

LCRM: Intrusive Site Investigation

LAND OFF BURY OLD ROAD, DARN HILL, HEYWOOD

Project Ref: GUK-0224-05

For: ECS Capital Limited

CLIENT:

ECS Capital Limited

PROJECT:

Residential Development

SITE REFERENCE:

**Land off Bury Old Road
Darn Hill
Heywood**

REPORT REFERENCE:

GUK-0224-05/Rp-002



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SUMMARY & RECOMMENDATIONS

This summary presents the salient points of the report but should not be referred to in isolation of the body text. There will be other information contained within the report which puts into context the findings of the Executive Summary. No reliance should therefore be placed on the Executive Summary until the report has been read in full. The recommendations given are considered reasonable based on available information and the assessment of the Site as carried out by Groundsmiths (UK) Ltd at this time.

1 ENVIRONMENTAL CONSTRAINTS

Radon: No radon precautions are indicated to be required in construction on the basis of available information.

General Soil Contamination: No elevated contaminant concentrations above the residential with home-grown produce GAC values were measured within either the made ground soils or underlying natural strata.

Asbestos: No asbestos fibres were identified within any of the soils tested.

Construction Workers: The on-Site ground conditions do not appear to present any particular risk to construction workers involved with the Site's redevelopment. However, all in-ground works should automatically be assessed and completed in accordance with current regulatory guidance.

Soil Remediation Requirements: No formal remediation to the on-Site soils is considered necessary. Where supplementary topsoil materials are to be imported for use in soft landscaping, these shall be in compliance with YALPAG guidance.

Should any currently unforeseen contamination be encountered, further assessment would be needed. If remedial works were subsequently required, specific details and verification of the works that are to be undertaken and how any deviation away from those works will be addressed will need to be provided to the Local Planning Authority in the form of a stand-alone LCRM Stage 3 Remedial Strategy. All remedial activities would need to be in accordance with the requirements of YALPAG.

Ground Gas and Remediation Requirements: Monitoring is ongoing, although a Characteristic Situation 2 determination in accordance with BS8485 is currently anticipated. The results of the monitoring and risk assessment will be issued under separate cover once complete, with any recommendation for mitigation being made at that time.

Controlled Waters Receptors: Risk from the off-site discharge of any leachable contaminants is considered to be very low. No further assessment is considered necessary.

Invasive Plants Species: Risk from invasive plant species is not expected, although this should be independently confirmed as required.

2 GEOTECHNICAL & GENERAL DEVELOPMENT CONSTRAINTS

Buried Concrete: Concrete to DS1/AC-1s is anticipated given the range of sulphate concentrations measured within the on-Site soils. This determination does not make any necessary allowance for the requirements of structural strength or durability so further consultation with the Designing Engineer should be made accordingly.

Anticipated Foundation Type: It is anticipated at this stage that traditional reinforced spread foundations could be suitable for lightly loaded structures of typical construction given the observed ground conditions. It should be noted that the use of traditional foundations would be subject to the integrity of the formation being preserved during Site clearance/enabling works and subsequent construction activities; refer to Section 7.2 of the Report text for further discussion. Alternatively, a rafted foundation solution could be implemented.

Anticipated Ground Floor Type: Ground bearing floors are anticipated for where traditional spread foundations are to be used, subject to usual construction requirements being met. If rafts are adopted, the floor will be integral to the construction.

Heave Precautions: The need for heave precautions is not anticipated on the basis of the observed soils. If cohesive materials are encountered beyond where investigation has been completed all necessary precautions in construction would need to be provided where foundations lie within the influencing distance of existing, removed, or proposed planting.

Retaining Structure: The need for retaining structures has been identified given the changes in elevation that occur along the eastern and southern boundaries and in relation to the positioning to some of the proposed dwellings. Further assessment and investigation should be completed as required.

Excavations: The general instability of the underlying soils should be anticipated, particularly during prolonged periods of wet weather and/or where excavations are deep, or are left open for protracted periods of time. Where there is the possibility of weak/unstable ground being present or passing across any boundary, a geotechnical risk assessment of the integrity/stability should be undertaken prior to excavation works being carried out. Designed and engineered temporary or permanent measures should be deployed to ensure their continued stability, as required.

In-ground Obstructions: Remnant foundation construction and other in-ground development is evident on-Site. This substructure will need to be grubbed-out, either in their entirety or at least where they interact with new foundation construction, so as not to create 'hard spots'.

Potable Water Supplies: It is evident that the contaminant load within the on-Site soils is very low, and that the presence of reconstituted material is limited. That said, the Site is considered to be brownfield land. The data suggests that standard pipework would likely be acceptable for use, although due consideration should be given to the slightly elevated EC10-EC16 Aliphatic and Aromatic Hydrocarbon concentrations which exceed the PE threshold of 10mg/kg. Further discussion should be made with the water provider. As a worst case scenario, it could be that protection consistent with brownfield development (e.g. Protecta-Line) is required.

Slopes: Notwithstanding the need to retain (either wholly or in part) the eastern and southern boundaries, global slope stability problems are not anticipated.

Groundwater: Other than for seepage in BH5 at 3.0m bgl no groundwater was encountered during the investigation. The large-scale dewatering of excavations is not anticipated at this time. All necessary equipment should be made available, however, should differing groundwater conditions be encountered during construction.

Surface Water Drainage: It is considered that the use of soakaways for the discharge of surface water should be possible in development given that the Site is underlain by granular soils which should have good infiltration potential. Further consultation with a specialist drainage consultant should be made, with testing to BRE365 being completed as directed. All drainage proposals will be subject to obtaining the necessary approvals from the Regulatory Authorities.

Pavement: It is considered that the excavation and replacement of any unsuitable material with suitably compacted engineered fill will be needed for roads and parking areas. Free draining and clay-free granular soils would not be frost susceptible.

3 MINING LEGACY CONSTRAINTS

Coal Authority data indicates that there are no records of past underground mining within the zone of likely physical influence, no probable unrecorded shallow workings at <30m below ground level, no mine entries within 100m, no on-Site coal outcrops, or any records of coal mining subsidence. Risk from shallow coal mining would not therefore be expected on this basis.

1 INTRODUCTION

1.1 Appointment

Groundsmiths (UK) Ltd ('Groundsmiths') were appointed by ECS Capital Limited (the 'Client') % Built Developments Limited to provide professional services in relation to the geotechnical and geo-environmental characterisation of land located off Bury Old Road, Darn Hill, Heywood (herein referred to as the 'Site').

Groundsmiths have prepared this report (the 'Report') for the sole use of the Client that commissioned it in accordance with the agreement under which our services are performed. No other warranty, expressed or implied, is made as to the professional advice included in this Report. Any unauthorised third parties using the information presented in this Report do so entirely at their own risk and are duly excluded from any warranty, duty of care or skill.

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1.2 General Objectives

The aim of this Report is to present the findings of an intrusive ground investigation carried out to support the Client's intentions to redevelop the Site. It follows on from previously submitted preliminary risk assessment ^[1] and therefore seeks to update the Conceptual Site Model ('CSM') on the basis of Site-specific data obtained with respect to the general properties of the underlying soils and their environmental condition (considering the presence, extent, and nature of any contamination encountered and the potential impact this may have on sensitive receptors). Furthermore, it identifies where any additional Site-based works, risk assessment and/or remediation is considered necessary to facilitate development within the framework of a generic residential with home-grown produce exposure scenario as defined by the Environment Agency ^[2].

1.3 Limitations of Study

This Report has been prepared subject to the limitations detailed in Section 9 and any other limitations stated specifically in the Report text.

Interpretation and recommendations given in this Report should not be assumed valid for adjacent areas of land, or for alternate land use. Should the proposed Site usage change, the recommendations and conclusions presented in this Report will need to be re-assessed in accordance with all current guidance.

All works presented herein have been completed in general accordance with the requirements of BS 10175:2011+A2:2017 ^[3], BS 5930:2015+A1:2020 ^[4] and Stage 1 of the Land Contamination Risk Management ('LCRM') guidance ^[5] (Note that CLR11 was withdrawn on the 8th October, 2020). Where further works are identified, these shall be completed within the framework of LCRM ^[6,7], any other current guidance, and/or specific regulatory requirements.

2 SUMMARY CONCEPTUAL SITE MODEL

2.1 General Details

In summary, Table 2.1 below indicates the Site's general setting.

Table 2.1 - General Site Details

National Grid Reference	The National Grid Reference (NGR) for the Site was indicated to be 383473mE 410396mN (approximate centre).
Area of Development	Approximately 0.5ha.
Topography	General topographic data indicated that the Site lies broadly at 135m AOD, although some variation was anticipated.
Boundary Development	To the immediate south of the Site are the ground associated with the Our Lady & St. Paul's RC Primary School, whilst to the east, at a higher elevation by about 5m, is an open area of [former] sports playing field. Sutherland Road marks the western boundary, and Bury Old Road (and a strip of grass verge with various trees), the north. The wider area to the south of Bury Old Road comprises housing, whilst to the north is open undeveloped land that falls down towards the A58.
Invasive Species	No evidence of invasive plant species was identified during the investigation. Further assessments should be completed by a specialist ecologist as required.

2.2 Anticipated Ground Conditions & Other Considerations

A summary of the pertinent ground conditions thought likely to be encountered at the Site, in addition to salient published environmental data that could affect the Site, is given in Tables 2.2 and 2.3, below and overleaf.

Table 2.2 - Geology and Hydrogeology

Radon	Third party data indicates that between 1% and 3% of properties exceed the Radon Action Level in the area. No radon protective measures are indicated to be required in construction on this basis. This should be confirmed with Building Control as they may have different requirements.
Recorded bedrock Faults & other Linear Features	The nearest recorded fault line lies 49m to the north-east.
Infilled or Made Ground Deposits	Third party information records the presence of made ground both on and immediately adjacent to the Site, with the presence of infilled ground (associated with former aggregates working) being situated to the north of Bury Old Road.

Table Contd./

Superficial Geology	Data obtained from the BGS stated that the Site is underlain by Glaciofluvial deposits (sand and gravel) of the Devensian. These soils typically comprise coarse grained sediments with some localised finer-grained layers and horizons of clay, silt, and organic (peat) material.
Solid Geology	The solid geology underlying the majority of the Site was indicated to be sandstone of the Helpet Edge Rock (previously referred to as the Warmden Sandstone). Although variation across its field should be acknowledged, general records suggested this unit of rock to be grey-brown, fine- to coarse-grained, and large-scale cross bedded or massive. The north-eastern and south-western corners of the Site were mapped as being underlain by Coal Measures mudstone deposits.
Aquifer	<u>Aquifer within Superficial Deposits on Site:</u> Secondary A (soils with permeable layers capable of supporting local water supplies, and potentially forming an important source of river base-flow. Previously classified as minor aquifers). <u>Aquifer within Bedrock on Site:</u> Secondary A.
Groundwater	On the basis of the Site's setting and indicated geology, shallow-depth groundwater was not anticipated.
Coal	Salient information obtained from the Coal Authority indicated that there are no records of past underground mining within the zone of likely physical influence, no probable unrecorded shallow workings at <30m below ground level, no mine entries within 100m, no on-Site coal outcrops, or any records of coal mining subsidence. Risk from shallow coal mining was not therefore expected on this basis.
Natural Cavities	There are no recorded natural cavities within at least 500m.
Mining Cavities	There are no recorded mining cavities within at least 1km.
Non-coal Mining	There are no records of non-coal mining within at least 843m.
Natural Ground Subsidence (within 50m)	There was an indicated 'Negligible' risk rating for shrink swell clay soils and the ground dissolution of soluble rocks hazards, a 'Very Low' reported risk rating for running sands, collapsible deposits and landslides hazards, and a 'Moderate' risk rating for compressible deposits hazards.
Mass Movement Deposits	Information reviewed at the preliminary risk assessment stage indicated that there were no records of mass movement deposits within 500m of the Site, whilst the hazard rating for slope instability (landslide potential) within 50m was very low. Furthermore, the available data indicated that there were no records of landslip permeability (i.e. the estimated rate of vertical movement of water from the ground surface through the unsaturated zone of any landslip deposit) within 50m.

Table 2.3 - Environmental & Other Data

Landfill	Records indicated the presence of former landfill activity within 250m of the Site at the following position: - From 38m north-east: Boo-Hole Sand Quarry Extension, Bury Old Road. Licensed wastes comprise inert, industrial, commercial, household, and special. Date of surrender was 18 th January 1991.
UXO	Information obtained from Zetica (Appendix A) suggests that the Site lies within a low risk zone for Unexploded Ordnance.
Dangerous or Hazardous Sites	There are no historical COMAH recorded sites within 500m.
Radioactive Substances	There are no live radioactive substance authorisations within 500m.
Historical Fuel Sites	There are no records of historical petrol stations within 500m.
Garages/Workshops	There are no records of historical garage sites within 500m.

2.3 Plausible Source-Pathway-Receptor Linkages for Contamination

Current UK legislation on contaminated land is set out in Part 2A of the Environmental Protection Act 1990 ^[8], which was retrospectively inserted by Section 57 of the Environment Act 1995 ^[9]. The Contaminated Land Regulations 2000 ^[10] were amended in 2005. The Environmental Protection Act 1990: Part 2A Contaminated Land, Statutory Guidance, Edition 2 (2006) promulgates the revised statutory guidance with respect to the operation of the Contaminated Land Regime following the implementation of the Contaminated Land Regulations, 2005. The definition of contaminated land is central to the operation of Part 2A. Legislation adopts the principle of a 'suitable for use' approach for the assessment of contaminated land, the rationale reflected in the site-specific risk assessment and determination of remedial strategy. Action is only required if unacceptable risks are posed to human health or to the environment, taking into account the current land use and geo-environmental setting. The legislation places a responsibility on the Local Planning Authority to determine whether the land under its jurisdiction is contaminated by consideration of whether:

- The presence of substances (potential contaminants) are present at concentrations that are causing significant harm or have the significant possibility of causing significant harm;
- There are receptors which may be harmed (e.g. the water environment, human health, buildings, fauna and flora), and/or
- There is in existence a pathway between the identified sources and receptors.

To qualitatively assess the level of risk at the Site from soil and/or any waterborne contamination the above rationale was applied. This approach is consistent with the preliminary risk assessment procedure defined in LCRM. The following section summarises Groundsmiths' understanding of the surface and sub-surface features at the Site, the potential sources of

contamination, transport pathways and receptors in order to support the identification and assessment of plausible potential contaminant linkages that needed to be investigated.

Sources

A potential source is defined as ‘a contaminant which is in, or under the land and has the potential to cause harm to human health or to cause contamination of controlled waters’.

In reviewing the Site’s general history it was indicated that the first edition OS plans from c.1851 showed the Site to be open undeveloped farmland until it was redeveloped with a school c.1966. It is understood that the school closed in 2020. The building was subsequently demolished, although remnant construction remains in the ground; part of the school also remains active to the Site’s immediate south to date.

Surrounding (and wider) land was formerly open undeveloped farmland, but with some of this being opened as sand extraction pits, particularly to the north of Bury Old Road where the Boohole and Prettywood quarry pits were located. The Boohole pit was licensed as a landfill in July 1979 (surrendered in 1991), whilst the Prettywood pit was licensed in August 1980 (surrender date unknown). Residential development expanded significantly c.1966 across the local area.

Third party data suggests that the entirety of the school-infrastructure, including its playing fields, are ‘made ground’. However, there’s no evidence to suggest that this is the case, although regrading of the original ground level and natural soils would have occurred to facilitate construction of the school buildings and their associated grounds at a lower level; this is evident in the elevational changes that occur between the playing field to the east and the other parts of the school’s landholding.

On the basis of the Site’s setting and use, it was considered that some contamination could potentially be present with concentrations being at levels above allowable GAC threshold values for the Site’s intended residential end use. Furthermore, the potential for off-Site landfilling to have an impact upon the Site was identified. Within the context of the CSM therefore, the following potential sources and contaminants that were thought likely to be associated with the Site are summarised in Table 2.4, below (a revised assessment of the CSM is given in Section 6, below, with that being based on the outcome of Site-specific investigation and analytical testing undertaken).

Table 2.4 - Summary of Potential Sources and Contaminants

Potential Sources	Potential Contaminants of Concern (not limited to)
Any potentially contaminated made ground and/or shallow-depth natural strata	Metals, metalloids, inorganic contaminants, phytotoxic contaminants, sulphate, PAHs (e.g. Benzo(a)pyrene) and asbestos
Sources of ground gas (e.g. off-Site landfilling)	CO ₂ and CH ₄

Migration Pathways

Migration pathways are routes by which contaminant sources may come into contact with receptors. Potential pathways for different types of contaminants vary depending on the properties of the contaminant, the mechanism of its release and the nature of the receptor. The principal potential contaminant pathways by which sensitive receptors were anticipated to become exposed to potential contamination at the Site are summarised in Table 2.5, below.

Table 2.5 - Summary of Plausible Migration Pathways

Potential Sources	Potential Pathways
Any potentially contaminated made ground and/or shallow-depth natural strata	Direct ingestion, dermal contact, dust and/or vapour inhalation
	Direct ingestion and/or dermal contact with liquid contaminants
	Leaching and direct contact with potable water supply pipes
	Leachable contaminants via surface run-off, vertical and lateral migration via any permeable strata with the potential to impact controlled waters receptors
	Soft landscaping
Sources of ground gas (e.g. off-Site landfilling)	Migration of gases and/or accumulation in void spaces via transport through service conduit, any permeable made ground and/or any permeable underlying natural strata

Receptors

A receptor is the potential target of the source contaminant, to which either significant harm or deterioration in quality may be caused. The potential sensitive receptors with respect to the potential contamination hazards identified above are considered in Table 2.6, below.

Table 2.6 - Summary of Potential Sensitive Receptors

Potential Receptor	Comment
Human Health	Site end-users in the residential (with home-grown produce) end use scenario Site operatives, during construction phase only Future workers involved with any in-ground maintenance works
Construction	Potable water supply pipes Foundations and service conduit
Controlled Waters	'Secondary A' aquifer soils

Environmental Risk Assessment

Risk assessment and the procedure of identifying sources, pathways, and receptors is recognised as an approach to determine the extent and significance of contamination either within the context of Part 2A (when assessing current site status or when considering the acquisition of an existing development) or the planning process (for the redevelopment of an existing site, or when considering the acquisition of a site for redevelopment purposes). Either way, the 'suitable for use' approach is adopted when assessing risk and the source-pathway-receptor assessment defines the conceptual model for the site. The statutory guidance describes a risk assessment methodology in terms of 'significant contaminants' and 'contaminant linkages', using the 'source-pathway-receptor' scenarios for the site. Contaminant linkages are formed when there is a linkage between a contaminant source and a receptor by means of a pathway. The existence of a contaminant linkage is dependent on-site use, as well as environmental conditions. If no contaminant linkages can be proven, then the risks may be discounted. However, it is not to say that remediation is required even if contamination is proven. The identified potential contaminants and receptors for the Site were considered in relation to the pathways that may link them. The risk classification was estimated in accordance with those methods prescribed by Rudland et al (2001) ^[11]. Risk is regarded as a combination of the likelihood of an 'event' occurring and its severity: both elements must be considered when assessing risk. The method for risk assessment, or evaluation, is purely qualitative. As defined in CIRIA C552 (Tables 6.3 and 6.4), the magnitude of the potential 'severity' of risk occurring may be assessed against:

- **Severe (acute):** short term risk to human health likely to result in significant harm as defined under Environmental Protection Act 1990, Part 2A. Short term risk of pollution to sensitive water receptor (may result in death).
- **Medium (chronic):** long term risk and significant harm to human health, contamination of sensitive water resource or significant change to an ecosystem or specific organism (may result in death).
- **Mild (chronic, but applicable to less sensitive receptors):** contamination of non-sensitive water resource but significant damage to crops, buildings, structures and services or the environment.
- **Minor (not significant):** harm, which may result in financial loss, or expenditure to resolve. Non-permanent effects to human health. Easily repairable effects of damage to buildings, structures and services.

Similarly, the classification of the magnitude of the 'probability' of the risk occurring may be assessed against:

- **High Likelihood:** a contaminant linkage exists and an event appears very likely in the short term, or almost inevitable in the long term, or contamination is causing harm at the receptor. Urgent action is required.
- **Likely:** a contaminant linkage exists and it is probable that an event will occur. An event may not occur, but it is possible in the short term and likely over the long term.
- **Low Likelihood:** a contaminant linkage exists and it is possible that an event will occur. It is not certain that an event will occur over time, but it is less likely in the short term.
- **Unlikely:** a contaminant linkage exists but it is not possible to say if an event will occur even over a very long time.

Following completion of the severity and probability assessment, classifications can be compared to indicate the actual risk each contaminant linkage presents: this can only be undertaken where there is a possibility of there being an active linkage. The risk categories which can be assigned are presented in Table 2.7, below, and range between 'very high' to 'very low' (NB - it is not possible to classify an identified risk as 'no-risk').

Table 2.7 - Risk Categorisation

		Consequence			
		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

Source: Table 6.5, C552 (2001).

- **Very High** – there is a high probability that severe harm could arise or that severe harm is occurring. Urgent investigation and remediation are likely to be required.
- **High** – harm is likely to occur, and that urgent investigation and remediation may be needed in the short term, but are likely over the longer term.
- **Moderate** – harm could occur. It is unlikely to be severe, most probably relatively mild. Investigation is normally required to clarify the risk with some remedial works being required in the longer term.
- **Low** – it is possible that harm could occur, but if it did, at worst it would be mild.
- **Very Low** – low possibility of harm arising, and that if it does it is not likely to be severe.

The identified potential contaminants and receptors for the Site were considered in relation to the potential pathways that may link them; the resultant contaminant linkages as identified at the preliminary risk assessment stage are summarised in Table 2.8, overleaf.

Table 2.8 - Summary of Environmental Risk (Current Site Condition without Mitigation)

Potential Sources	Potential Receptors	Plausible Pathways	Probability	Severity	Risk Rating
Any potentially contaminated made ground and/or shallow-depth natural strata	<u>Human Health</u> Site end-users, inc. maintenance and site workers (short term risk during redevelopment)	Direct ingestion, dermal contact with soil or inhalation of dust and/or vapour (Site end user)	Low Likelihood	Mild	Low
		Inhalation of asbestos fibres in made ground soils (Site end user)	Low Likelihood	Severe	Moderate
		Direct ingestion, dermal contact with soil or inhalation of dust and/or vapour (In-ground worker)	Low Likelihood	Mild	Low
		Inhalation of asbestos fibres in made ground soils (In-ground worker)	Low Likelihood	Severe	Moderate
		Direct ingestion and/or dermal contact with liquid contaminants (Site and user / In-ground worker)	Unlikely	Mild	Very Low
	Potable Water Supply Pipes	Direct contact/leaching (tainting)	Low Likelihood	Mild	Low
	Vegetation	Root uptake in soft landscaping	Low Likelihood	Mild	Low
	Foundations	Direct contact/leaching	Low Likelihood	Mild	Low
	Controlled Waters	Vertical and/or lateral migration	Unlikely	Mild	Very Low
Sources of ground gas	Site End Users	Inhalation (via ingress and accumulation into buildings)	Likely	Medium	Moderate

3 INTRUSIVE SITE INVESTIGATION

3.1 Rationale

The overall objectives of the investigation were to assess and characterise the general nature of the ground conditions underlying the Site to quantify the identified geotechnical and environmental risks postulated in the preliminary CSM. This was based on the anticipated condition of the underlying soils and the anticipated levels of potential contaminants of concern in relation to the identified plausible source-pathway-receptor linkages.

3.2 Objectives

The specific objectives of the investigation were to:

- Investigate the general nature of the underlying soils, the thickness of any made ground and the depth to, condition, and nature of the shallow underlying natural strata.
- Determine the geotechnical parameters of the underlying natural strata via in situ and laboratory based testing as required.
- Investigate the general shallow-depth hydrogeological regime beneath the Site.
- Report the presence of any buried obstructions and/or other excavation difficulties encountered.
- Identify the nature and concentration of any contamination within individual soil matrices, including sulphate analysis to assist with buried concrete design, and undertake Waste Acceptance Criteria testing for soils disposal purposes.
- Investigate the general level of risk associated with any fugitive ground gases, and
- Provide general advice in relation to any environmental or geotechnical issues associated with the Site and/or any other recommendations needed to facilitate the proposed development, including, where necessary, identifying any additional phases of investigation, assessment, or remediation that may need to be carried out.

3.3 Scope of Investigation

The scope of works completed at this time is summarised in Table 3.1, overleaf, whilst the locations of the exploratory holes are shown on the appended investigation positions plan, Figure Ref. 0224-05-001.

Table 3.1 - Summary of Site-Specific Ground Investigation Works

Element of Work	Date Completed	Investigation Position Reference	No. of Positions	Maximum Achievable Depth (m bgl)	Installations	Rationale
Percussive boring with <i>in situ</i> SPT	17 th September 2024	BH1 – BH6	6	5.0	-	To obtain general geotechnical and environmental data for the underlying soils
Dynamic Probing	24 th September 2024	DP1 – DP6	6	15.0	-	
Rotary Boring	25 th September 2024	GW1 – GW4	4	4.0	4	To facilitate installation of ground gas monitoring wells

Intrusive fieldwork was undertaken in general accordance with the requirements of BS 5930:2015+A1:2020, BS 10175:2011+A2:2017, BS EN 1997-1:2004+A1:2013 ^[12] and BS EN 1997-2:2007 ^[13].

Strata descriptions of the soils encountered are in general compliance with BS EN ISO 14688-1:2002+A1:2013 ^[14], BS EN ISO 14688-2:2004+A1:2014 ^[15] and BS EN ISO 14689:2003 ^[16]. The individual strata depths and reduced levels recorded on the investigation logs are those from existing ground elevations. All survey data is based on that supplied by Groundtech Surveys Ltd.

3.4 Testing

Environmental

Environmental sampling was undertaken for the purposes of collecting representative samples of the on-Site soils for laboratory analysis. The intention of the testing was to establish the nature, concentration, and spatial distribution of any contamination present within the individual soil matrices encountered.

Soil samples were recovered from within the following approximate depth range: ground level-GL-0.5m bgl, 0.5-1.0m bgl and then at 1.0m centres thereafter, or as ground conditions required/allowed. All environmental soil samples were collected in a combination of 500ml plastic tubs with sealable lids, 250ml glass amber jars and 60ml glass VOC jars. Care was taken to minimise cross contamination between sampling events.

Where analysis was scheduled, testing of all samples was undertaken at the premises of i2 Analytical Ltd. The analytical strategy adopted for the investigation was designed to provide an overall assessment of contaminant concentrations within the identified soil matrices, taking account of the potential contaminants of concern indicated in the preliminary CSM. The testing of the following principal analytes was therefore undertaken:

- 13 No. CLEA standard suite for metals/metalloids (including As, Ba, Bo, Cd, Cr, Cu, Hg, Pb, Ni, Zn), Cyanide (free and total) and Thiocyanate.
- 13 No. pH, Soil Organic Matter and Total Organic Carbon.
- 13 No. Sulphates (Total and Water Soluble) and Sulphide.
- 10 No. Total Potential Sulphate.
- 16 No. Speciated Polycyclic Aromatic Hydrocarbon.
- 5 No. Speciated Total Petroleum Hydrocarbon.
- 5 No. VOC and SVOC including Monoaromatics and Oxygenates (BTEX).
- 16 No. Electrical Conductivity & Redox Potential.
- 13 No. Asbestos identification and screen.
- 13 No. Monohydric Phenol (Total), and
- 2 No. Full Waste Acceptance Criteria (Single Stage 10:1 leachate extraction).

Geotechnical

Given the granular properties of the underlying natural soils as encountered, there was no particular requirement for testing to confirm the natural water content ^[17] or plasticity indices (Atterberg Single Point) ^[18] as the soils will be non-shrinkable ^[19]. In-situ standard penetration testing ('SPT') ^[20] was therefore undertaken at 1.0m centres in all six percussive boreholes to establish general ground strength with depth to the point where SPT N = 50¹. Furthermore, dynamic probe tests ^[21] were also completed at the same positions to further establish ground strength across the Site and penetration resistance with depth to refusal; refusal in this instance was taken as being DPSH 'N10/100mm' = 50.

3.5 Proven Ground Conditions

NOTE: The account given herein is based on the ground conditions observed during the investigation only. It is important to note that there could be lateral and vertical variation in the reported ground and groundwater conditions between each of the investigation positions completed. This should be allowed for at the detailed design-phase stage, as required.

A generalised summary of the lithologies encountered is given in Table 3.2, overleaf.

For a full description of the ground conditions recorded at each investigation position, reference should be made to the individual borehole records provided in Appendix B.

¹ NOTE: The reported relative density of the granular soils encountered is based on the SPT N-values obtained. Classification for relative density given in the individual borehole records is based those given in Table 10 of BS5930 (2015+A1:2020). The numerical SPT N-values stated on the borehole records are uncorrected. SPT N = 50 is taken as being very dense ^[22].

Table 3.2 - Summary of General Soils and Groundwater Profile

Lithology	Typical Descriptions
Made Ground (Reconstituted Ground)	- Compact brown sandy loam; - Loose brown-grey slightly clayey sand with hardcore and gravel; - Loose and compact brown gravelly sand with concrete fragments.
Glaciofluvial Deposits	- Loose becoming medium dense orange-brown slightly gravelly fine to medium grained SAND; - Medium dense orange-brown slightly gravelly fine to medium grained SAND with discrete partings of brown clay; - Medium dense orange-brown slightly gravelly fine to medium grained SAND; - Medium dense orange-brown medium to coarse grained gravelly SAND; - Interbedded horizons of loose and medium dense orange-brown slightly gravelly fine to medium grained SAND.

As indicated in the aforementioned preliminary assessment report, it was anticipated for the Site to be potentially underlain by some made ground soil, although the thickness, composition, and environmental condition of such material was unknown at the time; these would be associated with previous development and demolition. Beneath these, it was indicated for the natural undisturbed strata to comprise Glaciofluvial deposits, typically consisting of coarse grained sediments with perhaps some localised finer-grained laminations of clay, silt, and/or organic (peat) material. Due to the nature of the previous development and changes to ground elevation, however, it was also postulated for the Glaciofluvial deposits to have potentially been removed, and for there to be present sandstone of the Helpet Edge Rock from shallow depth.

Shallow-depth groundwater was not anticipated as the underlying soils were considered likely to be fairly well-drained.

Made Ground

On the basis of the ground investigation, it appears that the Site is underlain by a relatively thin and discontinuous mantle of made ground, with this being much thinner than anticipated. The thickness, as proven in the individual investigation positions where encountered, is generally around 0.5m albeit with some slightly thicker deposits (to ~1.5m) being recorded locally within the footprint to the former school building. Material composition was observed to be fairly consistent between each of the investigation positions, with the soils essentially comprising a loose or compact granular deposit of sand with some inclusions of concrete, hardcore, and gravel of mixed lithology.

Glaciofluvial Deposits

The underlying superficial deposits were recorded in all investigation positions, except for BH3 which encountered made ground to 2.0m bgl with an obstruction beneath (assumed to be an old foundation or similar). These soils were noted to consist of loose orange-brown slightly gravelly fine to medium grained sand over medium dense orange-brown slightly gravelly fine to medium grained sand.

Where loose deposits were encountered, they tended to be within the upper 1.0-1.5m, although there appears to be no particular spatial pattern across the Site for these and their presence was sporadic. Some localised and discrete partings of clay were noted in BH1 and BH2 within the upper 2.0m, on the northern side of the Site, although no other partings were recorded elsewhere.

The bulk of the deposits beneath the Site appear to be medium dense, although coarser (albeit medium dense) sand and gravel deposits were recorded in BH2 from 4.8m bgl. The observed nature of the soils is broadly consistent with the findings of other ground investigations undertaken within the south-western part of Heywood which recorded 'softer' nearer surface granular deposits over medium dense grey-brown silty slightly gravelly sand to c.8.0-12.0m bgl².

Helpet Edge Rock (Sandstone) and Coal Measures Bedrock

The underlying bedrock material was not visibly observed during the investigation. It should be noted that whilst the relative density of the superficial soils was determined as being largely medium dense, some of the investigation positions recorded collapse and had to be redrilled in addition to either very poor or nil sample recovery in the sampling barrels (i.e. BH2, 2.0-4.8m bgl; BH3, 3.0-5.0m bgl; BH5, 3.0-3.6m bgl). On this basis, the deepest that the percussive sampling was taken to was 5.0m bgl within the Glaciofluvial soils.

Dynamic probe refusal as indicated on the individual test records in Appendix B is assumed, however, to have been achieved within the top of the bedrock (see Section 4.0 below for further discussion).

Groundwater

It may be reported that only some localised groundwater seepage was recorded in BH5 at a depth of 3.0m bgl.

Organic Materials

No peat was observed within any of the boreholes during the investigation.

² e.g. British Geological Survey Borehole Records Refs: SD80NW400 and SD80NW403 (Pre-Piling Surveys Ltd, Peterborough).

4 GEOTECHNICAL FIELD TESTING

Test data obtained from the ground investigation has been assessed in order to identify the presence of any typical ranges, trends, and/or anomalies as may exist. The following data was assessed:

- In Situ Dynamic Probe tests;
- In Situ Standard Penetration tests.

4.1 Super Heavy Dynamic Probing

The use of superheavy dynamic probing (DPSH) is a recognised method to quickly investigate ground conditions with differing driving resistance and to identify buried features such as rock ledges, oversized clastic material, variations in high wall geometry, or other such obstructions. The simplest application of dynamic probing, however, is to identify where refusal on potential founding strata is achieved (e.g. where end bearing piles could be sited) or to determine whether penetration is actually possible to a given depth, or not. On this basis, probing was undertaken at the positions indicated on the appended investigation locations plan to assess the strength profile of the Glaciofluvial Deposits to refusal (wherever possible) within the area of proposed build.

All tests were carried out in general accordance with BS EN ISO 22476-2 with the number of blows being recorded for every 100mm penetration (N_{10}). Refusal of each test was recorded as being where $N_{10} = 50/100\text{mm}$ was achieved. The individual results of the probing are presented in Appendix B (a graphical plot of the penetration resistance is also given against depth for each of the tests) whilst a summary the results is given in Table 4.1, below.

Table 4.1 - Summary of Dynamic Probe Results

Investigation Position	Depth to Refusal (m bgl)	Refusal Reduced Elevation (m AOD)	Comment
DP1	10.0	122.78	Test taken to completion
DP2	14.2	119.61	Test taken to completion
DP3	1.5	-	Shallow depth buried obstruction
DP4	14.9	120.86	Refusal not achieved
DP5	9.8	122.87	Test taken to completion
DP6	11.4	121.40	Test taken to completion

Excluding positions DP3 and DP4, the overall dataset indicates that refusal at $N_{10} = 50/100\text{mm}$ was recorded between c.10.0m bgl and 11.0m bgl. These terminal depths are assumed to be consistent with the shallow dipping nature of the underlying bedrock. They're also broadly consistent with the recorded depth to 'shale', as indicated on the BGS records cited herein.

On average, the data indicates that the N_{10} values throughout the vertical profile of the Glaciofluvial deposits were less than 10/100mm to a depth of around 9.0-10.0m bgl, but then broadly increased with penetration to refusal with the exception of some individual and discrete lower-strength horizons. It is anticipated that where penetration counts were recorded in the high teens, this would likely be representative of the upper weathered surface of the sandstone/mudstone bedrock before more intact rock was encountered; a penetration thickness of around 1.0m is therefore postulated based on the investigation results.

4.2 In Situ Standard Penetration Testing

Standard Penetration Testing ('SPT') was carried out at metre intervals in each of the percussive boreholes to determine a strength profile of the Glaciofluvial soils with increasing depth. Given the recorded instability of the soils during testing (i.e. with hole collapse occurring at various depth intervals when extracting the sampling barrels to complete the SPT tests), boreholes located across the footprint to the development area were taken only to a depth of 5.0m bgl.

All (uncorrected) penetration data is presented on the individual borehole records in Appendix B, whilst a graphical representation of the data, presented as 'step diagrams', is also provided for reference.

In providing brief commentary on the SPT data, N values measured during the investigation at each of the incremental test depths ranged between: 0 and 22 at 1.0m bgl (average = 16.8); 13 and 50 at 2.0m bgl (average = 24.0); 10 and 50 at 3.0m bgl (average = 29.0); 15 and 43 at 4.0m bgl (average = 24.7), and 13 and 36 at 5.0m bgl (average = 24.5). As indicated above, SPT N = 50 is taken as the point of refusal and represents, on granular soil, a very dense material.

It should be noted that there is widespread 'scatter' within the dataset. This is not unusual and will be associated with localised variations in the degree of weathering and the impact of granular layers and/or lithorelicts/cobbles on the SPT tests. As with consistency and liquidity data for cohesive soils, interpretation of the in situ penetration test results for granular soils should not be taken as being definitive but should be regarded as a guide only given the expected variations that will occur between test positions, depths, and the fabric of the soils the tests are carried out in. It is evident, however, that there is a generally consistent strength profile with vertical depth, which concurs with the observed increase recorded in other parameters for the soils encountered.

As with the dynamic probing results, it is considered that a degree of caution should be applied when using the data given the variation in the character of the underlying soils encountered and the variability in the bearing capacities they likely offer. Data should therefore be assessed within the context of all other general Site-based observations and in relation to the development proposals. Differential settlement is thought likely to be a relatively low risk in development, but should be anticipated under load; the exact rate of any settlement would be difficult to predict however since the soils appear not to be wholly uniform in nature and contain horizons of fine and medium grained sand, material with different relative densities, and more coarse material at depth. Combined, these could have an effect on material behaviour and settlement characteristics.

5 ENVIRONMENTAL TESTING

5.1 Preamble

Representative disturbed samples of the made ground and underlying Glaciofluvial deposits as encountered were selected for laboratory chemical analysis. These samples were analysed for the suite of contaminants outlined in Section 3.4 above. A summary of the pertinent test results is given in the following tables, whilst a copy of the individual certification (Ref. 24-044060-1 and 24-044061-1) is presented in full in Appendix C.

5.2 Guidance for Laboratory Analytical Results - Assessment Criteria

Soil – Human Health

Change to UK human health risk assessment has seen the introduction of DEFRA's Category 4 Screening Levels (C4SL) ^[23] and the LQM/CIEH Suitable 4 Use Levels (S4UL) ^[24]. Both sets of guidance aim to provide Generic Assessment Criteria ('GAC') on the basis of updated assumptions relating to the modelling of human exposure to soil contaminants for the standard land uses: residential (with or without home-grown produce), allotments, commercial and public open space. With reference to the Site, the results of the chemical testing appended herein have been assessed as part of an environmental risk assessment against a number of potential receptors, considering risks to human health, environmental quality, and the built environment. In this instance, comparison against the residential with home-grown produce GAC values was undertaken; these values are provided in Appendix D for reference.

The general consensus between contaminated land practitioners has been that C4SL values, which are based on the 'Low Level of Toxicological Concern', are less cautious than the revised GAC values published by LQM/CIEH and may not, therefore, be wholly applicable for use outside the context of Part 2A Statutory Guidance. Although both publications in no way undermine the validity of existing Environment Agency guidance presented in, for example, SR2 ^[25], SR3 and the existing CLEA software, Groundsmiths are of the mind that the LQM/CIEH values, which are based on Health Criteria that represents minimal or tolerable levels of risks to health (as described in the Environment Agency's SR2 guidance) but incorporates the updated exposure assumptions presented in DEFRA's C4SL guidance, provide a better starting point from which to generate GAC that can be applied to development sites and are 'suitable for use' under the planning system.

It should be noted that both the C4SL and S4UL GAC values are based on sandy 'loam'. The C4SL values are derived for loam soils having a Soil Organic Matter (SOM) content of 6.0%, although more often than not soils on development sites are different in nature and have SOM contents much less than this. Whilst this is not a problem for metals and metalloids, as their environmental behaviour is not dependent on soil type or SOM content and may be applied directly, the algorithms used to model plant uptake and volatilisation for organic contaminants (such as PAH for instance) do take account of SOM in the soil; it is considered, therefore, that the application of SOM at 6.0% by default may lead to sites being incorrectly assessed in some instances.

In the same way that the LQM/CIEH values take account of SOM at 1.0%, 2.5% and 6.0% for organic contaminants (which better reflects soils routinely encountered in the UK), Groundsmiths adjust the GAC values we apply to contaminated land assessment in CLEA Version 1.071 ^[26], utilising the toxicological updates presented in the aforementioned documents. Our approach

adopts the same SOM grouping as LQM/CIEH, but with some further minor adjustments to reflect a granular component. On the basis of the observed ground conditions recorded during the investigation and the measured SOM values reported by the laboratory, a conservative value of 1.0% has been adopted for the assessment of organic contaminants in both the natural strata and made ground. These GAC values would be more conservative when applied to cohesive deposits, given the effects of retardation, although such soils were not observed during the investigation.

5.3 Laboratory Analytical Results

A summary of the complete laboratory chemical test results is presented on the master datasheet in Appendix C, whilst an individual breakdown of the results is given in Tables 5.1 to 5.4, below and overleaf.

Table 5.1 - Inorganic Contaminant Concentrations (Made Ground)

Contaminant of Concern	GAC [^] (mg/kg) Cc	Contaminant Concentration Range (mg/kg)	Sample Size (n)	UCL ₉₅ (mg/kg)	No. Of Samples >GAC	Outliers (mg/kg)	Result
Metals							
Arsenic	37*	6.8 - 23	5	na	0	na	<Cc
Barium	1,300 ^{^^}	42 - 140	5	na	0	na	<Cc
Boron	290**	0.4 - 0.7	5	na	0	na	<Cc
Cadmium	22*	<0.2 (dl) - 0.5	5	na	0	na	<Cc
Chromium (III)	910**	11 - 15	5	na	0	na	<Cc
Chromium (VI)	21*	<1.8 (dl)	5	na	0	na	<Cc
Copper	2,400**	20 - 45	5	na	0	na	<Cc
Mercury (inorganic)	40**	<0.3 (dl)	5	na	0	na	<Cc
Nickel	130**	6.6 - 19	5	na	0	na	<Cc
Lead	200*	18 - 80	5	na	0	na	<Cc
Selenium	250**	<1.0 (dl) - 1.3	5	na	0	na	<Cc
Zinc	3,700**	29 - 80	5	na	0	na	<Cc

[^] Published residential with home-grown produce GAC values applied for 1-6% SOM (Cc = Critical Concentration).

(dl) Laboratory detection limit.

na Not applicable as contaminant concentrations are below individual GAC values.

* DEFRA (2014). Development of Category 4 Screening Levels (SP1010).

** LQM/CIEH (2015). S4UL for Human Health Risk Assessment.

^{^^}CL:AIRE (2010). Soil Generic Assessment Criteria for Human Health Risk Assessment. ISBN 978-1-905046-20-1.

Table 5.2 - Inorganic Contaminant Concentrations (Natural Strata)

Contaminant of Concern	GAC [^] (mg/kg) Cc	Contaminant Concentration Range (mg/kg)	Sample Size (n)	UCL ₉₅ (mg/kg)	No. Of Samples >GAC	Outliers (mg/kg)	Result
Metals							
Arsenic	37*	4.4 - 9.6	8	na	0	na	<Cc
Barium	1,300^^	14 - 54	8	na	0	na	<Cc
Boron	290**	0.3 - 0.5	8	na	0	na	<Cc
Cadmium	22*	<0.2 (dl)	8	na	0	na	<Cc
Chromium (III)	910**	5.8 - 13	8	na	0	na	<Cc
Chromium (VI)	21*	<1.8 (dl)	8	na	0	na	<Cc
Copper	2,400**	7.5 - 16	8	na	0	na	<Cc
Mercury (inorganic)	40**	<0.3 (dl)	8	na	0	na	<Cc
Nickel	130**	5.4 - 15	8	na	0	na	<Cc
Lead	200*	6.8 - 12	8	na	0	na	<Cc
Selenium	250**	<1.0 (dl) - 1	8	na	0	na	<Cc
Zinc	3,700**	25 - 54	8	na	0	na	<Cc

[^] Published residential with home-grown produce GAC values applied for 1-6% SOM (Cc = Critical Concentration).

(dl) Laboratory detection limit.

na Not applicable as contaminant concentrations are below individual GAC values.

* DEFRA (2014). Development of Category 4 Screening Levels (SP1010).

** LQM/CIEH (2015). S4UL for Human Health Risk Assessment.

^^CL:AIRE (2010). Soil Generic Assessment Criteria for Human Health Risk Assessment. ISBN 978-1-905046-20-1.

Table 5.3 - Speciated PAH Contaminant Concentrations (Made Ground)

Contaminant of Concern	GAC [^] (mg/kg) Cc	Contaminant Concentration Range (mg/kg)	Sample Size (n)	UCL ₉₅ (mg/kg)	No. Of Samples >GAC	Outliers	Result
Naphthalene	1	<0.05 (dl) - 0.12	5	na	0	na	<Cc
Acenaphthylene	170	<0.05 (dl) - 0.1	5	na	0	na	<Cc
Acenaphthene	200	<0.05 (dl) - 0.08	5	na	0	na	<Cc
Fluorene	165	<0.05 (dl) - 0.13	5	na	0	na	<Cc
Phenanthrene	95	<0.05 (dl) - 1.8	5	na	0	na	<Cc
Anthracene	2,300	<0.05 (dl) - 0.68	5	na	0	na	<Cc

Table Contd./

Contaminant of Concern	GAC [^] (mg/kg) Cc	Contaminant Concentration Range (mg/kg)	Sample Size (n)	UCL ₉₅ (mg/kg)	No. Of Samples >GAC	Outliers	Result
Fluoranthene	280	<0.05 (dl) - 3.9	5	na	0	na	<Cc
Pyrene	620	<0.05 (dl) - 3.3	5	na	0	na	<Cc
Benzo(a)anthracene	7.5	<0.05 (dl) - 1.7	5	na	0	na	<Cc
Chrysene	15	<0.05 (dl) - 1.6	5	na	0	na	<Cc
Benzo(b)fluoranthene	2.6	<0.05 (dl) - 1.6	5	na	0	na	<Cc
Benzo(k)fluoranthene	77	<0.05 (dl) - 0.72	5	na	0	na	<Cc
Benzo(a)pyrene	2.2	<0.05 (dl) - 1.5	5	na	0	na	<Cc
Indeno(1,2,3-cd)pyrene	27	<0.05 (dl) - 0.66	5	na	0	na	<Cc
Dibenz(a,h)anthracene	0.24	<0.05 (dl) - 0.13	5	na	0	na	<Cc
Benzo(g,h,i)perylene	315	<0.05 (dl) - 0.63	5	na	0	na	<Cc

[^] [CLEA/LQM/CIEH, 2015] Calculated for a residential with home-grown produce end-use scenario in CLEA v1.071. GAC range for 1.0% SOM unless stated otherwise. Values will be more conservative where soils are cohesive due to the effects of retardation.

(dl) - Laboratory detection limit. (Cc = Critical Concentration).

na - Not applicable as contaminant concentrations are below or equal to individual GAC values.

Table 5.4 - Speciated PAH Contaminant Concentrations (Natural Strata)

Contaminant of Concern	GAC [^] (mg/kg) Cc	Contaminant Concentration Range (mg/kg)	Sample Size (n)	UCL ₉₅ (mg/kg)	No. Of Samples >GAC	Outliers	Result
Naphthalene	1	<0.05 (dl)	11	na	0	na	<Cc
Acenaphthylene	170	<0.05 (dl)	11	na	0	na	<Cc
Acenaphthene	200	<0.05 (dl)	11	na	0	na	<Cc
Fluorene	165	<0.05 (dl)	11	na	0	na	<Cc
Phenanthrene	95	<0.05 (dl)	11	na	0	na	<Cc
Anthracene	2,300	<0.05 (dl)	11	na	0	na	<Cc
Fluoranthene	280	<0.05 (dl)	11	na	0	na	<Cc
Pyrene	620	<0.05 (dl)	11	na	0	na	<Cc
Benzo(a)anthracene	7.5	<0.05 (dl)	11	na	0	na	<Cc
Chrysene	15	<0.05 (dl)	11	na	0	na	<Cc
Benzo(b)fluoranthene	2.6	<0.05 (dl)	11	na	0	na	<Cc

Table Contd./

Contaminant of Concern	GAC [^] (mg/kg) Cc	Contaminant Concentration Range (mg/kg)	Sample Size (n)	UCL ₉₅ (mg/kg)	No. Of Samples >GAC	Outliers	Result
Benzo(k)fluoranthene	77	<0.05 (dl)	11	na	0	na	<Cc
Benzo(a)pyrene	2.2	<0.05 (dl)	11	na	0	na	<Cc
Indeno(1,2,3-cd)pyrene	27	<0.05 (dl)	11	na	0	na	<Cc
Dibenz(a,h)anthracene	0.24	<0.05 (dl)	11	na	0	na	<Cc
Benzo(g,h,i)perylene	315	<0.05 (dl)	11	na	0	na	<Cc

[^] [CLEA/LQM/CIEH, 2015] Calculated for a residential with home-grown produce end-use scenario in CLEA v1.071. GAC range for 1.0% SOM unless stated otherwise. Values will be more conservative where soils are cohesive due to the effects of retardation. (dl) - Laboratory detection limit. (Cc = Critical Concentration).

na - Not applicable as contaminant concentrations are below or equal to individual GAC values.

Metals & Metalloids

Made Ground

No elevated inorganic contaminant concentrations were measured above the allowable residential GAC values within any of the soil samples tested.

Natural Strata

No elevated inorganic contaminant concentrations were measured above the allowable residential GAC values within any of the soil samples tested.

Organics – PAH

Made Ground & Natural Strata

No elevated organic contaminant concentrations were measured above the allowable residential GAC values within any of the soil samples tested.

Organics (Other)

All concentrations of phenol were measured at less than the laboratory limits of detection (<1.0mg/kg) for all samples, whilst all BTEX, TPH, MTBE, VOC and SVOC concentrations were either very low and/or below the allowable residential GAC values (where these are available).

Asbestos

No asbestos fibres were identified in any of the made ground or natural strata samples tested.

5.4 Contamination & Performance of Cementitious Products

Samples were analysed for general inorganics including water soluble sulphate so that an assessment of risk could be made in relation to those guidelines prescribed in BRE Special Digest

1^[27]. A copy of the laboratory test certification is presented in Appendix C, whilst a summary of the dataset is given in Table 5.5, below.

Table 5.5 - Summary of Sulphate & Sulphide Concentrations

Analytical Parameter	Units	Allowable Concentration	Concentration Range	
			Made Ground	Natural Strata
pH	pH units	<5	6.3 - 9.8	6.5 - 8.2
Total Sulphate (as SO ₄)	mg/kg	2,400	180 - 860	54 - 120
Water Soluble Sulphate (as SO ₄)	mg/kg	-	14 - 500	3.5 - 26
Water Soluble Sulphate (as SO ₄)	g/l (mg/l)	0.5	0.00673 (6.73) - 0.249 (249)	0.00173 (1.73) - 0.013 (13)
Total Potential Sulphate	%	0.24	0.039 - 0.138	0.006 - 0.024
Sulphide	mg/kg	-	<1.0	<1.0 - 3.9

(dl) – laboratory detection limit.

A qualitative assessment of the data was carried out in accordance with Sections C4 and C5 of BRE SD1, to assess whether the soil conditions at the Site would be aggressive to any new buried concrete products. In accordance with Table C2 of BRE SD1 and assuming a worst case water soluble sulphate concentration (based on a 2:1 water/soil extract) of 445mg/l for the made ground, a Design Sulphate Classification of DS1 and an ACEC of AC1s indicated. This is based on classification for a brownfield location and having a static groundwater regime at pH ≥2.5.

No Total Potential Sulphate to in excess of 0.24% (i.e. the threshold value for DS1 conditions) was measured. Risk associated with concrete being exposed to sulphate ions (SO₄) is not therefore anticipated. Due consideration will need to be given, however, to the durability and structural strength of all in-ground concrete products to be used. Design parameters for concrete should be discussed with the Designing Engineer, utilising the laboratory data presented herein. The Designing Engineer should refer to BS 8500-1^[28] or any other guidance to determine the correct concrete mix, as required.

5.5 Waste Acceptance Criteria (WAC)

Where arisings are generated during redevelopment works, and they are intended for disposal to landfill, there is a requirement to determine if they would be classified as inert, non-hazardous, or hazardous. Similarly, this would apply if soils to be removed as part of any remedial activity were to be disposed to landfill.

Given that it is a statutory requirement to ensure that wastes are characterised to meet specific acceptance criteria if disposal to landfill is to be undertaken, Waste Acceptance Criteria (WAC)

testing was carried out on representative samples of the on-Site soils. Technical Guidance WM3³ 'Guidance on the Classification and Assessment of Waste, (1st Edition)', which was introduced on the 1st July 2015 and is adapted from the third edition of Technical Guidance WM2, sets out the requirement for classification. The classification assesses the composition of the material and determines the concentrations of hazardous substances within it, in relation to particular thresholds. Two samples were scheduled for full WAC (single stage 10:1 leachate) analysis to determine if soils likely to go to landfill (such as foundation arisings) meet the acceptance criteria for inert waste disposal. This testing is recommended by the Environment Agency and replaced the traditional two stage batch test.

A summary of the samples tested for WAC is given in Table 5.6, below. A copy of the individual WAC test results is provided in Appendix C for reference.

Table 5.6 - Summary of Soils Tested for WAC

Sample	Typical Description*
BH1-ES1 (0.5)	MADE GROUND: Compact brown sandy loam (RECONSTITUTED GROUND).
BH4-ES2 (2.0)	Medium dense orange-brown fine to medium grained SAND (GLACIOFLUVIAL DEPOSITS).

* Where soils are to be disposed, classification data and the general spectrum testing presented herein will need to be submitted to the disposal site(s) for individual assessment. Any other specific requirements of the receiving site(s) would need to be met as required, prior to material disposal.

5.6 UKWIR

UK Water Industry Research ('UKWIR')^[29] published guidance in relation to the selection of appropriate water supply pipes to be laid at brownfield sites. This guidance supersedes the Water Regulations Advisory Scheme ('WRAS') Information and Guidance Note 9-04-03 "Laying Pipes in Contaminated Land", which has been withdrawn.

Soil samples were collected as part of the ground investigation from between 0.5m bgl and 4.0m bgl across the Site so that contaminant concentrations could be determined with spatial extent and depth. In general accordance with the testing requirements of the UKWIR guidance, however, analysis of various representative samples of the made ground and underlying natural strata were recovered from depths between 1.0m bgl and 1.5m bgl⁴. Notwithstanding the

³ WM3 provides guidance on waste classification and the assigning of classification codes (also referred to as List of Waste or European Waste Catalogue codes) for hazardous and non-hazardous waste materials.

⁴ UKWIR guidance states that water pipes are normally laid between 0.75m and 1.35m from finished ground level to crown of pipe. Samples taken for testing shall represent a) the soil in which the pipes are to be laid, and b) those to at least 500mm below the underside of the proposed pipes. Where proposed pipe depths are unknown at the time of investigation, soil samples representative of the ground conditions between surface level and 1.5m below finished ground level shall be taken as a minimum.

general suite chemical testing reported herein, testing for UKWIR comprised those determinands given in Table 5.7, below [NOTE: since not all contaminants assessed under UKWIR were assumed to be present at the initial risk assessment stage, not all determinands have values that may be assigned to them].

Table 5.7 - Summary of UKWIR Contamination Data

Determinand	PE Threshold (mg/kg)	Laboratory Limit of Detection	Sample Reference & Concentration				
			Made Ground	Natural Strata			
			BH3-ES2 (1.0)	BH1-ES2 (1.0)	BH2-ES2 (1.5)	BH5-ES2 (1.5)	BH6-ES2 (1.0)
Total VOC	0.5	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total BTEX and MTBE	0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total SVOC (excluding PAH)	2.0	Variable	<dl	<dl	<dl	<dl	<dl
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2.0	Variable	<dl	<dl	<dl	<dl	<dl
EC10-EC16 Aliphatic and Aromatic Hydrocarbons	10.0	1 (EC10-12)	2.5	5.0	3.4	<dl	<dl
		2 (EC12-16)	11.0	19.0	14.0	<dl	<dl
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	8 (EC16-35 Aliphatic)	13	43	30	<10	<10
		10 (EC16-35 Aromatic)	<10	<10	<10	<10	<10
Phenol (from SVOC)	2.0	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cresols and Chlorinated Phenol**	2.0	0.1-0.3	<dl	<dl	<dl	<dl	<dl
Ethers	0.5	Variable	-	-	-	-	-
Nitrobenzene	0.5	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Ketones	0.5	-	-	-	-	-	-
Aldehydes	0.5	-	-	-	-	-	-

Table Contd./

Determinand	PE Threshold (mg/kg)	Laboratory Limit of Detection	Sample Reference & Concentration				
			Made Ground	Natural Strata			
			BH3-ES2 (1.0)	BH1-ES2 (1.0)	BH2-ES2 (1.5)	BH5-ES2 (1.5)	BH6-ES2 (1.0)
Corrosiveness ^{^^} (Electrical conductivity, redox potential (Eh) and pH)	Conductivity (μS/cm)	10	230	18	51	43	17
	Redox (mV)	-800	172.6	160.3	152.5	168.5	163.6
	pH (pH units) [^]	No LoD	9.8	-	-	-	7.4

All results expressed as mg/kg unless stated otherwise.

<dl – Laboratory limit of detection.

**Sum of 2-Chlorophenol, 2-Methylphenol, 4-Methylphenol, 2-Nitrophenol, 2,4-Dimethylphenol, 2,4-Dichlorophenol, 4-Chloro-3-Methylphenol, 2,4,6-Trichlorophenol and 2,4,5-Trichlorophenol.

^{^^}For wrapped steel (ground is corrosive if pH is <7 and conductivity is >400μS/cm); for wrapped ductile iron (ground is corrosive if pH is <5, redox is not neutral and conductivity is >400μS/cm); for copper (ground is corrosive if pH is <5 or >8 and redox is positive).

[^]pH range for the complete made ground dataset was measured as being 6.3-9.8. For the natural strata the range was 6.5-8.2.

5.7 Ground Gas

Ground gas monitoring is currently underway, utilising the piezometers installed as part of the ground investigation. Once the monitoring period has been completed, all results will be provided under separate cover with any recommendation for mitigation being made at that time.

6 PHASE 2 ENVIRONMENTAL APPRAISAL

A phase of general intrusive ground investigation has been completed at the Site, with this being to facilitate the proposed development. The following updated CSM is therefore based on the ground investigation data presented herein. The revised CSM provided below summarises Groundsmiths' current understanding of the surface and sub-surface features to the Site, the identified contaminant sources and concentrations, their potential transport pathways, and receptors.

Ground Conditions & Contamination Status

The ground investigation completed within the remit of this assessment identified the presence of some anthropogenic soils associated with previous development, and underlying undisturbed Glaciofluvial (sand) deposits to depth. The made ground soils were predominantly proven as sandy loam and gravelly sand with inclusions of concrete, hardcore and gravel; the deepest area was at the position of BH3 to 2.0m bgl (underlain by an obstruction).

The underlying natural strata are locally loose fine to medium grained slightly gravelly sand over medium dense gravelly sand. Some soils on the northern side of the Site exhibited discrete thin of clay although these were limited. Sandstone and/or mudstone bedrock underlies the Site at depth and appears to be present at a depth consistent with other local ground investigations.

Only one borehole recorded groundwater seepage during the investigation, with this being BH5 at 3.0m bgl.

Inorganic and organic contaminant levels within both the on-Site made ground and natural strata were found to be below either the laboratory limits of detection or the individual residential with home-grown produce GAC values. No elevated contaminant concentrations were recorded between 0.5m bgl and 4.0m bgl across the Site. No asbestos fibres were identified.

Low levels of sulphate were measured within both the on-Site made ground and natural strata deposits.

Risk from ground gases is to be confirmed following the completion of on-Site monitoring. Should any protective measures commensurate with BS8485 ^[30] need to be provided in construction, such recommendations will be given at that time. Preliminary data suggests that the Site could be determined as Characteristic Situation 2 based on its environmental setting.

Revised Conceptual Site Model & Risk Assessment

Within the context of this Report, a revised risk assessment has been undertaken on the basis that the 'suitable for use' approach remains aligned with the Site being redeveloped for a residential with home-grown produce end use. The identified potential contaminants and receptors have been considered in relation to the pathways that may link them, having taken account of the findings of the intrusive ground investigation presented herein. The resultant contaminant linkages are presented in Table 6.1, overleaf.

Table 6.1 - Revised Environmental Risk (Current Site Condition without Mitigation)

Sources & Potential Source	Potential Receptors	Plausible Pathways	Probability	Severity	Revised Risk Rating	Comment
Any unforeseen elevated contaminant concentrations within the on-Site soils	<u>Human Health</u> Site end-users, inc. maintenance and site workers (short term risk during enabling works / construction)	Direct ingestion or dermal contact with soil, dust, and/or vapour inhalation (Site end user)	Unlikely	Mild	Very Low	The measured contaminant concentrations within the made ground and natural strata suggest an overall very low risk to human health when assessed in accordance with CIRIA C552 (See Section 7, below). For asbestos, the level of risk is based to some extent on the severity rating of the contaminant and the risk profile that can be assigned at this time. However, risk from asbestos fibres is not expected as no positive identification has been made in any soil sample.
		Direct ingestion or dermal contact with soil, dust, and/or vapour inhalation (In-ground worker)	Unlikely	Mild	Very Low	
		Direct ingestion and/or dermal contact with liquid contaminants	Unlikely	Mild	Very Low	
		Inhalation of asbestos fibres (Site end user)	Unlikely	Severe	Moderate/Low	
		Inhalation of asbestos fibres (In-ground worker)	Unlikely	Severe	Moderate/Low	
	<u>Construction</u> (Potable Water Supply Pipes)	Direct contact/leaching (tainting)	Low Likelihood	Mild	Low	Measures compliant with BS8588:2017 (e.g. Protecta-Line) are unlikely to be required, although consultation should be made with the water provider given the Site's brownfield status.
	<u>Construction</u> (Foundations)	Direct contact/leaching	Unlikely	Mild	Very Low	Sulphate resistant concrete is unlikely to be required in construction.
	Vegetation	Uptake via root system in soft landscaping	Unlikely	Mild	Very Low	See Section 7, below.
	Controlled Waters	Vertical and/or lateral migration	Unlikely	Mild	Very Low	No particular risk is anticipated based on the Site's setting.
Off-Site ground gas sources	<u>Human Health</u>	Inhalation (via ingress and accumulation into buildings)	Likely	Medium	Moderate	The requirement for precautions in construction is to be confirmed following the completion of ongoing monitoring.

7 CONCLUSIONS

7.1 Contamination – Risk Evaluation

Soil - Human Health Receptors – Site End Users

Having reviewed the Site's history, its environs, and the investigation-specific data acquired within the remit of this study, it is apparent that anthropogenic activity has had no significant impact on the condition of the Site. Whilst some made ground soils are present, both these and the underlying natural strata have been proven to be contaminant-free (where tested) and are considered unlikely to present an unacceptable level of risk to Site end users, either now or in the post-development case. No evidence of visual or olfactory contamination was made.

Soil - Human Health Receptors – In-ground Construction Workers

Although consideration should be given to the level of risk workers involved with Site enabling works and other in-ground construction will be exposed to, the contaminant data indicates that the on-Site soils are not contaminated above allowable residential GAC values.

It should be noted that UK contaminated land assessment tools (i.e. CLEA V1.071) available to practitioners cannot be used as the basis to assess the acute (short term exposure) risk that groundworkers or other such personnel in close contact with soils may experience during construction activities. On this basis, it is not practicable to generate allowable threshold limits for potential contaminants of concern as is ordinarily undertaken to determine whether a Site requires remediating, or not. Whilst works to be undertaken should be assessed as part of a health and safety evaluation to mitigate the exposure of workers to any dusts as may be generated during development, the potential for general dermal contact and the ingestion/inhalation of contaminated dusts is considered to be very low.

Asbestos

Whilst the revised CSM identifies a moderate to low risk from asbestos fibres, this is because of the severity of the contaminant and the framework in which risk can be assessed. The laboratory data indicates, however, that no fibres were identified in any of the soil samples tested. It's considered reasonable therefore to assume that asbestos does not present any particular risk to either construction workers or Site-end users, and that the risk rating may be downgraded to very low.

Unforeseen Contamination

As with any development site there is the potential for hotspots or other areas of contamination that have not currently been identified. This is unavoidable and may only come to light during clearance and enabling works or construction. Allowance should be made for this. Although considered unlikely, if any areas of grossly contaminated soil were ever encountered during development, these would need to be investigated further on a separate basis, with an appropriate level of testing and risk assessment being carried out.

Soil Remediation

No soils remediation is considered necessary given the contaminant concentrations identified within the remit of this assessment.

If currently unforeseen soil contamination is encountered during development all works should stop and further assessment be undertaken. If remedial measures are found to be required further specific detail about the works, verification of the works that are to be undertaken, and how any deviation away from those works will be addressed, will need to be provided to the Local Planning Authority in the form of an LCRM Stage 3 Remedial Strategy. All remedial activities shall be in accordance with the requirements of the Yorkshire and Lincolnshire Pollution Advisory Group ('YALPAG')^[31].

Topsoil

No formal remediation of the Site has been identified to date, so the provision of topsoil in development is not considered to be 'engineered capping'; a nominal thickness of 300-350mm is anticipated as being appropriate to support lawn and plant growth. However, where topsoil is to be imported to Site for use in gardens or areas of soft landscaped public open space, all such materials would need to be fully certified and fit for purpose to the satisfaction of the Local Planning Authority. Supplier certificates specific to the materials to be used would need to be submitted for approval prior to its importation.

Ground Gas

As indicated herein, ground gas monitoring is currently ongoing.

Specific remediation proposals and verification methodology for any gas protection measures to be introduced would need to be submitted to the Local Planning Authority in the form of a standalone Remedial Strategy. These works would need to be undertaken in accordance with the requirements of YALPAG^[32], if found to be required.

Radon

Third party reporting indicates that no radon precautions are required in construction. Consultation with Building Control should be made as required.

Controlled Waters Receptors

No risk is anticipated in relation to controlled waters receptors and the measured concentrations of soil contaminants. No further assessment of the underlying groundwater conditions is considered necessary.

7.2 Construction – Risk Evaluation

Potable Water Supplies

Water providers are required to maintain the safety of staff, contractors, and customers. On this basis, water providers work with a range of trigger values when laying mains pipes or services in contaminated ground, in the same way that assessment is made by contaminated land practitioners.

Testing to full UKWIR was not considered necessary on the basis of the initial risk assessment, Site-based observations made during the ground investigation, and the subsequent identified source-pathway-receptor linkages, although a broad spectrum of testing in addition to redox/electrical conductivity determination has been completed to assess the contaminative status of the underlying soils to depths between 0.5m and 4.0m across the Site.

Based on the data presented herein, it is evident that the contaminant load within the underlying soils is very low, and that the presence of reconstituted material is limited. That said, the Site has a history, and is considered to be brownfield land. The data suggests that standard pipework would likely be acceptable for use, although due consideration should be given to the slightly elevated EC10-EC16 Aliphatic and Aromatic Hydrocarbon concentrations which exceed the PE threshold of 10mg/kg; it is unknown why such concentrations have been measured as there was no visual or olfactory evidence of such organic contamination within any of the on-Site soils encountered.

It is recommended that the results of the chemical testing and details of the development proposal are provided to the utility company for their comment, prior to installation of any pipework. As a worst case scenario, it could be that protection consistent with brownfield development (e.g. Protecta-Line) may be required.

Sulphate Attack

A Design Sulphate Classification of DS1 is indicated on the basis of the laboratory data, with the Aggressive Chemical Environment Class being AC-1s. Further to this, no evidence of gypsum crystals, red-brown ferric oxide, or yellow-brown hydrated ferric oxide was recorded on any of the soils encountered. Elevated Total Potential Sulphate risk is not anticipated as the underlying soils are natural and undisturbed.

Further consultation should, however, be made with the Designing Engineer with respect to the final concrete mix to be adopted.

Stress Relief

Risk associated with stress relief is not expected.

Mining

Risk associated with either recorded or unrecorded probable shallow coal mining is not expected on the basis of available information.

Anticipated Foundation Type

With cognisance to the likely imposed loads and required settlement tolerances of the development, it is anticipated that traditional reinforced spread foundations could potentially be suitable for lightly loaded structures of typical construction. It should be noted, however, that the use of traditional foundations would be subject to the integrity of the formation being preserved during Site clearance/enabling works and subsequent construction activities. Plant/machinery and atmospheric effects can cause significant deterioration to an exposed granular formation and propagate stability problems including running-sand conditions and prevent the formation of foundation excavations. It would be anticipated, therefore, for construction to proceed on a manageable scale in small zones (or bays). Also see 'Excavations' below.

Where traditional spread foundations can be used, these shall be taken down through any made ground and/or loose, soft, or otherwise unsuitable material to be founded on strata having sufficient bearing capacity at a minimum depth as directed by the Designing Engineer.

It would be advisable for a bearing capacity assessment to be completed by the Designing Engineer during foundation design to ensure that the serviceability limit state of the structures is not compromised in any way. Although considered to be a low risk, this should take account of the amount of total and/or differential settlement that could potentially occur.

Notwithstanding any problems associated with enabling works and/or formation deterioration that could potentially occur, it is sometimes the case that the widening and strengthening and/or deepening of foundations (in accordance with current engineering standards) is required if foundations are found to straddle strata of different type, and/or where areas of softer or weaker ground are encountered at founding depth. In addition to this, the depth of footing could potentially vary across the Site, so other adjustments to final depth may need to be based on excavation as construction progresses and in discussion with Building Control.

If an alternate foundation solution is required, this would likely comprise the use of a raft.

Excavations

The ground investigation works completed to date indicate that the Site is underlain by predominantly medium dense granular soils, but that material with a lower relative density is present too. As indicated above it would be necessary to protect the formation, although in general terms it should be anticipated for the instability of loose and/or weathered soils to be encountered, particularly during periods of wet weather, where excavations are deep (i.e. for services conduit), or where they are left open for protracted periods of time. It is considered that all excavation works should be undertaken in bays, as indicated above, with support being used or excavation faces being battered to a safe angle (if there is sufficient space to do this). Further assessment of excavation stability or other such cut faces should be undertaken as necessary if problems are encountered. It could be that some remedial works comprising the

reworking of the soils is required, including where they need to be replaced with compacted granular materials.

No entry into unsupported excavations should be allowed without an appropriate risk assessment. All excavation works shall be carried out in accordance with current HSE guidance, 'Structural Stability During Excavation' ^[33].

Ground Slab

At this stage, it is anticipated that ground bearing floor slabs could be suitable, although the precise construction detail should be discussed further with the Designing Engineer once they have reviewed the investigation records provided herein. It should be noted, however, that ground bearing slabs cannot be used where the nature and load carrying capacity of the formation varies across its footprint, where any infill is greater than 600mm at any point in a self-contained area, where the ground is waterlogged, and/or where otherwise unstable soil is present. Furthermore, load bearing partitions should have proper foundations and not be supported off a ground bearing slab, if this type can be used.

If a ground bearing floor slab is found to be unsuitable for any reason, allowance should be made for the provision of a suspended floor (e.g. reinforced suspended, precast concrete, beam and block...) with this having a corresponding underlying ventilated void.

Allowance for the inclusion of ground gas precautions to Characteristic Situation 2 ('CS2') of BS8485 should be made at this time, until confirmed otherwise.

Heave Precautions

The on-Site soils were observed to be granular. Heave precautions are not anticipated at this time. If cohesive soils were proven elsewhere, appropriate precautions in construction would need to be provided.

Retaining Walls

There is a clear gradient change between the former developed area where the school building was once sited and the playing field to the east. Based on the development layout as proposed, it appears that some dwellings will lie within close proximity to the currently (and poorly) retained embankment and/or where general ground elevations rise (i.e. along the northern edge of the Site, and in the south-eastern corner) to meet the playing field.

Observations of the embankment (see also borehole record BH4) indicate that it comprises sand that extends to below the level of the lower Site area; active borrowing within the embankment (assumed fox den) has also exposed the sand. Notable collapse within BH4 was recorded during the completion of that position at numerous depths; furthermore, DP4 was taken to 14.9m bgl with no refusal being recorded.

The eastern boundary and perhaps along part of the southern boundary will need to incorporate a suitable retaining structure. Where retaining walls are proposed these should be designed in the permanent case for long term drained conditions using c' and ϕ' . Further

consultation should be made with the Designing Engineer in this regard, with any other ground investigation works being undertaken as directed.

Slopes

Notwithstanding the elevated nature of the adjacent school playing field and the need for proper retention measures to be implemented, global slope stability problems are not expected.

Information presented in third party reporting ^[34] indicates that there are no records of mass movement deposits within 500m of the Site, whilst the hazard rating for slope instability (landslide potential) on-Site and within 50m is very low. The data also indicates that there are no records of landslip permeability (i.e. the estimated rate of vertical movement of water from the ground surface through the unsaturated zone of any landslip deposit) within 50m.

Superstructure Precautions

The need for superstructure precaution, such as masonry reinforcement, is not anticipated.

Surface Water Drainage

The drainage proposals for the development are currently unknown. Further consultation with a specialist drainage consultant should be made as required, although it is envisaged that soakaways for surface water drainage would be suitable for use. Infiltration testing in accordance with BRE365 ^[35] should be completed as required. It should be noted, however, that it would be inappropriate for unstable, potentially unstable, and/or contaminated strata to receive point-source flows of water from dedicated soakaways. It should be noted that soakaways should not be used where they lie within at least 5m of roads, foundations, and/or other sensitive development.

All drainage proposals will be subject to obtaining the necessary approvals from the Regulatory Authorities.

Unforeseen In-ground Obstructions

Remnant foundation construction and other development is evident on-Site. This substructure will need to be grubbed-out, either in their entirety, or at least where they interact with new foundation construction so as not to create 'hard spots'. Excavation/breaking machinery of sufficient size and strength (along with any shoring required for any unstable soils) will need to be allowed for.

Pavement

The design of future trafficable areas would need to be such that it allows for the effects of any soft underlying or variable materials and for the potential reduction in the strength of any replacement material to its long-term CBR value. It is expected that the excavation and replacement of unsuitable material with suitably compacted engineered fill would be needed in development prior to finished surfacing being laid. Since the minimum permitted design CBR is 2.5%, it is recommended at this stage that this conservative value for subgrade be used.

In situ testing should be undertaken as required. Free draining and clay-free granular soils would not be frost susceptible.

8 REGULATORY APPROVAL

The conclusions presented are considered reasonable on the basis of available information and the assessment of the Site as carried out by Groundsmiths. However, it remains the responsibility of the Client to ensure that the Site poses no significant risk to any sensitive receptors and that it remains aligned with the proposed end-use and assessment framework adopted in this report.

If at any time in the future, additional information comes to light that puts into doubt the accuracy of the professional opinion or third party information presented herein, then it may be necessary to revisit the assessment.

Works undertaken cannot be guaranteed to gain approval by the regulators as the acceptability of the levels of risk presented may depend on the viewpoint of the Local Planning Authority and their Consultees. A copy of this Report should therefore be made available for comment and approval, prior to undertaking any irrecoverable works associated with the Site.

9 REPORTING LIMITS

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The findings and opinions provided in this Report are given in good faith and are subject to the limitations and constraints imposed by the methods and information sources described.

Factual information contained within the Report has been obtained from a variety of sources. Where third party data has been used, Groundsmiths assumes that this is reliable but cannot independently confirm this as the validity and accuracy of this information is outside our control. No guarantee can therefore be given as to the completeness of the information gathered during the study and no responsibility is accepted for errors or omissions in the third party information used. Groundsmiths' professional judgement and experience is however used to ensure that uncertainties are reduced to a level appropriate to the site conditions, the purpose of the assessment and the resources devoted to it by the Client.

Whilst every effort has been made to carry out an assessment that enables a realistic characterisation of the environmental and geotechnical parameters to be identified, the likelihood of significant variation in actual ground and groundwater conditions between investigation positions cannot be discounted. The findings and opinions presented in this Report are relevant to the time this assessment was undertaken but should not necessarily be relied upon to represent conditions at a substantially later date. Further information, supplementary ground investigation, construction activities, change of site use, or the passage of time may reveal conditions that were not indicated in the data presented herein and therefore could not have been considered in the preparation of this Report. Where such information might impact upon stated opinions, Groundsmiths reserve the right to modify the opinions expressed in this Report.

Where opinions expressed in this Report are based on current available guidelines and legislation, no liability can be accepted for the effects of any future changes to such guidelines and legislation. New information or improved practices and changes in legislation may require reinterpretation of the Report as a whole, or in part.

The recommendations presented in this Report are based on the site-specific assessment but utilising third party-provided information as appropriate. They are, however, limited to those that could be reasonably made at the time the assessment was undertaken. Where assessments of site areas affected in particular ways are given, these are approximate.

This Report does not constitute an archaeological, ecological, arboriculturalist / invasive plant species, or UXO survey. Any comment given in relation to these is for information only. Further assessments to assess these may be required as part of any planning condition and should therefore be undertaken by suitably qualified experts as required.

Groundsmiths reserve the right to edit and / or retract any conclusion or recommendation made in this Report should any further information, with respect to the Site, become available.

Groundsmiths disclaim any obligation to update the Report for events taking place after the time during which the assessment was carried out.

Groundsmiths do not provide or purport to provide legal advice. Should the Client require such advice then that of lawyers should be sought.

Groundsmiths accept no responsibility if any findings given in this Report are not implemented by the Client or their agents.

Groundsmiths accept no responsibility if any further works, as requested by the Local Planning Authority in the discharge of their duty of care, are not implemented by the Client or their agents.

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