2 (%)		CO (ppm)		H_2S (ppm)		Flow (l/hr)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Peak	0.00	0.00	3.50	9.80	10.00	17.20	0.00	0.00	0.00	0.00	0.1	0.1
Steady	0.00	0.00	3.60	8.60	9.40	16.90					0.1	0.1

Notes: CH_4 = Methane; CO_2= Carbon dioxide; O_2= Oxygen; CO= Carbon Monoxide; H_2S= Hydrogen Sulphide; TVOC (PID)= Total Volatile Organic Compounds (as measured with Photo Ionisation Detector); ppm= Parts Per Million.

The highest carbon dioxide concentrations were recorded in WS01 (9.80% v/v) on the fourth visit. A maximum peak flow of 3.6 l/hr was recorded in WS06 during the fourth visit. However, with the exception of this peak reading, all other peak and steady readings were below the limit of detection of 0.1l/hr on all other visits.

The atmospheric pressure ranged between 996mb and 1020mb over the monitoring period, of which visits were conducted over a range of falling and steady pressure trends.

10.6 Ground Gas Risk Assessment

Basis of Assessment

In order to assess the ground gas situation and the requirement for ground gas precautionary measures at the site, guidance was taken from CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings', BS8485:2015+A1:2019 'Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' and CL:AIRE Technical Bulletin TB17 'Ground Gas Monitoring and 'Worst-Case' Conditions'.

Rationale and Suitability of Dataset

As per the Phase 1 Desk Study, in accordance with CIRIA C665 and as set out in Appendix A of this report, the ground gas generation potential is considered to be **low**. The sensitivity of the development is **low** on account of the proposed a four storey self-storage facility with basement.

In line with current guidance, it is recommended gas monitoring should comprise 4 visits over a 2-month period. Gas monitoring is ongoing therefore the below assessment is based on the data available at this stage.

Assessment of Data
As the proposed end-use is a commercial development, guidance dictates that the gas monitoring results should be assessed in accordance with the methodology detailed in BS8485:2015+A1:2019.

The Wilson and Card methodology uses the concept of a Gas Screening Value (GSV) which is derived using the following equation: (max gas concentration / 100) x maximum steady flow.

A maximum steady flow of 0.1l/hr has been used to derive the GSVs. The GSV's for the site are presented below.

Ground Gas	Adopted Typical Flow Rate (l/hr)	Max Concentration (% v/v)	GSV (l/h)	Classification based on GSV	Typical Threshold Concentration Exceeded
Methane	0.1	0.1	<0.7	CS1	No
Carbon Dioxide	0.1	9.8	<0.7	CS1	Yes

The GSVs place the site the site into Characteristic Situation 1 (CS1) for carbon dioxide and methane, as outlined in CIRIA C665.

Exceedances above the typical threshold concentrations have been identified for carbon dioxide within four monitoring wells out of the five locations on all of the monitoring visits and therefore consideration of a classification as CS2 should be made. .

The ground gas monitoring has been reinforced by a lines of evidence approach in order to assess the ground gas risk at the site.

The initial peak flow reading in WS06 is not considered to be representative based on the data recorded in other locations on the same date and the fact that no other positive flow rates were detected during subsequent monitoring visits. Therefore, that gas concentrations recorded are not expected to migrate into confined spaces.

The majority of the installations were placed within naturally occurring gravelly sand, with the exception of WS04, which targeted made ground. However, the made ground deposits comprised a gravelly clay with demolition material as minor constituents. In addition, the proposed development incorporates a basement level beneath the entire building footprint, which will remove a significant proportion of the made ground soils.

Furthermore, no credible off-site ground gas sources were identified during the desk study.

The highest recorded exceedances of carbon dioxide were encountered within monitoring wells which targeted the natural strata.

In order to further increase confidence in this assessment and adopting a lines of evidence approach, reference has been made to the 2018 paper by Wilson et al (Ambience and EPG Ltd) "Using ternary plots for interpretation of ground gas monitoring results" and NHBC NF94 "Hazardous Ground Gas".

The paper states that carbon dioxide is widespread in the sub surface environment and is generated by microbial and geochemical processes. If there is any organic, carbonate or pyrite content in the soils or rocks then carbon dioxide could potentially be present at concentrations up to 21% v/v. Soils in the UK where carbon dioxide is present commonly include glacial Till and made ground.

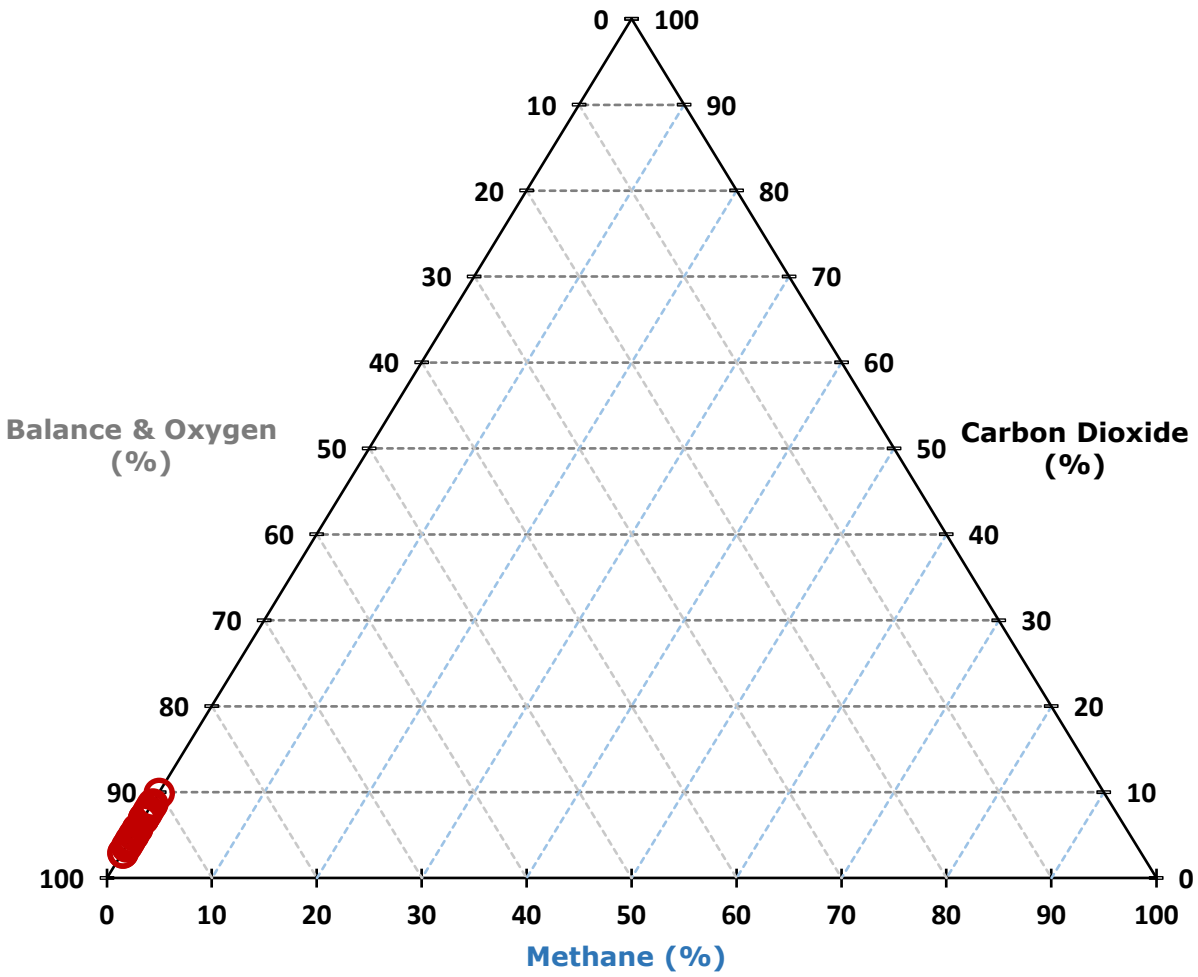
When monitoring wells are installed in these materials, the small volumes of organic material are exposed to oxygen. This can result in biological respiration or oxidation of the material resulting in the production of carbon dioxide.

Low volumes of organic material in made ground can also degrade aerobically to produce carbon dioxide or may locally be degrading anaerobically with the process being so slow that the methane completely oxides to carbon dioxide before reaching the well headspace. In all these cases the carbon dioxide is generated so slowly that it will not be emitted from the ground surface in quantities or at a rate that is sufficient to pose a risk to overlying development.

The screening approaches used in the UK for ground gas have a requirement to consider increasing the characterisation of a site identified as Characteristic Situation CS1 based on the Gas Screening Value, if carbon dioxide concentrations exceeding 5% have been recorded.

This increase in characterisation is not a mandatory requirement in any of the guidance documents. The distribution of elevated concentrations and the source of the gas should be considered before deciding whether the increase is appropriate. The paper goes on to state that in most cases there will not be any need to increase the classification if the carbon dioxide is caused by biological respiration of small quantities of organic material. Increasing the characteristic situation is only likely to be a requirement if the gas source is one of the high-risk sources (landfills, open mine workings, flow of acidic mine water through rocks).

Based on the methodology described in the paper, a ternary plot has been produced using the results from the continuous monitoring data and is presented below:



The distribution of the gas concentrations over the monitoring period fall within the area associated with microbial respiration of organic matter in soils in accordance with Wilson et. al.

Where gas monitoring results plot in the zone for microbial respiration, there is no requirement to increase the characteristic situation simply because the carbon dioxide concentration exceeds 5%. This, as the paper recommends, is supported by other data and lines of evidence such as the site conceptual model and continuous monitoring data.

Assessment Summary

In summary, based on a lines of evidence approach, we consider that the site should be placed within CS1 classification and ground gas protection measures are not required within structures at the development, subject to agreement with the Local Authority, based on the following rationale:

- Based on the GSVs alone, the site falls into CS1 classification.
- The "worst case" data has been plotted on a ternary diagram, which indicates the carbon dioxide concentrations are likely due to microbial respiration, where there is no requirement to increase the characteristic situation simply because the carbon dioxide concentration exceeds 5%.
- Representative flows are below the limit of detection in all locations on all visits.
- The majority of the installations were placed within naturally occurring gravelly sand.
- No credible off-site gas source has been identified within the desk study assessment.

The methodology of CL:AIRE RB17 states that where natural soils are present with made ground less than 1 m thick, composed of inert material such as sub-base of mineral soils, and no radon barrier is being provided, then no gas protection is required as this represents CS1.

10.7 Qualitative Risk Assessment

The CSM has been revised based on the findings of the site investigation and laboratory testing results and these are presented overleaf. Unless stated otherwise, in respect to off-site sources, only risks that are assessed as moderate and above within the preliminary CSM have been carried forward to this section, or where a previously unidentified potential source, pathway and / or receptor has been identified from the recent site works. .

Human Health						
Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk	Justification
On site Made Ground/ Coal Yard/ Railway Sidings Metals, PAHs, asbestos	Root uptake, ingestion, direct contact, inhalation of dusts	End-users	Low Likelihood	Medium	Moderate/ Low	The test results revealed no exceedance above the adopted screening criteria for metals and PAHs. Presence of Chrysolite and Amosite fibres were found on site, with one sample being above trace levels (0.007%).This sample is indicated to be present beneath the proposed building footprint, and thus the source would likely be removed as part of development of the site. However, the asbestos identified on-site is not localised and therefore there may also be asbestos within the areas that have not been investigated. Given there are proposed areas of soft landscaping, remedial measures may be required to reduce the risk to end-users.
On site Made Ground Metals and organic contamination	Migration into/chemical attack of water supply pipelines	Water Pipelines / End users	Unlikely	Medium	Low	Contaminants within the soil/groundwater could potentially attack the clean potable water supply pipe, contaminants should be assessed in accordance with the relevant guidance to determine the correct pipe material and level of precautions required.
On site Made Ground Ground Gas (carbon dioxide and methane)	Migration into confined spaces, inhalation and asphyxiation/ explosion	End-users	Low likelihood	Severe	CS1	Gas monitoring results showed elevated carbon dioxide concentrations in the majority of the locations. A lines of evidence approach has been used in order to classify the site as CS1. .

Controlled Waters						
Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk	Justification
Made Ground PAHs, Metals	Overland flow, / migration through saturated zone	Grand junction reservoir 242m away (Surface waters)	Unlikely	Medium	Low	It is considered contaminants associated with the made ground and other past industrial uses are unlikely to impact the Grand Junction reservoir. The made ground is limited in thickness and though the site is underlain with permeable strata, the site is predominantly surfaced with hardstanding and will remain so, which will limit leaching to the soils. Due to the distance from the site to the reservoir, it's likely that contaminants will have attenuated prior to reaching the reservoir. A low risk is posed to the reservoir from the made ground.
	Leaching through unsaturated zone / Migration through saturated zone	Principal Aquifer (Groundwater)	Unlikely	Medium	Low	No grossly contaminated soils were encountered during the site investigation and test results indicate low levels of PAHs and TPHs. In addition, the site is currently surfaced predominantly in hardstanding and will remain so. The nature of the development will reduce leaching through placement of a building with a larger footprint and a formal surface water drainage system, which will further reduce potential for contamination. By virtue of the development taking place, this should contribute to an overall "betterment" of groundwater quality. The risk is considered to be low.
	Migration through saturated zone	Unproductive Aquifer (Groundwater)	Unlikely	Mild	Very Low	The site is underlain by permeable strata which permits leaching through unsaturated and saturated zone into the bedrock aquifer. However, the site is currently surfaced predominantly in hardstanding and will remain so. The bedrock aquifer is unproductive, and not likely to be a sensitive receptor. The nature of the development will reduce leaching through placement of a building with a larger footprint and a formal surface water drainage system, which will further reduce potential for contamination. By virtue of the development taking place, this should contribute to an overall "betterment" of groundwater quality.

10.8 Outline Remedial Measures

No sources of contamination have been identified on site for metals, TPHs and PAHs. However, chrysotile and amosite fibres were detected, with one sample above trace levels. These are associated with the made ground, and the majority will be removed during the construction of the basement level. However, given the limited investigation on the site, there may be unidentified contamination and therefore further investigation works are recommended.

In regard to the soft landscaping around the perimeter of the site, made ground soils will either need to be removed or a cover layer system may need to be implemented to reduce the risk to end-users.

If adopted, a cover of "clean" subsoil and topsoil should be provided to break the pathway to site end users. This should be 450mm in soft landscaping areas (Public Open Space – POS) in accordance with BRE 465. This will allow plants to be grown and prevent undesirable soils being brought to the surface.

Prior to import or re-use of clean cover soils, they should be tested to confirm chemical suitability. After installation of the clean cover, soil depths should be verified by a suitably qualified independent geo-environmental engineer, such as BSL.

Utilities
The level of protection for the clean potable water supply pipes should be determined using the local water company risk assessment criteria in accordance with UKWIR. Further chemical testing is recommended as part of a post demolition investigation.

It would be prudent to lay new services in clean backfill to protect maintenance workers from inadvertent exposure to the localised low levels of asbestos identified.

Ground Gas Protection Systems
A lines of evidence approach has been used in order to assess the ground gas risk at the site. The site has been classified as CS1 based on the following rationale:

- Based on the GSVs alone, the site falls into CS1 classification.
- The "worst case" data has been plotted on a ternary diagram, which indicates the carbon dioxide concentrations are likely due to microbial respiration, where there is no requirement to increase the characteristic situation simply because the carbon dioxide concentration exceeds 5%.
- Representative flows are below the limit of detection in all locations on all visits.
- The majority of the installations were placed within naturally occurring gravelly sand.
- No credible off-site gas source has been identified within the desk study assessment.

As part of any enabling or remedial works, it is recommended that all boreholes with monitoring installations are decommissioned in line with EA guidance in order to remove preferential pathways for ground gas migration.

General
It is recommended that the approval of the Regulators (Local Authority /Environment Agency) is obtained in regard to the above prior to any irrevocable action is taken at the site.

Once the above bodies have approved the above outline remedial proposals, a Remedial Strategy and a Verification Plan for Ground Gas Protection Measures will need to be produced to meet planning requirements and submitted to the regulatory authorities for approval. This will also give guidance to enable a suitably qualified contractor to carry out the works.

In addition, the writing and approval of a Materials Management Plan (MMP) or suitable exemptions/permits will be required to allow re-use of suitable material at the site.

A watching brief is recommended during groundworks for any unidentified sources of contamination. If any grossly contaminated material is encountered works should cease in that area and BSL consulted.

As part of any enabling or remedial works, it is recommended that all boreholes with monitoring installations are decommissioned in line with EA guidance in order to remove preferential pathways for ground gas migration.

Once remediation is complete, verification reports will need to be produced by a suitably qualified independent geo-environmental engineer, such as BSL, in order to achieve regulatory sign off.

10.9 Health and Safety Issues

During the reclamation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. The risk to construction and ground workers is assessed in the table below:

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
Made Ground (heavy metals, PAHs, petroleum hydrocarbons)	Ingestion, direct contact, inhalation of dusts.	Construction Workers	Unlikely	Medium	Low
Asbestos	Ingestion, direct contact, inhalation of dusts.	Construction Workers	Likely	Medium	Moderate
Ground gas	Inhalation in confined spaces/trenches	Construction Workers	Low likelihood	Severe	Moderate

Trace levels of Chrysotile and Amosite asbestos have been identified in three samples to date, with a further sample above trace levels (0.007%) and trace levels of asbestos are assumed across the site. The risk from asbestos should be highlighted in the method statements and site induction. If further evidence of asbestos is encountered in the soils, work should cease until asbestos control measures have been agreed and put in place. Asbestos is further discussed in Section 10.10 below.

The risk from made ground will be mitigated by standard PPE including gloves. Welfare facilities should be made available to wash before hand to mouth activities.

It is noted that concentrations of carbon dioxide (an asphyxiant) in the soil exceed HSE Workplace Exposure Limits for personnel in the working environment of 1.5% for short term (15 minutes) exposure and/or 0.5% for long term exposure. Furthermore, soil concentrations of oxygen are below the HSE recommendations of 18%.

Soil gas concentrations are not necessarily reflected by those in the breathing zone, all contractors and maintenance workers should be made aware of the possible presence of carbon dioxide and should take all necessary health and safety precautions when working in trenches or confined spaces.

General guidance on these matters is given in the Health and Safety Executive (HSE) document “Protection of Workers and the General Public during the Redevelopment of Contaminated Land”. In summary, the following measures are suggested to provide a minimum level of protection:

- All ground workers should be issued with the relevant protective clothing, footwear and gloves. These protective items should not be removed from the site and personnel should be instructed as to why and how they are to be used.
- Hand-washing and boot-washing facilities should be provided.
- Care should be taken to minimise the potential for off-site migration of contamination by the provision of dust suppression control and wheel cleaning equipment during the construction works.
- Good practices relating to personal hygiene should be adopted on the site.
- The contractor shall satisfy the Health and Safety Executive with regard to any other matters concerning the health, safety and welfare of persons on the site.

10.10 Asbestos

The investigation of asbestos issues within structures was beyond the scope of this report. However, guidance from UK Government indicates that asbestos should be assumed to be present in buildings unless proven otherwise.

Any asbestos within structures will require removal prior to re-development. This will need to be done by a suitably qualified experienced and licensed contractor, who ensures that adequate PPE is provided to operatives, and that all the relevant legislation is adhered to.

In addition, the presence of asbestos within the ground will require, a safe system of work to be set up on site to deal with the asbestos risk from the made ground. This may include but be not limited to:

- The use of qualified personnel where required.
- Careful segregation of stockpiles on site.
- Defining transport routes.
- Cleaning down of machinery in designated areas.
- Decontamination unit for ground workers.
- Damping down of soils to prevent dust migration.

Asbestos fibres have been identified in four samples at the site with quantification analysis identifying three of four samples to contain trace amounts. At these concentrations the liberation of fibres is considered to be unlikely and no specific precautionary measures with regards to asbestos are likely to be required at the site. The level of precautions required are at the discretion of the principal contactor on site however good site practices including minimising the generation of dusts should be adhered to and sufficient to mitigate against the risk from asbestos. In addition, site personnel should have the risk communicated at the induction stage. It is recommended that the asbestos in construction materials assessment tool is used at the site to inform asbestos licensing and control measures.

Excavations in soils containing asbestos should comply with the CL:AIRE publication ‘Interpretation for Managing and working with Asbestos in Soil and Construction and Demolition Materials’ (CARSOIL) and CAR 2012. All such works will need to be agreed with the regulatory bodies (HSE and/or LA).

Additional guidance is provided within the BSL methodology Guidance Note in Appendix A.

11.0 WASTE SOIL CLASSIFICATION & ASSESSMENT

11.1 Summary

BSL have undertaken a preliminary assessment of potential excavation waste to arise from the site during redevelopment to:

- Classify the excavation waste to arise as either hazardous or non-hazardous.
- Identify the most sustainable options for the wastes to arise in accordance with the waste hierarchy.
- Provide a written description of the waste required as part of the Duty of Care.
- Provide details of "hazardous properties" to complete hazardous waste consignment note (where applicable).
- Be able to provide a basic classification report to a landfill operator (where waste is destined for landfill disposal).

11.2 Waste Classification Procedure

As described in the 'Waste Duty of Care Code of Practice (2016)' any substance or object that the holder discards, intends to discard or is required to discard is a waste. It is the responsibility of the waste producer to classify this waste. The classification process is described in the 'Guidance on the classification and assessment of waste' WM3 and aims to determine whether the waste is Hazardous or Non-Hazardous to human health and the environment.

Hazardous wastes are signified by entries where the code is followed by an asterisk, where some wastes are deemed hazardous without further assessment, which are termed "Absolute Entries" e.g. most waste oils. Alternatively, waste entries are termed "Mirror" entries that require further assessment of hazardous properties, in order to determine whether they are hazardous waste or not (e.g. soil and stones). The EWC codes relevant to excavation wastes are:

- 17 05 03* - soil and stones containing dangerous substances.
- 17 05 04 – soil and stones other than those mentioned in 17 05 03.

The Landfill Directive (Directive 1999/31/EC on the landfilling of waste, Decision 2003/33/EC and Landfill Regulations 2005) led to the establishment of a methodology for classifying wastes.

Wastes first need to be classified based on their total concentrations and classified as either hazardous or non-hazardous waste. WAC testing is only required if the end disposal route is a landfill and WAC analysis must not be used for waste classification.

Wastes can only be accepted at a landfill if they meet the relevant Waste Acceptance Criteria (WAC) for that type of landfill. A waste must comply with the WAC limits for the relevant landfill, otherwise the soil will need to be pre-treated. There are three different WAC criteria, these are:

- Inert waste.
- Stable Non-Reactive Hazardous Waste (SNRHW).
- Hazardous waste.

There are no standard set of WAC limits for non-hazardous landfill sites and each non-hazardous landfill will have its own set of criteria under which it is licenced to accept non-hazardous waste. These will need to be determined through the selected waste receiver prior to disposal.

A non-hazardous waste should not be compared with WAC limits for hazardous or SNRHW waste sites and the WAC test should only be used to determine if the waste is suitable for disposal at an inert waste landfill site. Likewise, wastes classified as hazardous based on their total concentrations should not be compared with WAC limits for inert waste landfill sites, as these will not be accepted.

Details of how material should be classified for waste disposal are presented in the BSL Methodology and Guidance in Appendix A and are summarised in the table below:

	PRIOR TO LEAVING SITE			
Classification based on Total Concentrations[1]	**Non-Hazardous Waste**		**Hazardous Waste**	
	IF SOILS CANNOT BE RE-USED ELSEWHERE AND MUST GO TO LANDFILL			
WAC testing	Below inert WAC limit values	Above inert WAC limit values	Below hazardous WAC limit values[4]	> WAC limit values
Landfill requirements	INERT landfill	NON-HAZARDOUS landfill[2]	HAZARDOUS landfill	PRE-TREATMENT[3]

1 Total concentrations are defined as tests results on solids as opposed to leachate (i.e. a liquid).
2 Individual sites may have certain limit values pre-determined in their licence.
3 After pre-treatment the material characteristics may have changed to an extent that allow the soil to be re-classified.
4 Possibility that wastes could be classified as stable Nonreactive HAZARDOUS waste in non-hazardous Landfill (e.g. soils containing low concentrations of asbestos, gypsum or sulphate bearing soils).

Waste classified as non-hazardous can be accepted into a non-hazardous landfill without having to pass any numerical WAC.

Soils above hazardous WAC limit values require pre-treatment prior to disposal. The effective pre-treatment, typically involving separation, sorting and screening, can offer cost savings through reducing the hazardous nature and volumes of soil. Costs for disposal of non-hazardous/hazardous soils are significant compared to the disposal of inert material.

Inert Waste
The possibility of automatic inert classification of the naturally occurring "clean" soils should be explored in accordance with Section 4.3 of the EA guidance document. The Council Decision includes a list of wastes in Section 2.1.1 of the document that are assumed to be inert and therefore acceptable at a landfill for inert waste without testing. This is the case if:

- They are single stream waste of a single waste type (although different waste types from the list may be accepted together if they are from a single source); and
- There is no suspicion of material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify contamination and they do not contain other classes of landfill.

11.3 Waste Classification and Waste Acceptance Criteria (WAC)

We have reviewed the testing results and assessed them through a waste classification database which allows users to code and classify waste as defined in the EWC (European Waste Catalogue) based on EC Regulation 1272/2008 on the Classification, Labelling and Packaging of Substances and Mixtures (CLP) and latest Environment Agency guidance (WM3 "Guidance on the classification and assessment of waste - Technical Guidance").

The samples tested were screened against assessment criteria within WM3 using the HazWasteOnline tool to assess whether they contained any contaminants in the hazardous range.

The Waste Classification Report and WAC testing results are presented in Appendix I The results of the waste assessment based on total concentrations are presented in the table below, alongside the WAC analysis test results.

Location	Depth (m)	Stratum	Waste Classification	WAC Analysis	Landfill	Comments
BH01	0.50	MADE GROUND	Non-hazardous	-	-	-
BH01	1.00	MADE GROUND	Non-hazardous	Exceeds Inert WAC	NON-HAZARDOUS landfill	-
BH03	0.40	MADE GROUND	Non-hazardous*-	Inert	INERT landfill	-
BH03	0.70	MADE GROUND	Non-hazardous	-	-	-
WS03A	0.30	MADE GROUND	Non-hazardous	-	-	-
WS03A	0.60	MADE GROUND	Non-Hazardous	-	-	-
WS03B	0.25	MADE GROUND	Non-hazardous	-	-	-
WS04	0.40	MADE GROUND	Non-hazardous	-	-	-
WS06	0.50	MADE GROUND	Non-hazardous	-	-	-
WS06	0.70	MADE GROUND	Non-hazardous*-	Exceeds Inert WAC	NON-HAZARDOUS landfill	-
WS07	0.40	MADE GROUND	Non-hazardous	-	-	-

***Results have been inferred from HazWaste Online classification for similar materials on the site, and therefore landfill classification has also been inferred assuming non-hazardous classification.**

Based on the waste classification database assessment, the majority of the made ground soils have been classified as **non-hazardous.**

Waste Containing Asbestos

Should soils contain asbestos, the concentration and type of asbestos identified, in addition to the chemical composition (i.e. hazardous or non-hazardous detailed above), will determine which waste code is applicable to the soils and which landfill will accept it.

Waste	Conc. by Weight (%)	EWC 2002 Catalogue Entry Code	Waste Disposal Route
Non-hazardous containing asbestos fibres	<0.001 - <0.1%	17 05 04 (soil and stones other than those mentioned in 17 05 03*)	Non-hazardous landfill subject to achieving Waste Acceptance Criteria (WAC) for a stable non-reactive hazardous landfill site.
Hazardous containing asbestos fibres	<0.001 - <0.1%	17 05 03* (soil and stones containing dangerous substances)	Hazardous landfill subject to achieving Waste Acceptance Criteria (WAC) for a hazardous landfill site.
Non-hazardous soils containing asbestos fibres	>0.1%	17 05 03* (soil and stones containing dangerous substances)	Hazardous landfill authorised to receive asbestos, or in a stable non-reactive

Waste	Conc. by Weight (%)	EWC 2002 Catalogue Entry Code	Waste Disposal Route
			hazardous waste cell at a non-hazardous landfill authorised to receive asbestos.
Non-hazardous Soils containing ACM (Mechanically separable)	>0.1%	17 06 05 (construction material containing asbestos) 17 05 04 (soil and stones other than those mentioned in 17 05 03*)	ACMs disposed of at a hazardous landfill authorised to receive asbestos, or in a stable non-reactive hazardous waste cell at a non-hazardous landfill authorised to receive asbestos. Soils should be disposed of at a non-hazardous landfill subject to achieving Waste Acceptance Criteria (WAC) for a stable non-reactive hazardous landfill site.
Hazardous soils containing ACM	>0.1%	17 05 03* (soil and stones containing dangerous substances)	Hazardous landfill subject to achieving Waste Acceptance Criteria (WAC) for a hazardous landfill site.

The concentrations of fibres in the samples tested outside the existing building footprint ranged from trace to 0.007% which indicate the soils will potentially be accepted as stable non-reactive hazardous waste.

Location	Depth (m)	ACM	Conc. by Weight (%)	Waste Disposal Route
BH01	0.50m	Chrysotile Loose Fibre	0.007	Non-hazardous
BH03	0.70	Amosite Loose Fibre	<0.001	Non-hazardous
WS03B	0.25	Amosite Loose Fibre	<0.001	Non-hazardous
Ws07	0.44	Amosite Loose Fibre	<0.001	Non-hazardous

A watching brief should be maintained for evidence of Asbestos Containing Materials (ACMs), any ACMs observed should be handpicked and disposed of in accordance with current asbestos disposal regulations.

Testing for total contaminant concentrations on natural soils was not undertaken and they are assumed to be non-hazardous.

11.4 Options Assessment

Following the classification of waste materials, the options available for the waste can be considered in the context of the waste hierarchy as below:

- Onsite re-use (with or without prior treatment) under suitable exceptions/permits.
- Offsite processing for recycling or recovery e.g. screening.
- Offsite disposal (with or without prior treatment) i.e. landfill.

Where feasible, efforts should be made to retain soils for onsite re-use to minimise costs and maximise the sustainability of projects.

Based on the above, the possible options for the generation of waste soils at the site are described in the table below:

Waste Generation Source	Comments
Crush	Crushed concrete is/will be site derived from structures which had not been used for potentially contaminative activities. These should be subject to an asbestos survey and removal of asbestos as required, prior to demolition and crushing of structures. Assuming the above criteria are met, with materials containing no asbestos or ACM, crushed concrete is considered to be inert without testing. Where samples of crushed concrete have been subject to totals testing this is likely to hazardous due to pH, and where subject to WAC testing, the sulphate and TDS limits are breached, this is to be expected due to the presence of concrete.
Made Ground from site levelling/foundations excavations/services excavations.	Samples of made ground from across the site have been classified as non-hazardous for off-site disposal purposes, although should be suitable for re-use on site if required under suitable exemptions/permits.
Natural ground from site levelling/foundations excavations/services excavations.	The superficial deposits may be considered suitable for re-use onsite as fill where the criteria of the WFD exception for re-use of naturally occurring soils can be met. Naturally occurring clean materials could also be exported to another site under the direct transfer scenario of the DoWCoP.

General
If any grossly contaminated material is encountered during the construction phase, it is possible that this may be classified as hazardous, and testing should be undertaken at that time.

Where it is necessary to dispose material off site it is recommended that materials are segregated and sufficient time is allowed to further classify the actual soil arisings that constitute the waste, including discussion with landfill sites and waste transfer stations to find the best disposal route. It is illegal to dilute and mix soils without a suitable permit.

As a significant proportion of the soils likely to be generated on site are clean it is recommended that where possible that the soils could be recycled at a suitable local waste treatment plant or transfer station rather than a landfill disposal route.

11.5 Re-use of Soils

By definition in law, any material excavated from the ground becomes waste at the moment of excavation. If that soil (now a “waste”) is then placed on another part of the development site (or used on another development site) without an appropriate materials management plan, permit or exemption being in place, by law this material is defined as “illegally deposited waste”.

Landfill tax rules allow HM Revenue & Customs (HMRC) to recover landfill tax on illegally deposited waste on construction sites. This could lead to excessive costs without the correct documentation in place. In addition, a person who makes, knowingly causes or knowingly facilitates a disposal to be made at an unauthorised site is also liable to pay Landfill Tax.

In order to comply with UK legislation and avoid excessive costs, if the re-use of soils is proposed on site, this should be done in accordance with the relevant exemptions or permits in place.

Soils Re-use Under DoWCoP
One of the main industry mechanisms for allowing the re-use of soils in construction is the CL:AIRE “Development Industry Code of Practice for the Definition of Waste” (CL:AIRE DoWCoP) also known as a Materials Management Plan (MMP). Further guidance is provided in the BSL Methodology and Guidance in Appendix A.

To implement the DoWCoP (for Route A), there is a requirement to notify the Environment Agency and Local Authority of the intention to use the code of practice in principal, after which there is a 21-day notice period for their response.

In order to re-use soils under the DoWCoP, there are four key criteria that need to be met:

- The aims and objectives of the project meet the requirements of the Waste Framework Directive (does not harm human health or the environment).
- The soils can be demonstrated to be suitable for use (backed up by chemical/geotechnical testing and assessment).
- There is certainty of use (planning consents are in place alongside materials tracking, which should be in place as part of good site practice in any case).
- Quantity (the quantity of materials used should be known).

Information on existing site levels, proposed levels, volumes generated (e.g. foundation / drainage excavation arisings) would need to be known in order to complete the MMP.

If the DoWCoP is the chosen route, the MMP should be in place and declared by a Qualified Persons (QP) before works commence, otherwise excavated soils could constitute an illegal deposit of waste and enforcement action could be taken by the EA and HMRC.

The declared MMP should be amended as new import sources are added.

Once the project is complete, a verification report detailing soils re-use/import will need to be produced and submitted to CL:AIRE, which may be subject to a random audit process. Sites found to be non-complaint with the CoP can be referred to the EA for further investigation.

Regardless of implementing re-use under the code of practice or not, all sites should have some form of materials tracking in place in compliance with current legislation. Any re-use scheme should also be designed to minimise disposal costs.

Re-use of soils containing asbestos should comply with the CL:AIRE publication 'Interpretation for Managing and working with Asbestos in Soil and Construction and Demolition Materials' (CAR-SOIL™) and CAR 2012.

In terms of the re-use of brick/concrete crush materials, the DoWCoP does cover aggregates, but only on the site of origin, and the EA WRAP aggregate Quality Protocol might best apply to ensure quality standards, which are discussed further below.

Soils Re-use under Exemptions and Permits
Other potentially suitable / options to allow the re-use and/or import of soils and aggregates on site are provided in the table below:

Re-use Mechanism	Description
U1 Exemption	Can be applied to re-use/import of soils and stones, but only up to 1000 tonnes or for brick and concrete up to 5000 tonnes. This is usually an efficient way to re-use small volumes of waste materials. However, only one U1 can be filled in per site in any 3-year period. Quick and free via online registration.
WRAP Quality Protocols	Describes how processed demolition arisings can be removed from regulatory waste regime. Requires a demonstration of appropriateness by: • Factory Production Control Manual. • Facility Permit (or Exemption). • Grading Analysis.

Re-use Mechanism	Description
Waste Framework Directive (WFD) exclusion	In regard to "clean" naturally occurring soils only that are to be re-used on their site of origin, these are covered by a Waste Framework Directive (WFD) exclusion which is an EA regulatory position statement. So long as the project can prove the four criteria listed above for the DoWCoP, then permits or the DoWCoP are not required. However, many projects still use the CoP to ensure compliance.
T5 Screening and blending of waste	The T5 exemption allows you to temporarily treat waste on a small scale to produce aggregate or soil at a particular location, such as a construction or demolition site. The limit is 5,000 tonnes. This applies to: • Screening soil on a demolition site to remove wood and rubble. • Blending soil and compost that has been produced under an exemption on a construction site to produce better soil for landscaping on that site (e.g. peaty deposits). • Crushing waste (except bricks, tiles and concrete) before screening or blending • Grading waste concrete after it has been crushed to produce a certain type of aggregate.
T7 Exemption	The T7 allows treatment of waste bricks, tiles and concrete by crushing, grinding or reducing in size. This needs to be registered with the Local Authority.
Other Permitting Routes	Other options include use under an Environmental Permit (Standard or Bespoke Rules), however these may be a time consuming and costly route, where use of the other above options (if applicable) are likely to be more feasible in construction.

12.0 CONCLUSIONS

12.1 Geo-Environmental

Geo-Environmental – Human Health
Testing of the made ground at the site did not reveal any exceedances of heavy metals, PAHs, petroleum hydrocarbons, BTEX or MTBE compounds.

Chrysotile and Amosite fibres (loose fibres) have been detected in four samples of made ground across the site. On quantification analysis the asbestos level within the four samples was between <0.001% and 0.007% mass with three samples classified as being trace levels.

Ground gas monitoring has revealed a maximum peak carbon dioxide concentration of 9.80%v/v and methane concentrations of 0.1%v/v. The gas monitoring is completed and ground gas protection measures are not required based on the following rationale:

- Based on the GSVs alone, the site falls into CS1 classification.
- The "worst case" data has been plotted on a ternary diagram, which indicates the carbon dioxide concentrations are likely due to microbial respiration, where there is no requirement to increase the characteristic situation simply because the carbon dioxide concentration exceeds 5%.
- Representative flows are below the limit of detection in all locations on all visits.
- The majority of the installations were placed within naturally occurring gravelly sand.
- No credible off-site gas source has been identified within the desk study assessment.

The above are considered to pose a risk to human health and remedial measures may be required in the form of a cover system in soft landscaping areas to mitigate the risk.

Further intrusive works are recommended in the area of the existing building footprint to confirm the ground conditions and further assess the risks to human health.

Geo-Environmental – Controlled Waters
The overall risk to controlled waters is considered to be low and no further action is required.

Waste
Waste classification for the made ground at the site has revealed the soils to be non-hazardous.

Waste recommendations are for re-use on-site where suitable. Alternatively, soils may be accepted at a local recycling facility.

12.2 Geotechnical

Foundations

Piled foundations are considered a suitable option for the site. Preliminary pile calculations indicate that an allowable load of 350kN may be achieved for a 450mm diameter circular concrete pile at a depth of 15m bgl, increasing to 480kN for a 18m pile. Further intrusive investigation is recommended to confirm ground conditions and obtain data for detailed piled design.

Floor slabs
Suspended floor slabs are recommended. However, ground bearing floor slabs may be adopted, providing the criteria are met.

Concrete classification

DS-1 and ACEC Class AC- 1 conditions generally prevail within the made ground and superficial deposits. Total potential sulphate values within the London Clay Formation indicate that pyrite may be present within the strata. However, further data would need to be obtained in order to determine the concrete classification for this material.

Highways
Equilibrium CBR values of 5% are likely to be achieved in undisturbed natural granular soils and 2.5-3% for natural clays soils for pavement design purposes, unless proven otherwise by in-situ testing at formation level by a specialist geotechnical engineer. Equilibrium CBR values are likely to be 2% within the made ground.

Drainage (SUDS)
The use of soakaways within the natural ground may be feasible at the site due to the presence of permeable strata underlying the site.

12.3 Further Work

The following further work is considered necessary to progress the site to construction phase:

- Demolition Asbestos survey.
- Further intrusive investigations – Post demolition, including Cable Percussive boreholes and Window sampling to confirm ground conditions within the existing building footprint.
- Detailed foundation design by a structural engineer
- Design of Remedial Strategy and confirmation with the Local Authority.
- Implementation of the Remedial Strategy and verification of the remedial works.

13.0 ABBREVIATIONS AND DEFINITIONS

GLOSSARY	
Term / Abbreviation	**Definition**
AST	Above Ground Storage Tank.
B(a)P	Benzo (a) Pyrene.
BGS	British Geological Survey.
BRE	Building Research Establishment.
BS	British Standard.
BSL	Brownfield Solutions Ltd.
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes.
CBR	California Bearing Ratio (used in pavement/highways design).
CAR 2012	Control of Asbestos Regulations (2012).
CBCB	Cheshire Brine Compensation Board.
CBCD	Cheshire Brine Compensation District.
CBR	California Bearing Ratio.
CIEH	Chartered Institute of Environmental Health.
CIRIA	Construction Industry Research Association.
CL:AIRE	Contaminated Land: Applications in Real Environments.
CLEA	Contaminated Land Exposure Assessment.
CLO	Contaminated Land Officer.
COMAH	Control of Major Accident Hazards.
Contamination	Presence of a substance which is in, on or under land, and which has the potential to cause significant harm or to cause significant pollution of controlled water. There is no assumption in this definition that harm results from the presence of the contamination. Naturally enhanced concentrations of harmful substances can fall within this definition of contamination. Contamination may relate to soils, surface water, groundwater or ground gas.
Controlled Waters	Inland freshwater (any lake, pond or watercourse above the freshwater limit), water contained in underground strata and any coastal water between the limit of highest tide or the freshwater line to the three-mile limit of territorial waters.
CPT	Cone Penetration Test.
CSM	Conceptual Site Model. A schematic hypothesis of the nature and sources of contamination, potential migration pathways (including description of the ground and groundwater) and potential receptors, developed on the basis of the information from the preliminary investigation and refined during subsequent phases of investigation and which is an essential part of the risk assessment process. The conceptual site model is initially derived from the information obtained by the preliminary investigation (i.e. the Phase I Desk Study). This conceptual model is used to focus subsequent investigations, where these are considered to be necessary, in order to meet the objectives of the investigations and the risk assessment. The results of intrusive investigations can provide additional data that can be used to further refine the conceptual site model.
DCP	Dynamic Cone Penetrometer.
DNAPL	Dense Non-Aqueous Phase Liquid.
DoWCoP	Definition of Waste Code of Practice.
DWS	Drinking Water Standard.
EA	Environment Agency.
EHO	Environmental health Officer.
EQS	Environmental Quality Standard.

GLOSSARY	
Term / Abbreviation	**Definition**
GAC	Generic Assessment Criteria.
GDR	Geotechnical Design Report.
GFR	Geotechnical Feedback Report.
GIR	Ground Investigation Report.
GSV	Gas Screening Value.
Harm	Adverse effect on the health of living organisms, or other interference with ecological systems of which they form part, and, in the case of human health, including property/structures and water supply pipelines.
Hazard	Inherently dangerous quality of a substance, procedure or event.
HDPE	High Density Polyethylene.
HSV	Hand Shear Vane.
K	Modulus of Subgrade Reaction.
LCRM	Land Contamination: Risk Management (EA guidance).
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene).
LOD	Limit of Detection (for particular method adopted).
MMP	Materials Management Plan.
Mv	Modulus of Volume of Compressibility.
ND	Not Detected.
NHBC	National House Building Council.
NR	Not Recorded.
OS	Ordnance Survey.
PAH	Polycyclic Aromatic Hydrocarbon.
Pathway	Mechanism or route by which a contaminant comes into contact with, or otherwise affects, a receptor.
PCB	Poly-Chlorinated Biphenyl.
PCSM	Preliminary Conceptual Site Model.
pH	Scale used to specify how acidic or basic a water-based solution is.
PHC	Petroleum Hydrocarbons.
PID	Photo Ionisation Detector.
PNEC	Predicted No-Effect Concentration.
Precision	Level of agreement within a series of measurements of a parameter.
PSD	Particle Size Distribution.
PVC	Polyvinyl Chloride.
Receptor	Human health, living organisms, ecological systems, controlled waters (surface waters and groundwater within aquifers), atmosphere, structures and utilities that could potentially be adversely affected by contaminant(s).
Risk	Probability of the occurrence, magnitude and consequences of an unwanted adverse effect on a receptor.
Risk Assessment	Process of establishing, to the extent possible, the existence, nature and significance of risk.
Sampling	Methods and techniques used to obtain a representative sample of the material under investigation.
SOM	Soil Organic Matter.
Source	Location from which contamination is, or was, derived. This could possibly be the location of the highest soil, groundwater or gas concentration of the contaminant(s).
SPT	Standard Penetration Test.
SVOCs	Semi Volatile Organic Compounds.
TOC	Total Organic Carbon.

GLOSSARY	
Term / Abbreviation	**Definition**
TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group).
TVOCs	Total volatile organic compounds.
UCS	Unconfined Compressive Strength.
Uncertainty	Parameter, associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measurement.
UST	Underground Storage Tank.
UXO	Unexploded Ordnance.
VCCs	Vibro Concrete Columns.
VSCs	Vibro Stone Columns
VOCs	Volatile Organic Compounds.
WAC	Waste Assessment Criteria.
WFD (in waste context)	Waste Framework Directive.
WFD (in water context)	Water Framework Directive.
Units	**Definition**
°	Degrees
Φ	Phi angle (in degrees)
g/l	Grams per Litre
Km	Kilometres
kPa	Kilo Pascal (Equivalent to kN/m^2)
$KN/m^2/mm$	Kilo Newton per metered squared per millimeter
kN/m^2	Kilo Newtons per metre squared
kPa	Kilo Pascal (Equivalent to kN/m^2)
l/hr	Litres per hour
MJ/kg	Mega joule per kilogram
MN	Mega Newton
M^2/MN	Mega Newton per metre squared
M	Metres
m bgl	Metres Below Ground Level
m OD	Metres Ordnance Datum (sea level)
µg/l	Micrograms per Litre (parts per billion)
µm	Micrometre
mb	Millibars (atmospheric pressure)
mg/kg	Milligrams per kilogram (parts per million)
mg/m^3	Milligram per metre cubed
mm	Millimetre
ppb	Parts Per Billion
Ppm	Parts Per Million

14.0 REFERENCES

Association of Ground Investigation Specialists. 'Guidelines for Good Practice in Site Investigation'. Issue 2, March 2006.

Black, W.P.M. & Lister, N.W. The strength of clay fill subgrades, its prediction in relation to road performance Report LR889, TRRL. 1979.

BRE Special Digest 1: 'Concrete in Aggressive Ground' 3rd Ed 2005.

BRE Report BR211, Scivyer, C. 'Radon – Guidance on protective measures for new buildings' 2015 Edition.

BRE Digest, vols. 240 and 241 'Low-rise buildings on shrinkable clay soils'. 1993.

BRE Digest 298 'The influence of trees on house foundations in clay soils'. 1999.

BRE Digest 365 'Soakaway Design'. 2016.

BRE Report 391 "Specifying vibro stone columns". 2000.

BRE Report 414. 'Protective measures for housing on gas contaminated land. Building Research Establishment Report'. 2011.

BRE Report 465 'Cover Systems for Land Regeneration'. 2004.

BRE Report 470 'Working platforms for tracked plant: good practice guide to the design, installation, maintenance and repair of ground-supported working platforms'. 2004.

British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R&D Publication 8. 'The physical properties of major aquifers in England and Wales'. 1997.

British Geological Survey Technical Report WD/00/04. 234pp. Environment Agency R&D Publication 68 'The physical properties of minor aquifers in England and Wales'.

British Geological Survey 'The advanced soil geochemical atlas of England and Wales'. 2012.

BS 1377 'Method of Test for Soils for Civil Engineering Purposes'. 1990.

BS EN 1997-1. 'Eurocode 7 – Geotechnical design - Part 1: General rules'. Plus associated UK National Annex. 2004.

BS EN 1997-2. 'Eurocode 7 – Geotechnical design - Part 2: 'Geotechnical investigation and testing'. Plus associated UK National Annex. 2007.

BS 3882: 'Specification for topsoil'. 2015.

BS 5837: 'Trees in relation to design, demolition and construction Recommendations'. 2012.

BS 5930+A1:2020: 'Code of Practice for Site Investigations'. 2020.

BS 6031: 'Code of practice for earthworks'. 2009.

BS 8004: 'Code of practice for foundations'. 2015.

BS 8485+A1: 'Code of practise for the design of protective measures for methane and carbon dioxide ground gases for new buildings'. 2019.

BS 8500-1 AMD 2. Concrete. Complementary BS to BS EN 206. Part 1. 'Method of specifying and guidance for the specifier'. 2018.

BS 8576 'Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)'. 2013.

BS 10175:2011+A2 'Investigation of Potentially Contaminated sites - code of practice'. 2017.

BS 10176:2020 'Taking soil samples for determination of volatile organic compounds (VOCs)'. 2020.

BS EN ISO 14688 'Geotechnical investigation and testing – Identification and classification of soil'. 2018.

BS EN ISO 14689 'Geotechnical investigation and testing – Identification and classification of rock'. 2018.

BS EN ISO 17892 'Geotechnical investigation and testing. Laboratory testing of soil.' Parts 1-12 :2018.

BULL ET AL. Promoting the Use of B(a)P as a Marker for PAH Exposure in UK Soils. February 2013.

CIRIA Special Publication SP32, PSA Civil Engineering Technical Guide 34, 'Construction over abandoned mine workings'. 1984.

CIRIA Special Publications 101-112, 'Remedial Treatment for Contaminated Land'. 1998.

CIRIA Special Publication 124, 'Barriers, liners and cover systems for containment and control of land contamination'. 1996.

CIRIA R143, 'The Standard Penetration Test (SPT): methods and use'. 1995.

CIRIA 149 'Protecting Development from Methane'. 1995.

CIRIA 150 'Methane Investigation Strategies'. 1995.

CIRIA 151 'Interpreting Measurements of Gas in the Ground'. 1995.

CIRIA 152 'Risk assessment for Methane and Other Gases from the Ground'. 1995.

CIRIA 552 'Contaminated Land Risk Assessment – A guide to good practice'. 2001.

CIRIA C659 'Assessing risks posed by hazardous ground gases to buildings.' 2006.

CIRIA C665 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'. 2007.

CIRIA C681 'Unexploded Ordnance (UXO) A guide for the construction industry'. 2009.

CIRIA C716 'Remediating and mitigating risks from volatile organic compound (VOC) vapours from land affected by contamination'. 2012.

CIRIA C733 'Asbestos in Soil And Made Ground: A Guide To Understanding And Managing Risks'. 2014.

CIRIA C735 'Good Practice on The Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases'. 2014.

CIRIA C748 'Guidance on the Use of Plastic Membranes as VOC Vapour Barriers'. 2014.

CIRIA C750 'Groundwater control: design and practice, second edition". 2016.

CIRIA C753 'The SuDS Manual'. 2015.

CIRIA C758 'Abandoned Mine Workings Manual'. 2019.

CL:AIRE and CIEH. 'Guidance on Comparing Soil Contamination Data with a Critical Concentration'. May 2008.

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

CL:AIRE RB17 'A Pragmatic Approach to Ground Gas Risk Assessment'. 2012.

CL:AIRE SP1010 'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination'. Rev 2 2014.

CL:AIRE 'Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials – CAR-SOILTM'. 2016.

CL:AIRE 'Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies' Version 1. March 2017.

CULP, S.J., ET AL., A comparison of the tumours induced by coal tar and benzo[a]pyrene in a 2-year bioassay. Carcinogenesis. 1998.

DEFRA and the Environment Agency, CLR10 'Soil Guideline Value Reports for Individual Soil Contaminants'. 2002-2004.

DEFRA and the Environment Agency, CLR Report No 11 'Model Procedures for the Management of Contaminated Land'. 2004. [Withdrawn 2019.]

Department of the Environment, CLR Report No 1 'A framework for assessing the impact of contaminated land on groundwater and surface water'. 1994.

Department of the Environment, CLR Report No 2 'Guidance on Preliminary Site Inspection of Contaminated Land'. 1994.

Department of the Environment, CLR Report No 3 'Documentary research on Industrial Sites'. 1994.

Department of the Environment, CLR Report No 4 'Sampling Strategies for Contaminated Land'. 1994.

Department of the Environment Waste Management Paper No. 27. 'Landfill Gas: A Technical Memorandum Providing Guidance on the Monitoring and Control of Landfill Gas'. 1992.

Department of the Environment. 'Industry Profiles' - 48 separate publications available from The Stationery Office, London. 1995.

DETR. Circular: Contaminated Land. 2006.

EC Regulation 1272/2008 'The Classification, labelling and packaging of substances and mixtures (CLP)' 2008.

Environment Agency guidance - Land Contamination: Risk Management (LCRM). 2020.

Environment Agency 'Using Soil Guideline Values'. 2009.

Environment Agency, 'Updated Technical Background to the CLEA model'. 2009.

Environment Agency, 'Human health toxicological assessment of contaminants in soil'. 2009.

Environment Agency Hazardous Waste: 'Guidance on the classification and assessment of waste' WM3 ver 1.1 May 2018.

Environment Agency. 'Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination'. 2006.

Environment Agency & NHBC. R&D Publication 66. 'Guidance for the Safe Development of Housing on Land Affected by Contamination'. 2008.

Environment Agency. R&D Publication 20. 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources'. 1999.

Environment Agency Technical Guidance Note 01. Hydrogeological Risk Assessment for Landfills. [Withdrawn Feb 2016. Replaced with below].

Environment Agency and DEFRA 'Landfill developments: groundwater risk assessment for leachate'. 2016.

Environment Agency Petroleum Hydrocarbons in Groundwater 'Supplementary Guidance for Hydrogeological Risk Assessment'. 2009.

Environment Agency 'Groundwater protection: Principles and practice (GP3)'. 2013. [Superseded 2017 by www.gov.uk online guidance].

Environmental Permitting Guidance: version 3.1 'The Landfill Directive for the Environmental Permitting (England and Wales) Regulations'. 2010.

Environmental Quality Standards. 2008.

European Parliament Directive 2008/98/EC of the Council of 19 November 2008 on waste and repealing certain Directives. 2008.

European Parliament. Directive 2014/955/EU: Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC.

Ground Engineering. Wilson & Card 'Proposed method classifying gassing sites' /1999.

Hazardous Waste (England and Wales) Regulations. 2005.

Health & Safety Executive (HSE). 'Protection of Workers & the General Public during the Development of Contaminated Land'. 1991.

Health and Safety Executive (HSE). Control of Asbestos Regulations (CAR). 2012.

Highways Agency. Design Guidance for Road Pavement Foundations (Draft HD25). Interim Advice Note 73/06. Rev 1. Highway Agency, London. 2009. [Withdrawn 30th May 2017].

ICE Thomas Telford 'Applications of Dynamic Cone Penetrometer testing in East Anglia'. 1989.

Land Quality Press, Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R. C. and Nathanail, J.F. 'The LQM/CIEH S4ULs for Human Health Risk Assessment.' 2015.

Landfill Directive 'Directive 1999/31/EC on the landfilling of waste'. 1999.

Japanese Geotechnical Society. Hatanaka and Uchida 'Empirical correlation between penetration resistance and effective friction of sandy soil'. Soils & Foundations, 36 (4), 1-9. 1996.

Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1, Amendment August 2014. [Withdrawn 30th May 2017].

Manual of Contract Documents for Highway Works, Specification for Highways Works – Series 600 Earthworks November 2006. [Withdrawn 30th May 2017, Replacement unknown].

National Planning Policy Framework (NPPF). 2021.

National Planning Policy Framework - Technical Guidance. March 2012.

NHBC. Hazardous Ground Gas - An essential guide for housebuilders. May 2023.

Public Health England (PHE). Contaminated land information sheet: risk assessment approaches for polycyclic aromatic hydrocarbons (PAHs). September 2017.

Total Petroleum Hydrocarbon Criteria Working Group Volume 1 'Analysis of Petroleum Hydrocarbons in Environmental Media'. 1999.

Total Petroleum Hydrocarbon Criteria Working Group Volume 2 Composition of Petroleum Mixtures. May 1998.

Total Petroleum Hydrocarbon Criteria Working Group Volume 3 'Selection of Representative TPH Fractions Based on Fate and Transport Considerations'. July 1997.

Total Petroleum Hydrocarbon Criteria Working Group Volume 4 'Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH)'. 1997

Total Petroleum Hydrocarbon Criteria Working Group Volume 5 'Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach' June 1999.

UK Drinking Water Standards: Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) and Water Supply (Water Quality) Regulations 2000 (SI 2000/3184).

UKTAG. Updated recommendations on environmental standards. River Basin Management (2015-21). UK Technical Advisory Group on the Water Framework Directive. November 2013 (updated January 2018).

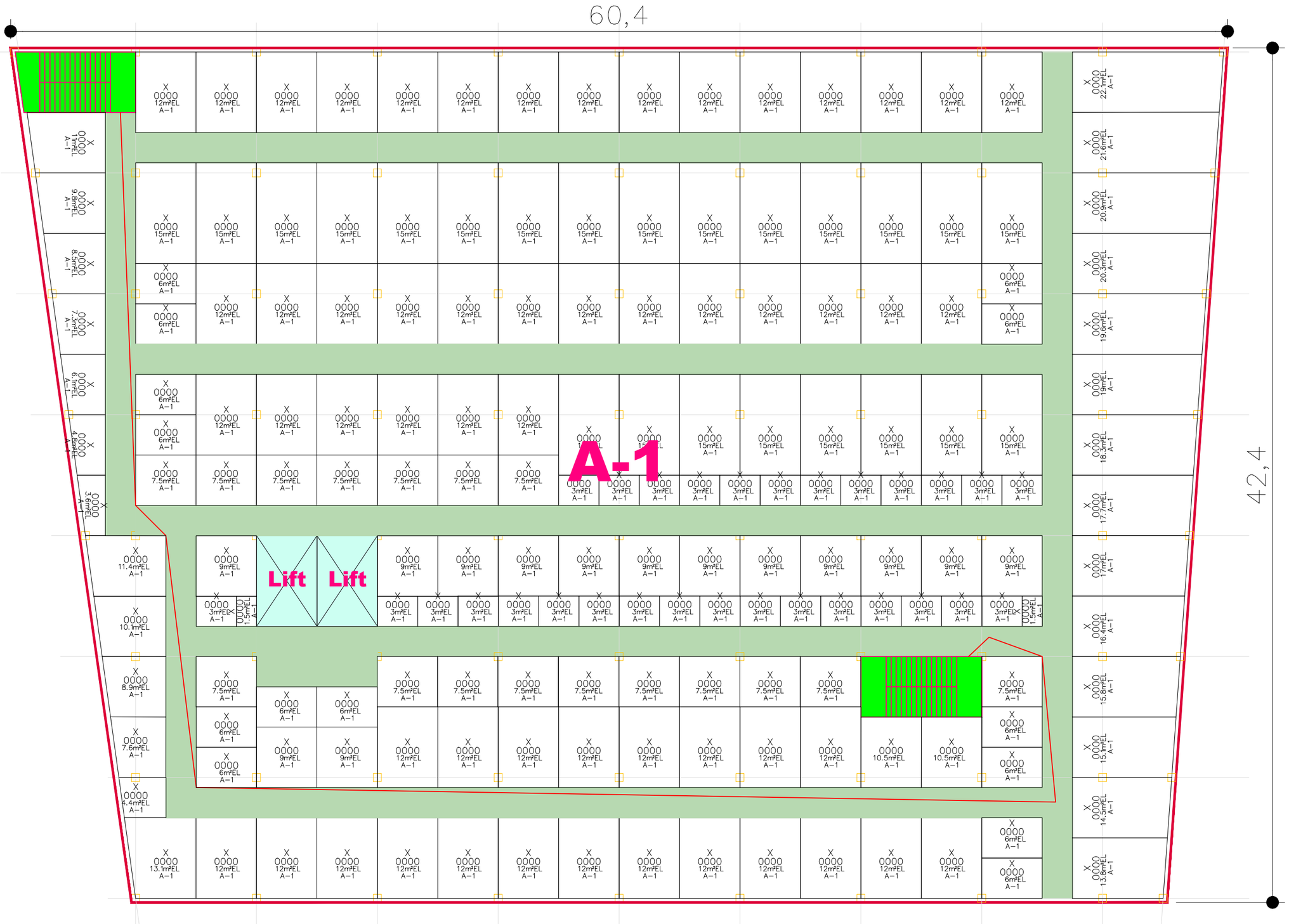
UKTAG-WFD. UKTAG River & Lake Assessment Method, Specific Pollutants (Metals), Metal Bioavailability Assessment Tool (M-BAT). Water Framework Directive – United Kingdom Technical Advisory Group. 2014.-

UKWIR Report 10/WM/03/21 2010 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' 2010.

Water Framework Directive, 2000.

Water UK HBF. Contaminated Land Assessment Guidance. Water UK and the Home Builders Federation.

DRAWINGS



SHURGARD
SELF-STORAGE

HAMPTON
OLDFIELD ROAD

SK04

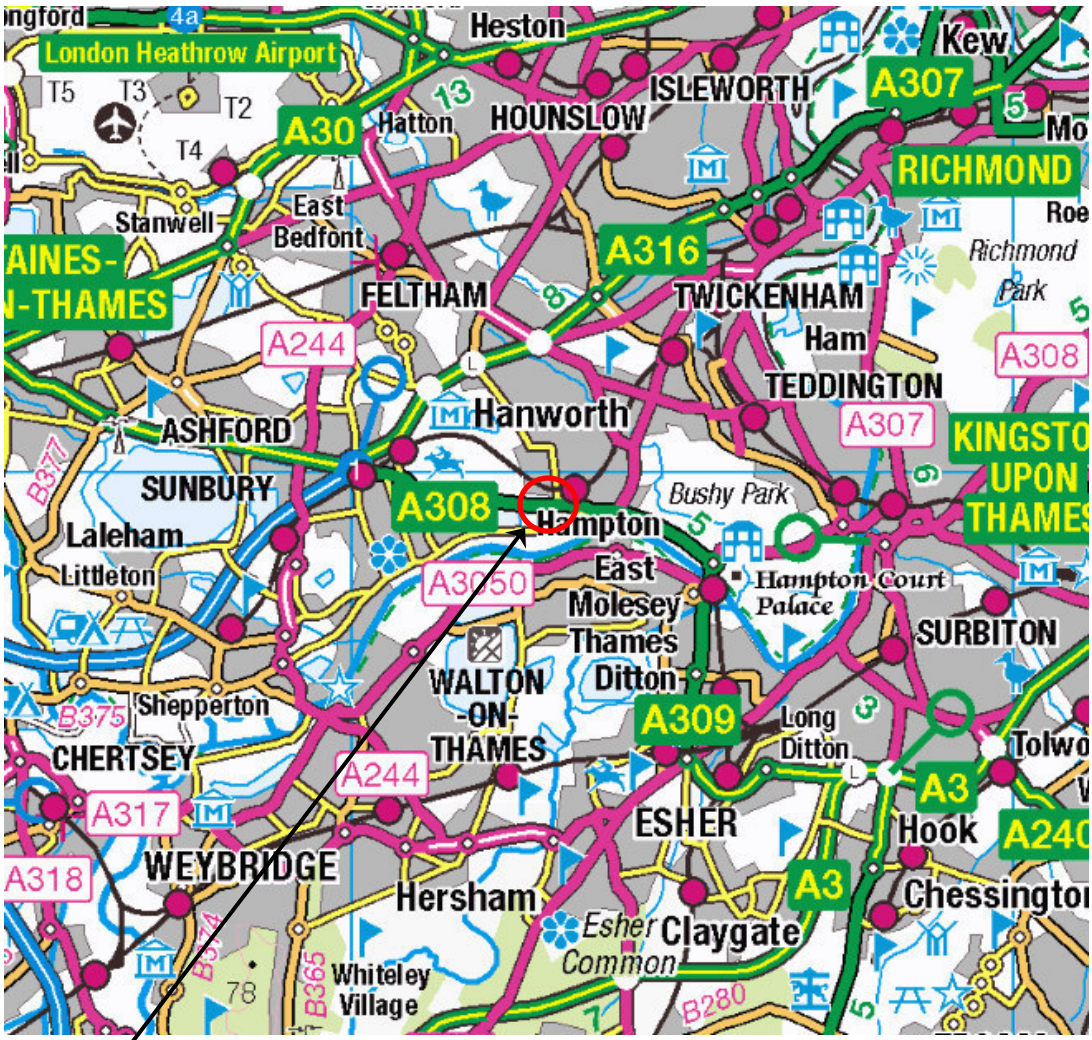
BASEMENT

SHURGARD
SELF-STORAGE

HAMPTON
OLDFIELD ROAD

SK04

GROUND FLOOR



SITE LOCATION

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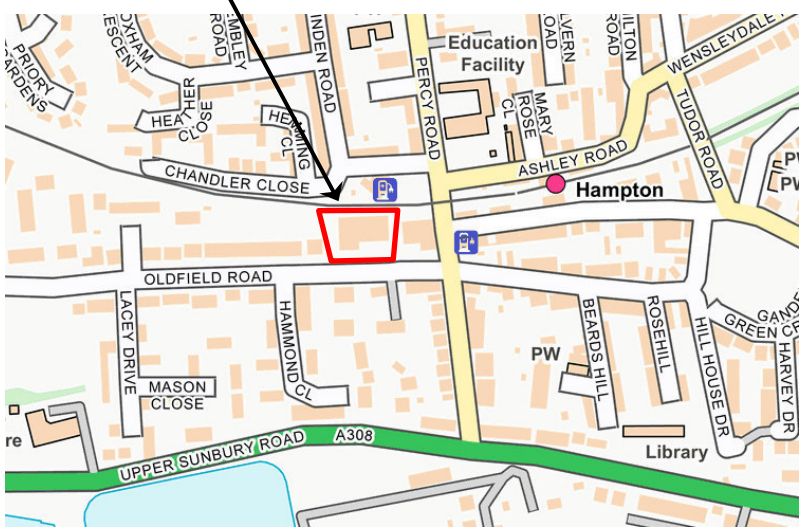
SITE ENTRANCE WHAT3WORDS: ///manliness.storms.radar



REV	DATE	DESCRIPTION	BY	CKD

BROWNFIELD SOLUTIONS LTD
GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

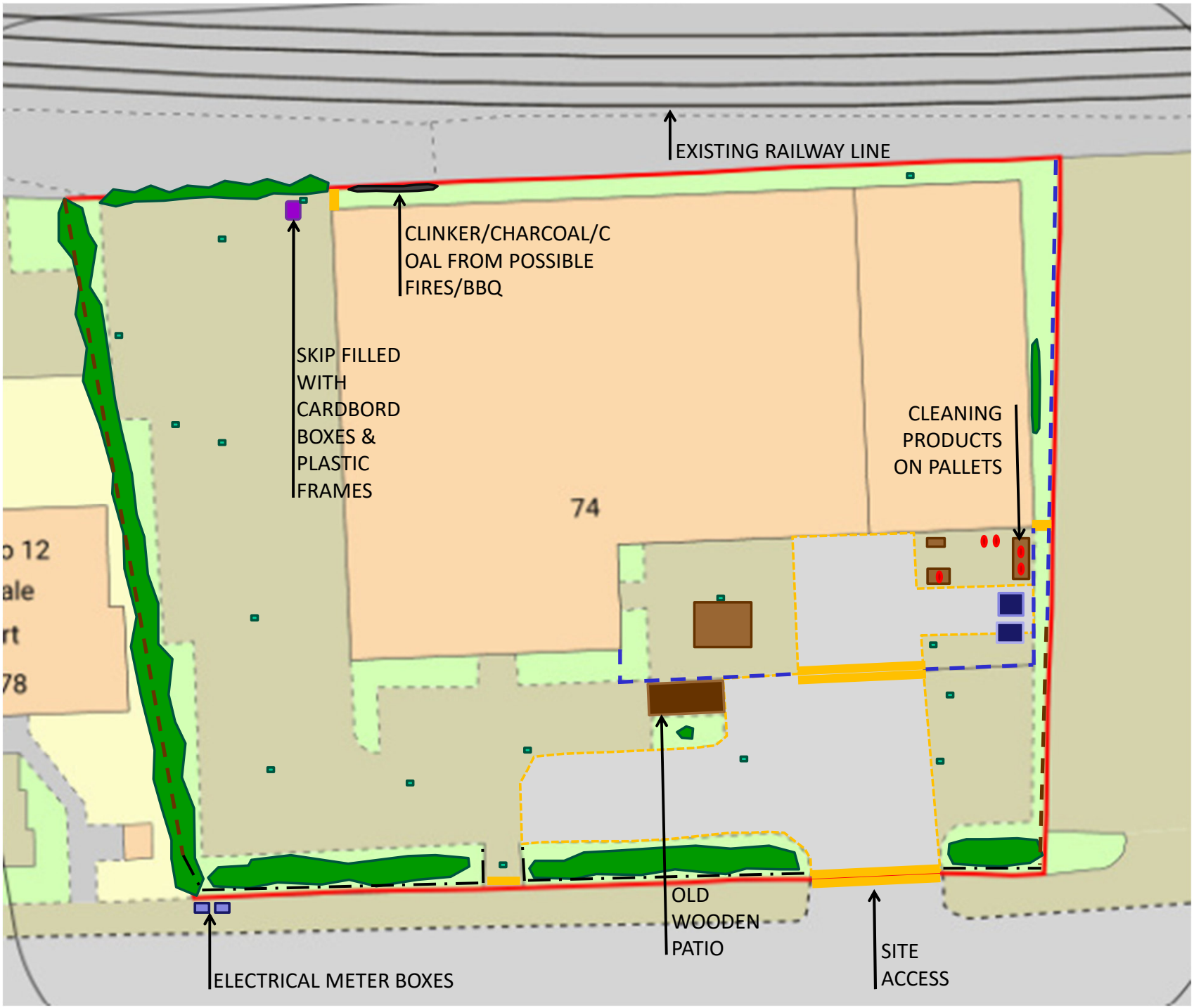
CLIENT: SHURGARD UK LTD

PROJECT TITLE: OLDFIELD ROAD, HAMPTON

DRAWING TITLE: SITE LOCATION PLAN

DRAWING No.	REVISION	SCALE	DATE
M5478/01	-	NTS	25/07/2023

DRAWN BY	CHECKED BY
LN	XXX



KEY

- APPROXIMATE SITE BOUNDARY
- WOODEN PALLETS
- GENERAL WASTE SKIPS
- MANHOLE COVERS
- TREES & SHRUBS
- RETAINING WALL
- WOODEN FENCE
- METAL PALISADE FENCE
- CONCRETE HARDSTANDING
- PADLOCKED GATES

REV	DATE	DESCRIPTION	BY	CKD

BROWNFIELD SOLUTIONS LTD
GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

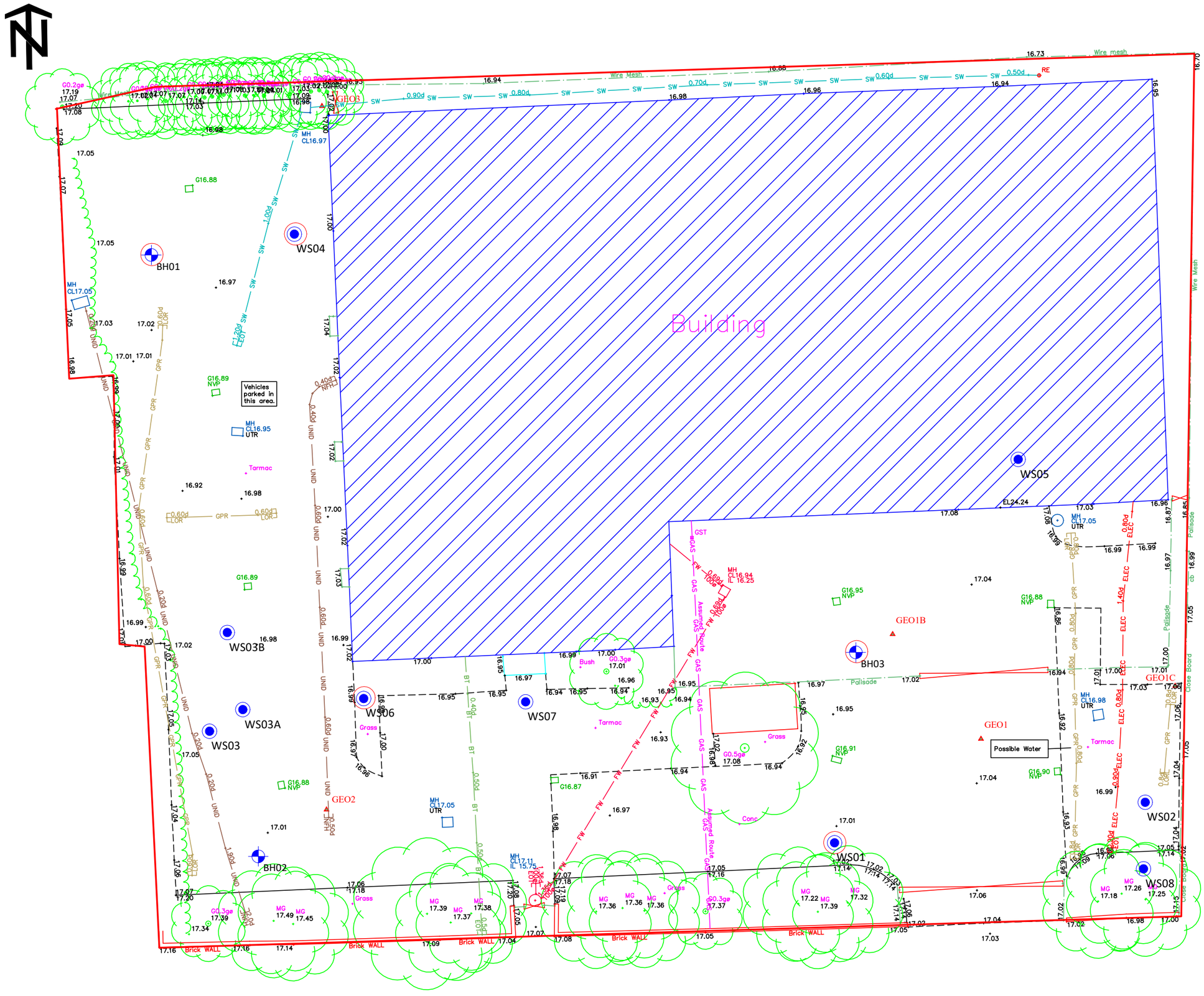
CLIENT
SHURGARD LTD

PROJECT TITLE
OLDFIELD ROAD, HAMPTON

DRAWING TITLE
SITE FEATURES PLAN

DRAWING No.	REVISION	SCALE	DATE
M5478/02	-	NTS	31/07/23

DRAWN BY	CHECKED BY
LN	AT



KEY

- APPROXIMATE SITE BOUNDARY
- WSXX WINDOW SAMPLE BOREHOLE
- BHXX CABLE PERCUSSIVE BOREHOLE
- BOREHOLE INSTALLATION

NOTES

1. ALL DIMENSIONS TO BE CHECKED ON SITE BEFORE COMMENCING WORKS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ARCHITECT & ENGINEER FOR VERIFICATION. FIGURED DIMENSIONS ONLY ARE TO BE TAKEN FROM THIS DRAWING.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS REPORTS. THIS DRAWING IS COPYRIGHT OF BSL.
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REV	DATE	DESCRIPTION	BY	CKD

BROWNFIELD SOLUTIONS LTD

CLIENT

SHURGARD UK LTD

PROJECT TITLE

OLDFIELD ROAD, HAMPTON

DRAWING TITLE

EXPLORATORY HOLE LOCATION PLAN

DRAWING No.	REVISION	SCALE	DATE
M5478/03	-	NTS	15/08/23

DRAWN BY	CHECKED BY
CO	AT

APPENDIX A

BSL Methodology and Guidance

BSL Phase I & II Geo-Environmental Assessment Reports - Methodology and Guidance

This Appendix provides information on the approaches, methods and guidance used by Brownfield Solutions Ltd in the preparation of this report.

The term 'geo-environmental' is used to describe aspects relating to ground-related environmental issues (such as potential soils and groundwater contamination). The term 'geotechnical' is used to describe aspects relating to the physical nature of the site (such as foundation requirements). It should be noted that this is an integrated investigation and these two main aspects are related, unless otherwise specified within the report.

Phase I reports are written in general accordance with the description of a Preliminary Investigation as defined in BS10175:2011+A2:2017 and are also produced in general accordance with the recommendations for a Tier 1 Preliminary Risk Assessment as described in LCRM guidance

The first stage of the investigation and assessment of a site is the Preliminary Investigation/Tier 1 Preliminary Risk Assessment, often referred to as a Phase 1 Desk Study, comprising a desk study and walk-over survey and collation of desk-based searches, which culminates in the Preliminary Risk Assessment and the development of a preliminary/initial Conceptual Site Model (CSM). From this are identified any potential geotechnical and geo-environmental hazards and the qualitative degree of risk associated with them.

From the geo-environmental perspective, the hazard Identification process uses professional judgement to evaluate all the hazards in terms of possible contaminant linkages (of source-pathway-receptor). Possible contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and generic risk assessment as part of Phase II investigations and reports.

The second stage is the Ground Investigation, Generic Risk Assessment and Geotechnical Interpretation. This represents the further assessment mentioned above. The Ground Investigation comprises field work and laboratory testing based on the findings of the Preliminary Risk Assessment, to reduce uncertainty in the geotechnical and geo-environmental hazard identification. This may include an exploratory, a detailed or/and supplementary Investigations as described in BS 10175:2011+A2:2017. Phase II Assessments are produced in general accordance with the recommendations for a Tier 2 Generic Quantitative Risk Assessment as described in LCRM guidance and are also intended to fulfil the requirements of a Ground Investigation Report (GIR) as detailed in BS EN 1997-2:2007.

Contaminated Land - Legislative Background

Land contamination can be addressed in several ways, e.g. during planning, under Part 2A, following an incident, during an investigation into environmental damages, or during the application of an environmental permit, or its surrender.

For the planning process the key test is **as a minimum the site cannot be determined as contaminated land**, e.g. there is not significant harm, significant possibility of significant harm to human health or that there is not significant harm to, or the significant possibility that the pollution of controlled waters will occur.

Environmental liabilities and risks have been evaluated in terms of a source -pathway - target relationship in accordance with the approach set out in:

- The 1995 Environment Act.
- The Contaminated Land Statutory Guidance, DEFRA – April 2012.
- The Contaminated Land (England) Regulations 2006.
- The Contaminated Land (England) Amendment Regulations 2012.
- Water Resources Act.
- Water Framework Directive.
- Environmental Damage Regulations.
- Environment Agency (EA) - Land Contamination Risk Management (LCRM) 2019.

Contaminated land is defined within the legislative framework as land which is in such condition by reason of substances in, on or under the land that:

1) Significant harm is being caused or there is a significant possibility of such harm being caused.
2) Significant pollution of controlled waters is being or is likely to be caused.

The potential for harm is based on the presence of three factors:

Source - substances that are potential contaminants or pollutants that may cause harm.
Pathway - a potential route by which contaminants can move from the source to the receptor , and the impact of that migration on the source e.g. ;attenuation.
Receptor - a receptor that may be harmed, for example the water environment, humans and water, considering the sensitivity of the receptor

Where a source, pathway and target are all present a pollutant linkage exists and there is potential for harm to be caused. The presence of a source does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm. The nature and importance of both pathways and receptors are site specific and will vary according to the intended end use of the site, its characteristics and its surroundings.

The key principle which supports the S-P-R approach is 'suitable for use' criteria. This requires remedial action only where contamination is considered to pose unacceptable actual or potential risks to health or the environment and, taking into account the proposed use of the site.

Relevant Guidance Documents
This report has been prepared in accordance with the list of guidance below, however the list is not exhaustive:

- DETR: Circular 02/2000: Environmental Protection Act 1990: Part IIA: Contaminated land. 2012.
- Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the EPA1990, May 2002.
- BS 10175:2011+A2:2017.
- Environment Agency (EA) - Land Contamination Risk Management (LCRM). 2019.

- Groundwater Protection - https://www.gov.uk/government/collections/groundwater-protection.
- UK Technical Advisory Group (UKTAG) - - Water Framework Directive
- Incidents and their classification: the Common Incident Classification Scheme (CICS) – Used by the Environment Agency to classify pollution incidents.

Relevant Legislative Documents
The following is a non-exhaustive list of legislative framework documents that has been considered in the production of this report:

- The Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance (2012).
- The Environment Protection Act (1990).
- The Water Resources Act (1991).
- The Environment Act (1995).
- The Contaminated Land (England) Act (2000).
- The Pollution Prevention and Control (England and Wales) Regulations (2000).
- The Landfill Regulations (England and Wales) Regulations (2002).
- The Landfill (England and Wales) (Amendment) Regulations (2004).
- Contaminated Land (England) Regulations (2012).
- The Environmental Damage (Prevention and Remediation) Regulations (2009).
- Environmental Permitting Regulations (England and Wales) Regulations (2010).
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
- Health and Safety at Work Act.
- National Planning Policy Framework (NPPF)(2021).

Contaminated Land Risk Assessment Approach

Contaminated Land Risk Assessment is a technique that identifies and considers the associated risk, determines whether the risks are significant and whether action needs to be taken. The four main stages of risk assessment are:

Hazard Identification ➡ Hazard Assessment ➡ Risk Estimation ➡ Risk Evaluation.

LCRM outlines the framework to be followed for risk assessment in the UK. The framework is designed to be consistent with UK legislation and policies including planning. The starting point of the risk assessment is to identify the context of the problem and the objectives of the process. Under LCRM, three tiers of risk assessment exist – Stage/Tier Preliminary Risk Assessment, Stage 2 Generic Quantitative and Stage 3 Detailed Quantitative.

Further information can be found at the below site:
https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm

Formulating and developing a conceptual model for the site is an important requirement of risk assessment, this supports the identification and assessment of pollutant linkages. Development of the conceptual model forms the main part of preliminary risk assessment, and the model is subsequently refined or revised as more information and understanding is obtained through the risk assessment process.

Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, both the likelihood and the consequences of an event must be taken into account when assessing risk.

The risk assessment process needs to take into account the degree of confidence required in decisions. Identification of uncertainties is an essential step in risk assessment.

The likelihood of an event is classified on a four-point system using the following terms and definitions from CIRIA C552, with reference to Incidents and their classification: the Common Incident Classification Scheme

(CICS), Environmental Protection Act 1990: Part 2A – Contaminated Land Statutory Guidance 2012 and other guidance as appropriate which will be detailed within the main body of the report if applied.

The likelihood of a given receptor being impacted is related to a number of factors, e.g. the geology which could inhibit contaminant migration. For example, a site with a significant thickness of clay between it and a receptor may reduce migration of contamination via the subsurface, which will reduce the likelihood of a given receptor being impacted. The geology or drainage for example could offer a preferential pathway e.g. mines shafts/faults increasing the likelihood and potential magnitude of an impact. The depth of contamination will also affect the exposure pathway, for example petroleum hydrocarbons at depth are unlikely to reach a receptor via dermal contact but could via vapour pathways which will influence the likelihood of an impact being felt e.g. if there are no buildings on site.

The terms and definitions used for the assessment of the likelihood are provided below:

High likelihood: There is a pollution linkage and an event appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Examples - Extensive areas with concentrations above saturation limits for mobile contamination e.g. petroleum hydrocarbons within the water table.

Likely: There is a pollution linkage and all the elements are present and in the right place, which means it is probable that an event will occur. Circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term.
Examples – Localised areas of contaminants with concentrations above saturation limits for mobile contamination e.g. localised petroleum hydrocarbons within the water table; shallow contamination above relevant human health generic assessment criteria is present with little or no hardstanding,

Low likelihood: There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain even over a longer period such event would take place, and is less likely in the short term.
Examples - A thickness/distance of low permeability deposits preventing contaminant migration to a receptor is present; a site is mostly covered hard standing preventing exposure to soil contamination.

Unlikely: There is a pollution linkage but circumstances are such that it is improbable the event would occur even in the long term.
Examples – A site is underlain by a substantial thickness of low permeability clays, between the source and potential receptors which will inhibit significantly, but not completely rule out migration to sensitive receptors.

The severity is also classified using a system based on CIRIA C552, with reference to Incidents and their classification: the Common Incident Classification Scheme (CICS), Environmental Protection Act 1990: Part 2A – Contaminated Land Statutory Guidance 2012 and other guidance as appropriate which will be detailed within the main body of the report, if applied. The terms and definitions are:

Severe: Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. A short-term risk to a particular ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Draft Circular on Contaminated Land', DETR 2000);
Examples – High concentrations of contaminant on surface of recreation area, major spillage of contaminants from site into controlled waters, explosion causing building to collapse.

Medium: Chronic damage to human health ('significant harm' as defined in DETR 2000). Pollution of sensitive water resources. A significant change in a particular ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Draft Circular on Contaminated Land', DETR 2000);
Examples - Concentrations of contaminants exceed the generic assessment criteria, leaching of contaminants from a site to a Principal or Secondary Aquifer, death of species within a designated nature reserve.

Mild: Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000). Damage to sensitive buildings, structures, services or the environment.
Examples – Pollution of non-classified groundwater or damage to buildings rendering it unsafe to occupy.

Minor: harm, not necessarily significant harm, which may result in financial loss or expenditure to resolve. Non-permanent health effects to human health (easily prevented by use of personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.
Examples – Presence of contaminants at such concentrations PPE is required during site work, loss of plants in landscaping scheme or discolouration of concrete.

Once the likelihood and severity have been determined, a risk category can be assigned using the table below.

		Consequences			
		Severe	Medium	Mild	Minor
Probability	Highly likely	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very Low	Very low
	No Linkage	Negligible			

Definitions of the risk categories obtained from the above table are as follows together with an assessment of the further work that might be required:

Very high: There is a high probability that severe harm could arise to a designated receptor from an identified hazard or there is evidence that severe harm is currently happening. This risk, if realised, could result in substantial liability. Urgent investigation and remediation are likely to be required.

High: Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation is required and remedial works may be necessary in the short term and are likely over the longer term.

Moderate: It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it would be more likely to be relatively mild. Investigation is normally required to clarify the risk and determine the liability. Some remedial works may be required in the longer term.

Low: It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.

Very Low: There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

Some linkages may be identified which constitutes a theoretical connection between a source and a receptor, but professional judgement shows them not to be possible for some reason. These are labelled 'no linkage' in the summary table, which give rise to a **negligible** risk category and no further action is required.

Ground Gas Risk Assessment Guidance

BS8485:2015+A1:2019, BS 8576:2013, CIRIA C665 and CL:AIRE RB17 are the current guidance which gives up-to-date advice on all aspects of ground gas. They outline good practice in investigation, the collection of relevant data and monitoring programmes in a risk-based approach to ground gas contamination.

Within BS8485:2015+A1:2019, BS 8576:2013 and CIRIA C665, two semi-quantitative methods are set out for the assessment of risk:

1 For low rise housing with a ventilated under floor void at minimum 150 mm (Boyle and Witherington).
2 For all other development types (Wilson and Card).

Both methods use the concept of Gas Screening Values (GSVs) to identify levels of risk. The mitigation and management of potentially unacceptable risk is described with reference to both passive and active systems of gas. Source removal is also discussed as an option. A sperate approach is discussed under the RB17 header further below.

The aim of the guidance is for a consistent approach to decision making, particularly relating to the scope of protective design measures on a site-specific basis.

Legislative Framework
BS8485:2015+A1:2019, BS 8576:2013 and CIRIA C665 provides technical guidance, however they also recognise the context into which the guidance has to be employed. Government policy is based upon a "suitable for use approach", which is relevant to both the current and proposed future use of land. When considering the current use of land, Part IIA of the Environment Protection Act 1990 provides the regulatory regime. The presence of hazardous ground gases could provide the "source" in a "pollutant linkage" which could lead the regulator to determine that considerable harm or there is a significant possibility of such harm being caused. Under such circumstances, the regulator would determine the land to be "contaminated land" under the provisions of the Act, setting out the process of remediation as described in the DETR Circular 02/2000 *Statutory guidance on contaminated land.*

Generation Potential of Sources
BS 8576:2013 Figure 6 provides a basis for assessing the generation potential from sources identified as part of the Phase I Assessment. These are summarised below:

Generation Potential	Typical Sources
Very Low	• Natural carbonate soil and strata, e.g. chalk and limestone. • Natural soil strata with a low degradable organic content, e.g. alluvium, peat. • In-filled pond less than 15 m diameter, in-filled before 1930s to 1940s. • Made ground with low degradable organic content (e.g. up to 5% organic material such as pieces of wood, pieces of paper, rags, etc. with a high proportion of ash and no food or other easily degradable waste). • Mine workings shallow or shaft (where there is clear evidence that they are flooded). • Inert landfill sites.
Low	• Natural soil strata with a high degradable organic content (DOC). • Made ground with total organic carbon (TOC) up to 6% (e.g. dock silt, no food or other easily degradable waste). • Foundry sand (includes phenolic binders, rags and wood that decay, albeit at low rates). • Landfill 1945 to mid 1960s (see also Moderate below).
Moderate	• Sewage sludge. • Mine workings – unflooded, more than 50 years since last worked (gas is liberated from coal when mine workings are excavated; this continues for up to about 50 years). • Landfill 1945 to mid 1960s (this could also be "low" or, if disturbed, "high").

Generation Potential	Typical Sources
High	• Landfill mid 1960s to early 1990s. • Mine workings – unflooded – less than 50 years since last worked.
Very High	• Municipal landfill sites. • Landfill early 1990s onward.

Frequency and Duration of Monitoring

The monitoring period for a specific site covers the "worst case" scenario. A "worst case" scenario will typically occur during falling atmospheric pressure and, in particular, weather conditions such as rainfall, frost and dry weather.

The benefits of the additional information and whether it is likely to change the scope of gas protection should be considered, as are the consequences of failing to characterise adequately pollutant linkages. Investigations concerned with soil gas are required to provide monitoring data sufficient to allow prediction of worst case conditions enabling the confident assessment of risk and subsequent design of appropriate gas protection schemes. Monitoring programmes should not be an academic exercise in data collection. CL:AIRE publication TB17 "Ground Gas Monitoring and 'Worst-Case' Conditions" provides further guidance.

Below are matrices that will aid in determining an appropriate number of gas monitoring visits and the length of monitoring period.

Typical/idealised periods of monitoring

		Generation of Potential Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	1 month	2 months	3 months	6 months	12 months
	Moderate (Apartments)	2 months	3 months	6 months	12 months	24 months
	High (Low rise Residential)	3 months	6 months	6 months	12 months	24 months

Typical/idealised frequency of monitoring/Number of Visits Required

		Gas Generation of Potential Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	4	6	6	12	12
	Moderate (Apartments)	6	6	9	12	24
	High (Low rise Residential)	6	9	12	24	24

Note

1 NHBC guidance also recommends this period of monitoring (Boyle and Witherington, 2007).
2 Generation potential of sources based on descriptions within BS 8576:2013.
3 At least two sets of readings should be at low and falling atmospheric pressure (but not restricted to periods below <1000 mb) known as worst case conditions. Historical data can be used as part of the data set (Table 5.5b).

It is recommended that newly installed monitoring wells are left for 24 hours to allow the soil gas to reach equilibrium. It should be recognised, however, that some soil gas regimes could take considerably longer (up to seven days). Interpretation of any initial readings should take this equilibrium process into account.

RB17 Approach

CL:AIRE RB17 (Card et al 2012) is a pragmatic approach to ground gas risk assessment and was developed because gas concentration, pressure and flow rate measured in a well headspace may not be representative of the conditions in the surrounding formation.

In these low-risk situations, the approach is to use the conceptual site model and the estimation of the likely gas generation from a source to identify where or if gas monitoring is required to better define the risks.

Under this approach, for sites with natural soils only with no credible methane source, then no action is required (no monitoring or gas protection measures) as this represents Characteristic Situation 1 (CS1).

Unexploded Ordnance (UXO) Guidance

Clients have a legal duty under the CDM 2015 Regulations to provide designers and contractors with project-specific health and safety information needed to identify hazards and risks. This includes the possibility of unexploded ordnance (UXO) being encountered on the site. Further details are given in CIRIA report C681.

BSL carry out non-specialist UXO screening exercises by considering any evidence of UK defence activities on or near the site evident from gathered desk study information and the unexploded aerial delivered bomb (UXB) online risk maps produced by Zetica. Other data sources are available, but as a first stage screening exercise the freely available online Zetica maps have been used. The level of risk stated is that determined by Zetica, a company experienced and considered competent in the assessment of UXO.

Contaminated Land Screening Values

In assessing the potential for contamination Brownfield Solutions Limited (BSL) follows UK guidance and current best practice.

General
The current recommended method for assessing contamination is on the basis of:

Source-Pathway-Receptor

Where any one of these "pollution linkages" is absent there is deemed to be no risk.

Fundamentally, receptors can be considered as humans (human health) and controlled waters (surface and ground waters).

The purpose of using generic Tier 1 screening levels is to have a simple means of assessing the potential contamination of a site and to inform decisions on whether further investigation is warranted or whether an option to undertake clean up based on the data to hand is cost effective.

Human Health
Current UK guidance is provided by DEFRA and the Environment Agency (EA). Publications forming part of the guidance include the CLEA Mode and toxicological reports collectively referred to as the CLEA Guidance. The CLEA Guidance has included a number of publications which have provided initial screening values for soil contamination based on standard land uses and soil assumptions.

CLEA guidance has gone through a number of revisions over time. Tier 1 generic S4UL values have been published using the CLEA 1.06 Model by CIEH/LQM. These are the third set of generic assessment criteria generated by CIEH and replace the previous two sets of GACs (Generic Assessment Criteria). The revised S4UL values are based on greater knowledge of relevant toxicology and further consideration of exposure frequencies.

C4SL values for six determinands including lead was published by DEFRA/CL:AIRE in December 2014 and they represent a low risk as opposed to minimal risk. These screening values were published by DEFRA for Part 2A use, although with the dual purpose for use under planning. However, S4ULs remain the first reference due to the broader range of end uses and soil organic content.

The preference from the EA is that site specific screening levels are used wherever possible. Due to numerous factors it is not always possible to utilise site specific values. In these instances the following data sources are used in the order of preference given below:

- CIEH S4UL values (derived by CIEH/LQM).
- DEFRA/CL:AIRE C4SL's.
- CL:AIRE GAC values.
- Guidance from other European countries.
- Guidance from the outside Europe.

Controlled Waters
The European Water Framework Directive (WFD) became UK law in December 2003. It was created to ensure that European countries manage their rivers, groundwater and lakes so that they stay healthy for people and for wildlife.

This is achieved by the use of chemical standards for surface waters and groundwater. These values describe concentrations of chemicals that are not expected to cause harm to environmental organisms or human health, provided they are not exceeded. The same chemical may have several standards for different environmental regimes, and for different protection objectives.

Statutory Standards are set in legislation and if exceeded, this constitutes non-compliance with statutory obligations. European Directives are implemented in England and Wales by corresponding statutory instruments (i.e. regulations). The statutory instruments can be the exact same standards as they appear in the Directive or be more stringent.

A number of non-statutory standards also exist, these are set by various organisations (including the EA) for chemicals that are considered to be of concern, but are not covered by any specific legislation.

The chemical standards used in the UK to control impaction of contamination on controlled waters are Environmental Quality Standards (EQS). The EQS's cover a large number of compounds.

Where certain compounds are not covered by the EQS these are commonly compared to the UK Drinking Water Standards (DWS).

Further Assessment
When screening values are exceeded then further consideration is required. This could include the use of simple measures to break the pollution pathway and mitigate the risk, further additional detailed investigation, including the deriving of site-specific values to better define the risk, and to design appropriate remedial measures.

Re-Use Of Waste - Guidance Note

Definition of Waste
The Environment Agency considers waste to be "*...any material that is discarded, or intended to be discarded*..." This includes any soil from trenches, footing, site strip etc. It is no longer required in its original location, therefore it is considered to be waste.

CL:AIRE: Code of Practice
Where materials are excavated for construction purposes, wherever possible these should be retained on site for engineering purposes if they are suitable for use. This can be implemented under the CL:AIRE "Development Industry Code of Practice for the Definition of Waste" (CL:AIRE DoWCoP), also commonly referred to as a "Materials Management Plan".

The developer/contractor is advised to complete all works under the DoWCoP.

Potential scenarios where soils may be able to be re-used:

- Material capable of being used in another place on the same site without treatment.
- Material capable of being used in another place on the same site following ex-situ treatment on site.
- Material capable of being used in another development site without treatment (Direct Transfer).
- Material capable of being used in another development site following ex-situ treatment on another site eg Hub site.

The Code of Practice requires 4 No. Factors to be addressed:

1) Protection of human health and protection of the environment.
2) Suitability of use, without further treatment.
3) Certainty of use.
4) Quantity of material.

In order to satisfy these requirements the following are required:

i) Consultation/approval with Local Authority & Environment Agency to confirm they have no objections to the proposed re-use of waste soils, or the risk assessments for the site.
ii) Risk Assessments to demonstrate that the site does not present an Environmental Hazard.
iii) Remediation Strategy for contaminated sites (or Design Statement for non-contaminated sites).
iv) Materials Management Plan (MMP) which details material generated stockpiles and the end use.
v) Volume calculations.
vi) Planning permission for the development.
vii) Contractual details to be clear, regarding who steps in is a contractor goes into administration/liquidation.

The use of the CoP is effectively industry regulated, there is a requirement to appoint an independent Qualified Person (QP) who checks all the requirements have been met and registers the documentation with the Environment Agency. This person must not have had any involvement with the preparing of the risk assessments or remedial strategy on the site.

Soils which require treatment on site (eg bioremediation, stabilisation) will require an Environmental Permit for treatment, together with justification and validation to prove, once treated, this material is suitable for use.
Site management procedures need to be in place to ensure that material is tracked through from excavation stockpiling, treatment and remediation processes. Should the process of material tracking be considered non-robust, or not adhered to, this may fail the test whether excavated materials may be considered non-waste.

Waste Classification for Soils

Introduction
Waste producers have a duty of care to classify the waste they are producing:

- Before it is collected, disposed of or recovered.
- To identify the controls that apply to the movement of the waste.
- To complete waste documents and records.
- To identify suitably authorised waste management options.
- To prevent harm to people and the environment.

The most sustainable and economic method of dealing with waste soil is usually the retention and re-use on site. Where this is not possible there are three main options for the disposal of soils:

1. Disposal to a permitted waste recycling facility.
2. Re-use on another site (subject to the suitability).
3. Disposal to a landfill site.

The disposal to a permitted facility will be subject to the **specific conditions of the permits for each individual facility** and will vary dependent on location and environmental sensitivity of the receiving site. Re-use on another site will also be subject to the acceptability criteria of that site.

The guidance below relates to disposal to **landfill sites only**.

Background for Landfill Disposal
In July 2005 the United Kingdom implemented the European Directive 1999/31/EC (The Landfill Directive), this introduced the current regime for waste and waste disposal to landfill. The Landfill Directive places controls on waste disposal. These controls include requirements to follow the waste acceptance procedures and criteria that have been agreed by the Council of the European Union and are laid out in Council Decision 2003/33/EC.

Before a waste can be accepted at a landfill site, the landfill **operator** must be satisfied that the waste meets his permit conditions, the waste acceptance procedures (WAP) and waste acceptance criteria (WAC).

If disposal to landfill is the best management option for the waste soils, these procedures **must** be followed or the operator may refuse to accept the waste.

Key Points:

- Not all waste can be landfilled
- Landfills are classified according to whether they can accept hazardous, non-hazardous or inert wastes.
- Wastes can only be accepted at a landfill if they meet the waste acceptance criteria (WAC) for that class of landfill.
- Most wastes must be treated before you can send them to landfill.
- There are formal processes for identifying and checking wastes that must be followed before wastes can be accepted at a landfill site.

Classification
Wastes are listed in the European Waste Catalogue (EWC 2002) and grouped according to generic industry, process or waste types. Wastes within the EWC are either hazardous or non-hazardous. Some of these wastes are hazardous without further assessment (absolute entries) or are 'mirror' entries that require further assessment of their hazardous properties in order to determine whether they are hazardous waste.

Waste soil has mirror entries on the EWC and as such the first phase of the waste classification process is that of determining if the waste is hazardous or not i.e the hazard assessment. The most common EWC waste codes related to soil are:

17 05	**soil (including excavated soil from contaminated sites), stones and dredging spoil**
17 05 03*	soil and stones containing dangerous substances
17 05 04	soil and stones other than those mentioned in 17 05 03

Soils may contain certain contaminants (eg asbestos, oil,) which have prescribed concentration thresholds, that if breached will render the material hazardous waste. These are based on specific "hazardous properties" which include hazards such as carcinogenicity, flammability and toxicity.

In the first instance the concentrations of plausible contaminants within the soil should be identified and wastes should be **classified based on their total concentrations**.

Waste Definitions

Inert	• Will not undergo any significant physical, chemical or biological transformations. • Will not dissolve. • Will not burn. • Will not physically or chemically react. • Will not biodegrade. • Will not adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm to human health. • Has insignificant total leachability and pollutant content. • Produces a leachate with an ecotoxicity that is insignificant (if it produces leachate).
Non-Hazardous	Is not inert (see above) Is not hazardous (see below)
Hazardous	Soil has hazardous properties as defined in WM3 (Guidance on the classification and assessment of waste (1st edition 2015)- Technical Guidance)
Stable Non-reactive hazardous waste#	Hazardous waste, the leaching behaviour of which will not change adversely in the long-term, under landfill design conditions or foreseeable accidents either: in the waste alone (for example, by biodegradation), under the impact of long-term ambient conditions (for example, water, air, temperature or mechanical constraints) or by the impact of other wastes (including waste products such as leachate and gas).

This option allows hazardous waste that is stable and thus has a low leaching potential to be deposited in cells with a standard of containment consistent with non-hazardous wastes.

WAC Testing

The purpose of WAC analysis is to confirm that the waste complies with the relevant WAC for the receiving landfill. If the waste has any disposal route other than a landfill site (e.g. recycling facility, incineration etc) the WAC is not relevant. Furthermore, the WAC limits **cannot** be used to make an assessment of whether a waste is hazardous. WAC testing does however define if a non-hazardous waste is suitable for an inert landfill.

Classification based on Total Concentrations[1]	**Non-Hazardous Waste**		**Hazardous Waste**	
WAC testing	Below inert WAC limit values:	Above inert WAC limit values:	Below hazardous WAC limit values	Above hazardous WAC limit values
Landfill requirements	INERT landfill	NON-HAZARDOUS landfill[2]	HAZARDOUS landfill	PRE-TREATMENT[3]

1 Total concentrations are defined as tests results on solids as opposed to leachate (i.e. a liquid).
2 Individual sites may have certain limit values pre-determined in their licence.
3 After pre-treatment the material characteristics may have changed to an extent that allow the soil to be re-classified.

Hydrocarbons in Soils
WM3 uses the term Oil or Waste Oil to cover hydrocarbons products such as fuel oil, petrol or diesel. These are defined by WM3 as hazardous under an absolute entry in the List of Wastes. However, hydrocarbons in soils are a mixture rather than a pure product and are therefore not absolute entries.

Known Oils
The simplest scenario is where the identity of the contaminating oil is known or can be identified. If the oil is known the manufacturer's or supplier's REACH compliant safety data sheet for the specific oil can be obtained and the hazard statement codes on that Safety Data Sheet can be used for the hazardous waste assessment.

Where the identity of the oil can only be identified down to a petroleum group level (i.e. the contaminating oil is known to be diesel, but the specific type/brand is unknown), then the classification of that petroleum group should be used in the assessment. The marker compounds associated with that petroleum group may be used to confirm carcinogenicity.

Oils may contain a range of hydrocarbons, so the presence of for instance Diesel Range Organics (DRO) does not enable the assessor to conclude that diesel is present. These hydrocarbons may have arisen from other oils, the laboratory needs to provide an interpretation of the chromatograph to determine if it is consistent with diesel or weathered diesel as a whole.

The concentration of known oils should be determined using a method that as a minimum spans the range in which the carbon numbers for that known oil fall.

Unknown Oils
Where hydrocarbons are contaminating soils, it is likely that the oil will be unknown or cannot be determined.

WM3 states that:

> For contaminated land specific consideration must be given to the following before proceeding;
>
> - The presence of other organic contaminants, for example solvents or coal tar that could be detected as hydrocarbons. Coal Tar is not an oil and is considered separately in WM3 example 2. Where the site history or investigation indicates the presence of hydrocarbons from oil and other sources (e.g. coal tar), and the origin of the hydrocarbons cannot reliably be assigned to either, then a worst case approach of considering the hydrocarbons both as waste oil (in accordance with this example) and from other sources, for example coal tar should be taken.
> - The presence of diesel, or weathered diesel, should be specifically considered by the laboratory and where this is confirmed by the hydrocarbon profile the oil should be assessed as a known or identified oil (diesel).

The use of marker compounds is optional; however, it is recommended that where possible the marker compounds should be used. WM3 states:

> If the identity of the oil is unknown, and the petroleum group cannot be established, then the oil contaminating the waste can be classified as non-carcinogenic/mutagenic due to the presence of oil if all three of the following criteria are met:
>
> - The waste contains benzo[a]pyrene (BaP) at a concentration of less than 0.01% (1/10,000th) of the TPH concentration (This is the carcinogenic limit specified in table 3.1 of the CLP for BaP)
> - This has been determined by an appropriate and representative sampling approach in accordance with the principles set out in Appendix D of WM3, and
> - The analysis clearly demonstrates, for example by carbon bands or chromatograph, and the laboratory has reasonably concluded that the hydrocarbons present have not arisen from petrol or diesel.

For example:

TPH Concentration (mg/kg)	Petrol or Diesel	BaP (mg/kg)	Classification
10,000	No	0.9	Non- Hazardous
1,000	No	Not available	Hazardous
1,000	Yes	Not relevant	Hazardous

References

1. Environmental Permitting (England and Wales) Regulations 2010 (as amended) (EP Regulations), the Landfill Directive (1999/31/EC) and the subsequent Council Decisions.
2. Environment Agency Environmental Permitting Regulations: "Inert Waste Guidance- Standards and Measures for the Deposit of Inert Waste on Land" 2009.
3. Environment Agency "Waste acceptance at landfills - Guidance on waste acceptance procedures and criteria" Nov 2010.
4. Environment Agency "Guidance on the classification and assessment of waste (Technical Guidance WM3)".
5. Classification, Labelling and Packaging of Substances Regulation (EC 1272/2008) (CLP).
6. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives
7. 2014/955/EU: Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European Parliament
8. Environmental Permitting Guidance The Landfill Directive For the Environmental Permitting (England and Wales) Regulations 2010 Updated March 2010 Version 3.1
9. Classification, Labelling and Packaging of Substances Regulation (EC 1272/2008) (CLP).

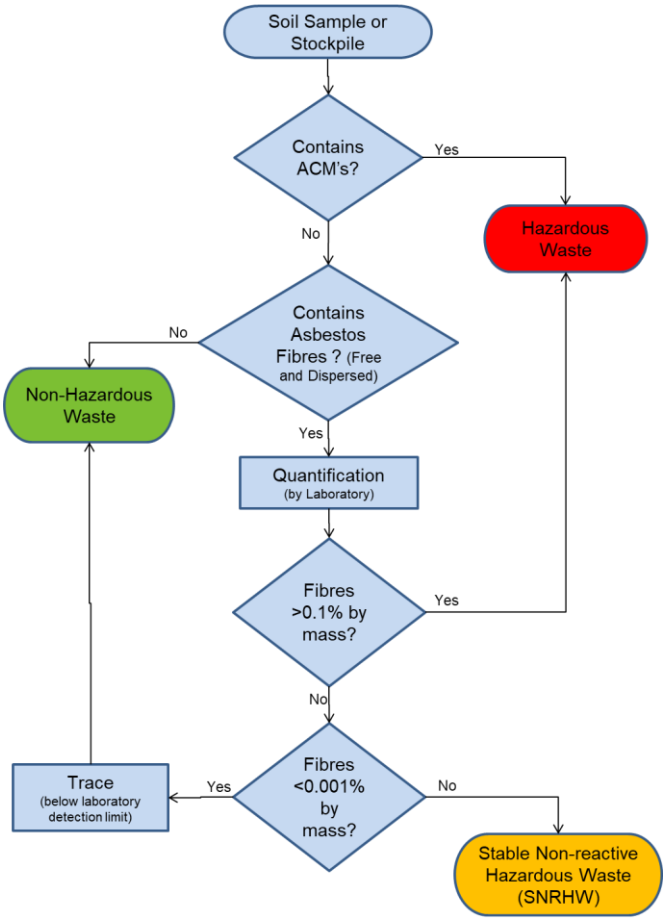
Additional Asbestos Guidance Notes

Disposal

The 1st Edition of WM3 "Guidance on the classification and assessment of waste", details the way in which Asbestos is assessed within soils.

The assessment of asbestos containing waste is dependent on whether the asbestos is present as:

- Fibres that are free and dispersed, or
- Identifiable pieces of asbestos containing materials (ACM's)



Identifiable pieces of asbestos are any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye. The result is that commonly soils with visible ACM's are sorted and the ACM's removed by hand picking and separate disposal.

Asbestos concentrations below 0.001% by mass are below standard laboratory detection limits and are not currently regarded as containing asbestos for the purposes of disposal and may be disposed of to an inert landfill site[1]. These levels are often termed "trace" by laboratories.

Asbestos concentrations between 0.001% and 0.1% are stable non-reactive hazardous waste (SNRHW)[1]. Waste transfer stations where soil recycling takes place may be able to take SNRHW, but are unlikely to take soils containing asbestos above trace concentrations.

The following codes should be assigned to the asbestos waste as appropriate:

17 06	**Insulation materials and asbestos-containing construction materials**
17 06 01	Insulation materials containing asbestos
17 06 03	Other insulation materials consisting of or containing hazardous substances
17 06 04	Insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 06 05	Construction material containing asbestos

WM3 indicates that 17 06 05 would normally be used in preference to 17 06 01 for the asbestos in asbestos contaminated soil and stones.

Construction materials containing asbestos and "*other suitable materials*" may be landfilled at landfills for non-hazardous waste in accordance with the Landfill Directive without testing.

This means that wastes that are only hazardous because of their asbestos content can be disposed of at landfills for non-hazardous waste in separate landfill cells that only accept asbestos wastes and other suitable materials. The Landfill Directive requires that stable non-reactive hazardous waste shall not be deposited with biodegradable waste (for example organic material, household waste, paper etc..) and must meet the waste acceptance criteria set out in accordance with Annex II.

Construction
Health and Safety Executive (HSE) guidance on asbestos is not directly related to soil and much of the guidance focuses on the removal of asbestos from buildings. The overarching legislation is the Control of Asbestos Regulation (CAR 2012). However, where work involves (or is likely to involve) contact with asbestos then CAR 2012 requires a risk assessment including whether or not the work is licensed or notifiable non-licensed work and may require an Asbestos Management Plan. Work becomes notifiable if it is considered that the control limit could be exceeded.

Brownfield sites frequently have soils that contain asbestos and the presence of asbestos needs to be considered within the context of construction, particularly in relation to groundworks. The exposure of soils and the use of excavators and plant to move soil around increases the possibility of fibres becoming airborne. However, it is good site practice to not generate dusts and to employ dust suppression on all sites regardless of the presence of asbestos.

The legal control limit for asbestos is 0.1f/ml over a continuous four-hour period. The control limit is not a '*safe*' level and exposure from work activities involving asbestos must be reduced to as far below the control limit as possible.

Clearly the higher the concentrations in the soil the greater potential there is for fibres to be released, however IOM publication TM/88/14 "the release of dispersed asbestos fibres from soil" 1988 concludes that:

- Mixtures of asbestos in dry soils with asbestos content as low as 0.001% can produce airborne respirable asbestos concentrations greater than 0.1f/ml in dust clouds where the respirable dust concentrations are less than 5mg/m^3.
- An action limit is recommended of no higher than 0.001% asbestos in soils above which steps should be taken to minimise exposure to airborne fibres (e.g. by wetting).
- The addition of relatively small quantities (10%) of water can reduce the airborne fibre concentrations by an order of magnitude.

Where asbestos has been identified at concentrations above 0.001% as free and dispersed fibres in the soil precautions need to be adopted. Concentrations below this are considered to be normal background, although good site practice dictates that the generation of dusts should be avoided and therefore any fugitive fibre release from minor concentrations should be kept to a practical minimum.

End Use
The use of materials containing asbestos and material containing asbestos is prohibited under EU legislation. There is currently a Joint Industry Working Group (JIWG) tasked with producing a Code of Practice for Asbestos in Soil, Made Ground and Construction & Demolition Material that will clarify in due course the position of the various government agencies.

Asbestos containing materials can remain in situ under a suitable cover system which may be hardsurfacing or soft landscaping (with or without hard dig layers and markers).

There is a risk that future maintenance may compromise such systems and details of the presence of asbestos should be kept in the Health and Safety File.

Preliminary publications from JIWG (April 2015) provide guides for decision making in relation to construction.

The re-use of waste soils should be undertaken in accordance with the CL:AIRE Code of Practice and is subject to suitable risk assessments demonstrating low risk . There is nothing that specifically excludes the re-use of soils containing asbestos as fill to raise levels. However, the movement of materials increases the risk of fibres becoming airborne and suitable precautions will be required.

The re-use of soils containing asbestos at concentrations above hazardous waste levels is likely to meet with regulatory opposition. Assuming a suitable strategy could be agreed this would take a considerable amount of time and is only likely to be feasible where there is a long program for implementation.

Asbestos in Soil as Free Fibres

Concentration (by weight)	Waste Disposal				Construction Issues	End Use	
	Recyc	Inert	SNR	Hazardo		Suitable for re-use on site	Precautions
Not detected	√	√			No precautions necessary, however on a brownfield site asbestos not previously identified may be found during works and a statement within the contractors method statement for how they will deal with this unforeseen asbestos would be good practice to ensure compliance with CAR2012.	Yes	None
Trace (<0.001%)		√ [2]			Precautions are unlikely to be required, however a detailed method statement may be required to ensure compliance with CAR2012. Basic asbestos management good practice will be required. Typically precautions would include: • Ensuring soils do not dry out to become dusty. • Site personnel have the risk communicated at induction stage.	Yes Soils can be re-used under CL:AIRE CoP with the correct precautions in place.	Generally clean cover or hardstanding cover required.
0.001% – 0.099%			√		Contractor needs to produce an Asbestos Management Plan in accordance with CAR2012 as part of their method statement. Typical precautions would include: • Site personnel have the risk communicated at induction stage. • Ensuring personnel have suitable training. • Task monitoring to inform PPE requirements. • Ensuring soils do not dry out to become dusty and that misting is available during groundworks. • Separate stockpiling. • Clean haulage routes.	Possibly Soils may be able to be re-used under CL:AIRE CoP, subject to a satisfactory Risk Assessment and regulatory agreement with the correct precautions in place.	Clean cover or hardstanding cover required.
0.1+%				√	Contractor needs to produce an Asbestos Management Plan in accordance with CAR2012 as part of their method statement. Typical precautions would include: • Site personnel have the risk communicated at induction stage. • Ensuring personnel have suitable training. • Task monitoring to inform PPE requirements. • Site wide and or perimeter monitoring. • Ensuring soils do not dry out to become dusty and that misting is available during groundworks. • Separate stockpiling. • Clean haulage routes. • Decontamination unit	Unlikely [3] Re-use of soils containing asbestos within an earthworks scheme will involve significant engineering and the Risk for generating dusts will be significantly increased with	Clean cover and a hard dig layer. A plan should be in place for future excavations as part of the Health and Safety File.

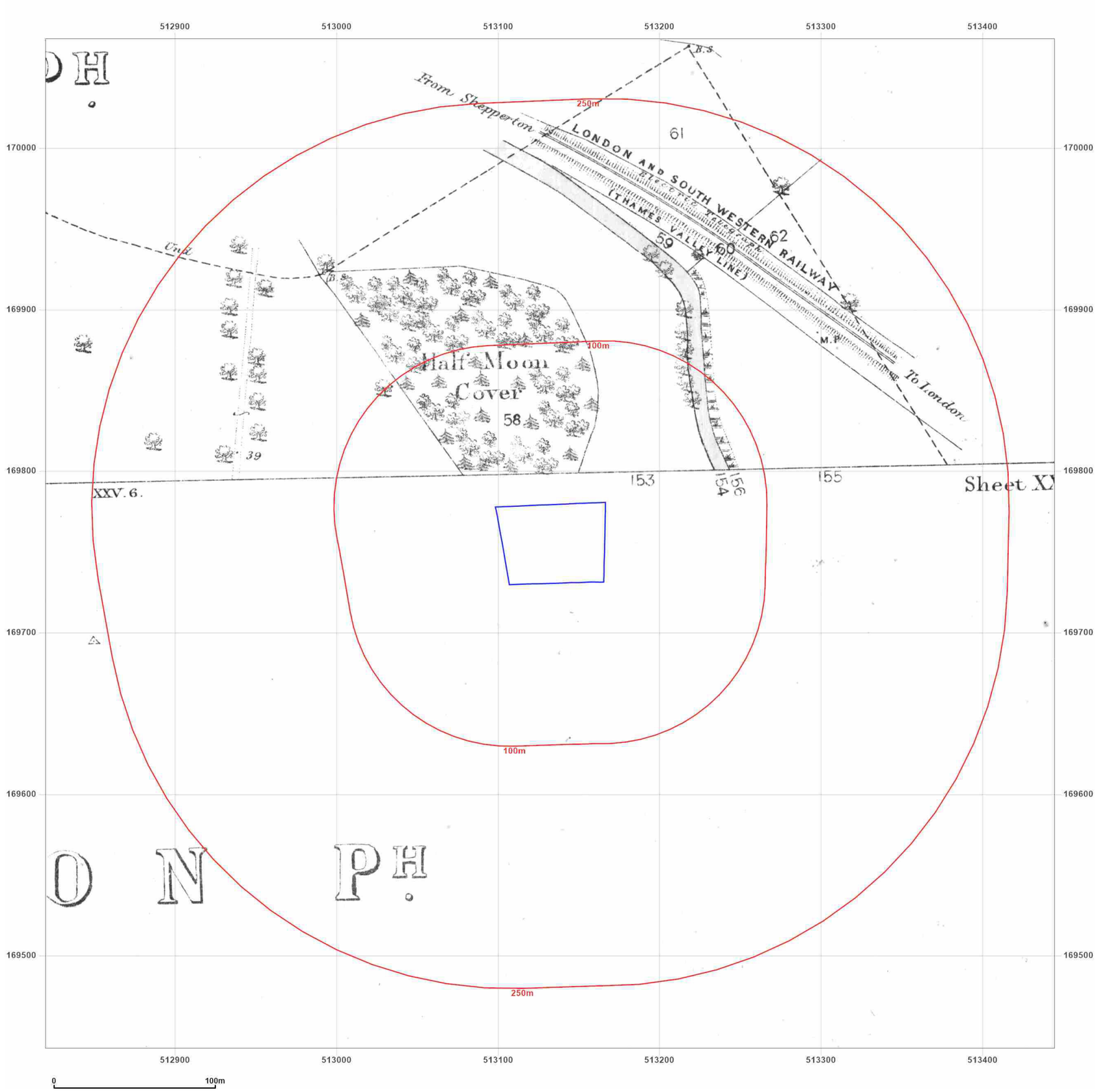
Concentration (by weight)	Waste Disposal				Construction Issues	End Use	
	Recyc	Inert	SNR	Hazardo		Suitable for re-use on site	Precautions
						repeated handling and compaction.	

1. The standard laboratory detection limit is normally 0.001%. Below 0.001% is trace and currently regarded as not containing asbestos for the purposes of disposal off site. However the waste producer has a duty to fully classify the waste and the presence of trace asbestos should be declared. Consequently it is unlikely that a waste treatment site will take this soil and an inert landfill may make a commercial decision to only take it under some circumstances.

2 The re-use of soils containing asbestos at concentrations above hazardous waste is likely to meet with regulatory opposition. Assuming a suitable strategy could be agreed this would take a considerable amount of time and is only likely to be warranted where there a long program for implementation.

APPENDIX B

Historical Maps



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Site Details:

OLDFIELD ROAD, HAMPTON,
TW12 2HR

Client Ref: M5478-4416-SD
Report Ref: BRO-EZN-5A3-W4S-IWL
Grid Ref: 513132, 169755

Map Name: County Series

Map date: **1865**

Scale: 1:2,500

Printed at: 1:2,500

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Revised 1865
Edition N/A
Copyright N/A
Levelled N/A

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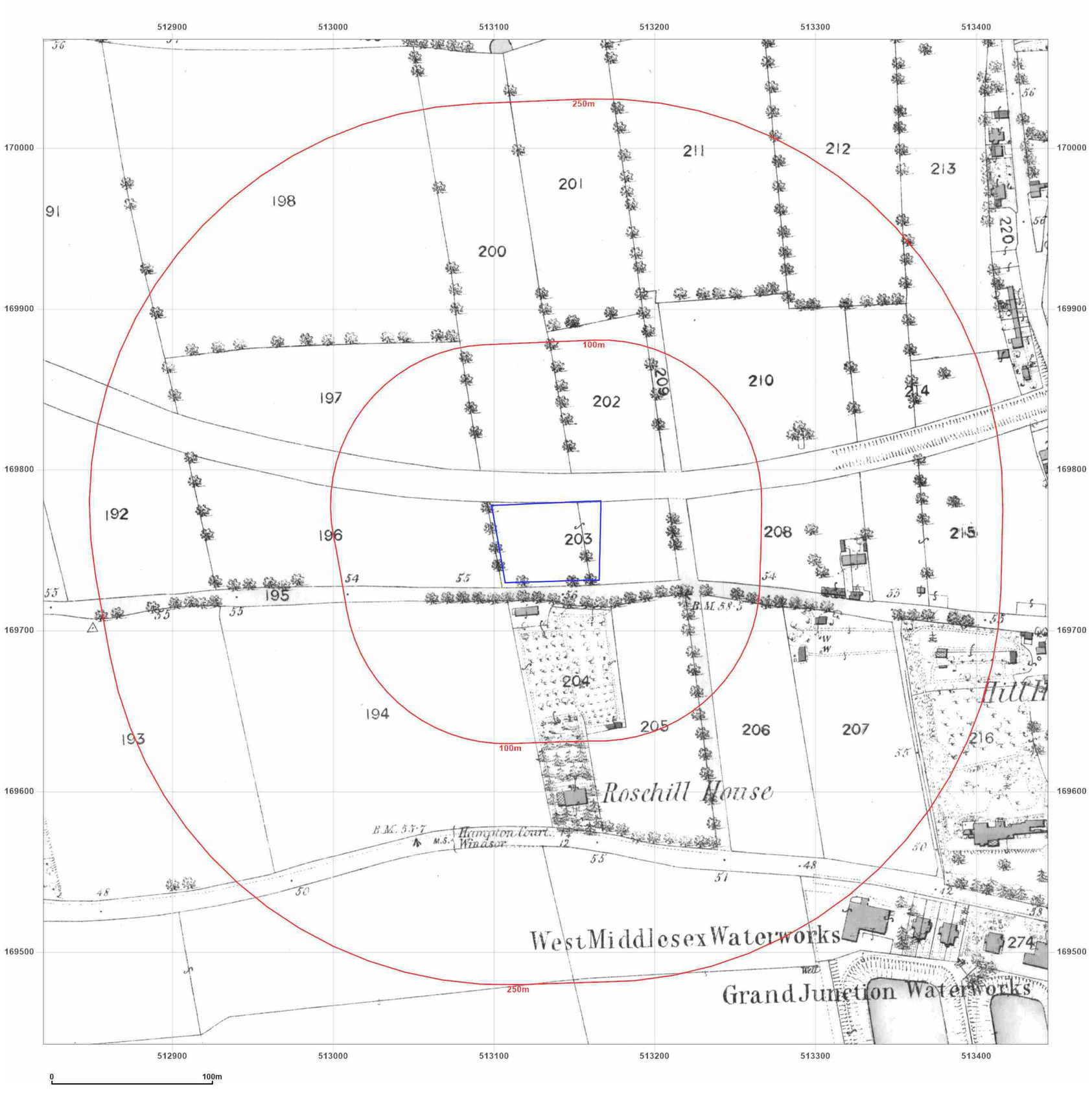

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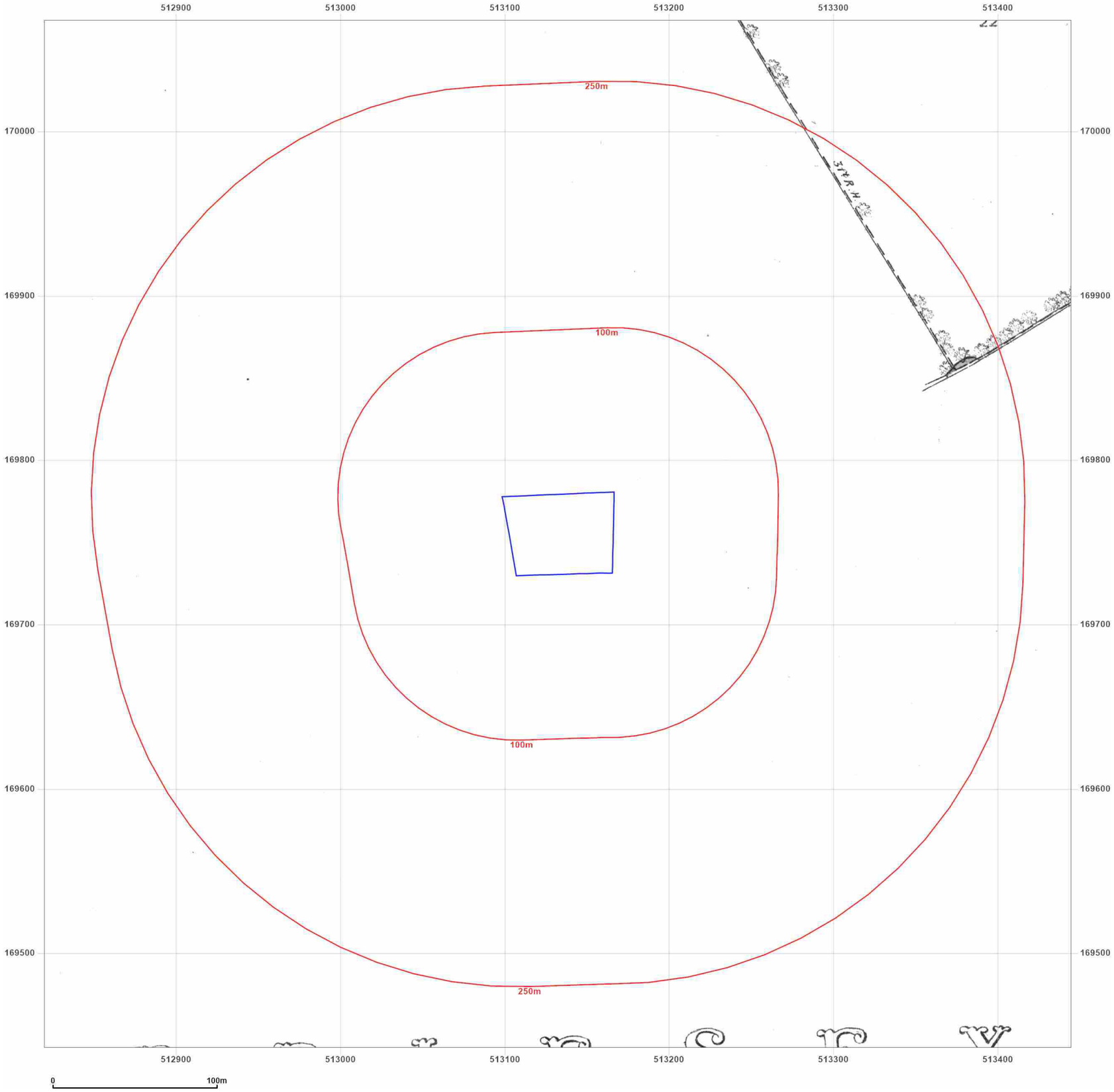

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Map Name: County Series
Map date: **1869**
Scale: 1:2,500
Printed at: 1:2,500

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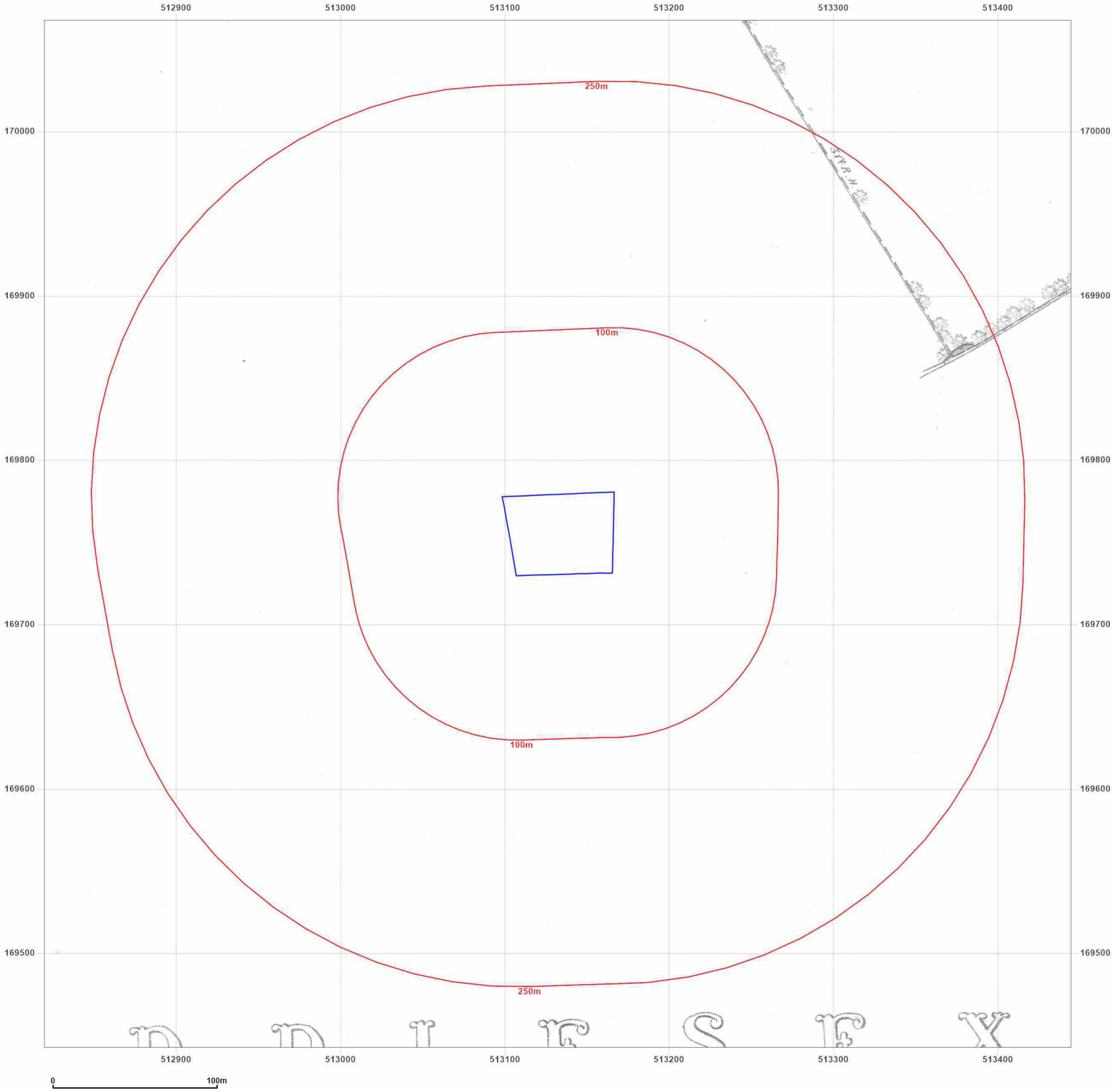

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GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

Site Details:

OLDFIELD ROAD, HAMPTON,
TW12 2HR

Client Ref: M5478-4416-SD
Report Ref: BRO-EZN-5A3-W4S-IWL
Grid Ref: 513132, 169755

Map Name: County Series

Map date: **1897**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1897
Revised 1897
Edition N/A
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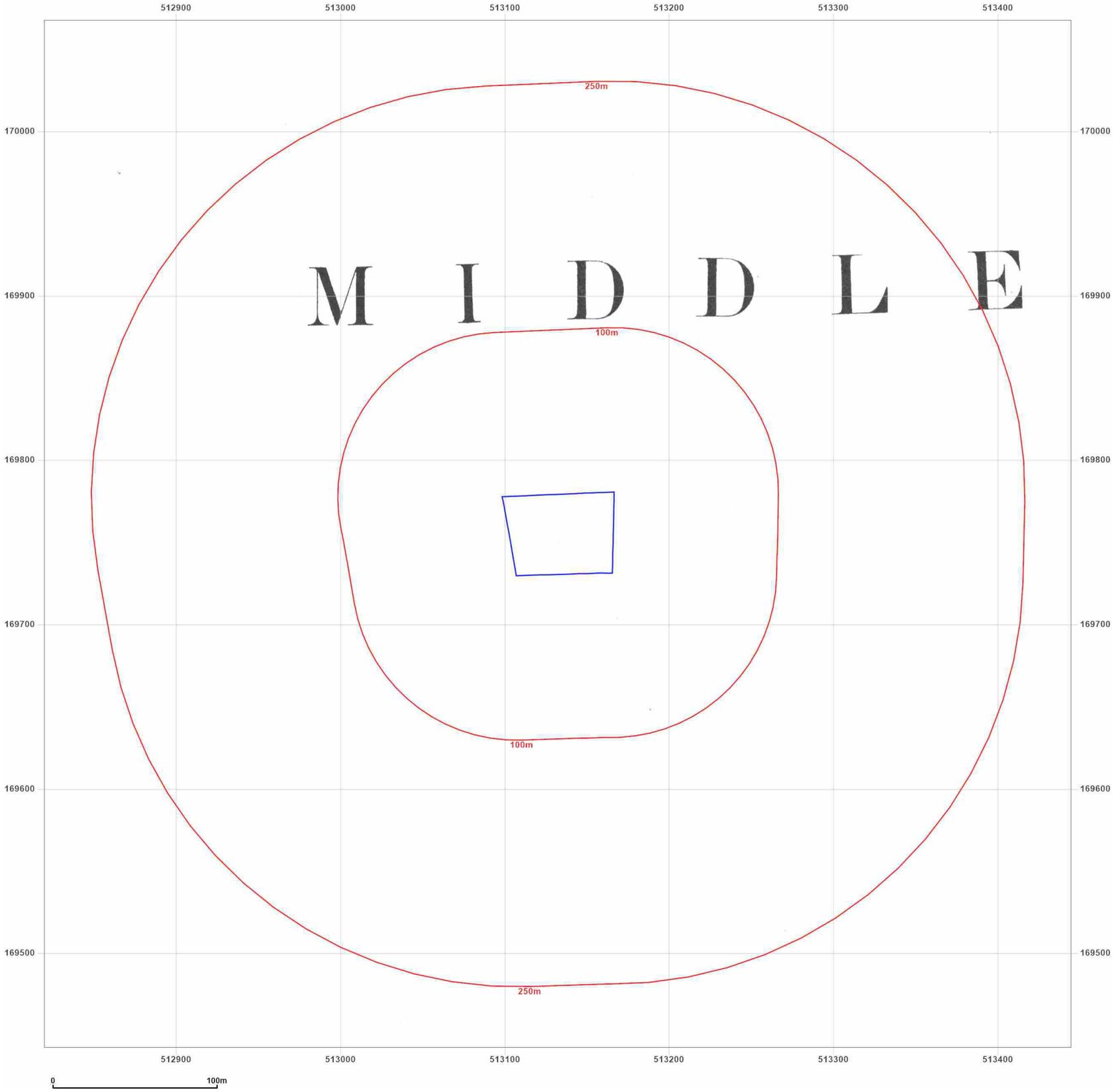

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Client Ref: M5478-4416-SD
Report Ref: BRO-EZN-5A3-W4S-IWL
Grid Ref: 513132, 169755

Map Name: County Series

Map date: **1914**

Scale: 1:2,500

Printed at: 1:2,500

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