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CYPRESS BUILDING, LIVERPOOL UNIVERSITY

PHASE 1 SITE INVESTIGATION REPORT

Carried out for: University of Liverpool

Structural Engineer: Alan Johnson Partnership LLP



CYPRESS BUILDING, LIVERPOOL UNIVERSITY

PHASE 1 & 2 SITE INVESTIGATION REPORT

Date: 23/11/2017

Report No 3571/01 Issue 1

Prepared for:



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DISCLAIMER

This report should be read with the Service Constraints Report Limitations & Planning Requirements set out in Appendix A.



CYPRESS BUILDING, LIVERPOOL UNIVERSITY

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CYPRESS BUILDING, LIVERPOOL UNIVERSITY

PHASE 1 & 2 SITE INVESTIGATION REPORT

1. INTRODUCTION

1.1 Background Information

1.1.1 TerraConsult Limited was instructed by Alan Johnston Partnership acting on behalf of Liverpool University to carry out a site investigation for an area of land adjacent to the Cypress Building on the Liverpool University Campus.

1.1.2 This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Part IIA of the Environment Protection Act, 1990;
- Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, April 2012);
- National Planning Policy Framework (HCA, March 2012);
- BS5930:2015: “Code of practice for site investigations”;
- BS10175: 2011 +A1:2013 “Investigation of Potentially Contaminated Sites - Code of Practice”;
- DEFRA/Environment Agency (2004) Report CLR11 “Model Procedures for the Management of Land Contamination”;
- Environment Agency (2011) Report GPLC1 “Guiding Principles for Land Contamination”; and
- Environment Agency (2013) Report GP3 “Groundwater protection: Principles and Practice” Version 1.1.

1.1.3 TerraConsult’s service constraints and report limitations are presented in Appendix A and a description of environmental risk assessment methodology and terminology is presented in Appendix B.

1.2 Development Proposals

1.2.1 The proposed development of the site is understood to comprise site clearance and then construction of a six storey commercial university teaching building. The development will include soft landscaped areas and service provision. There is no proposal for a basement.



Figure 1: Proposed Development Plan

- 1.2.2 The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed use for university buildings which is equivalent to a commercial end use in terms of the contaminated land guidance. If there is a subsequent change in the proposed end land use, then the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

1.3 Planning Status & Requirements

- 1.3.1 This report is designed to comply with the requirements of The National Planning Policy Framework (NPPF, 2012) and is intended to be used by the developer as part of the submission to gain planning for the works.

1.4 Scope of the Investigation

1.4.1 The scope of the investigation met the requirements to provide information for planning purposes and for design of the development. The specific activities carried out were as follows:

- undertake a desk study of available information to include a review of existing reports, history of the site and geo-environmental data;
- carry out a site walk over;
- develop a preliminary conceptual site model and refine this according to the findings of the investigation;
- carry out an intrusive investigation comprising dynamic sampling boreholes, rotary coring in the bedrock and trial pitting with associated sampling;
- laboratory testing for potential contaminants and geotechnical purposes;
- assess the general nature and extent of contamination at the site and carry out a contamination risk assessment to determine if the site poses a risk to potential receptors; and
- provide a geotechnical assessment of the ground conditions for foundation design.

1.5 Previous Investigations

1.5.1 No previous reports are available for review.

2. SITE LOCATION AND DESCRIPTION

2.1 Site Location

2.1.1 The site is indicated in Figure 2 and 3 below and the site location is summarised in Table 1:

Table 1: Summary of Site Location	
Location	Located in central Liverpool on the University of Liverpool Campus. Bordered by University department buildings.
Grid Reference	335954, 389892
Post Code	L7 7EL
Site Area	0.05 ha (approx.)
Site Shape	The site has maximum plan dimensions of 35 m by 20 m and is roughly rectangular in shape.
Topography	The site elevation is approximately 52 mOD. The site slopes gently from south to north by approximately 1.0 m. In addition there is a raised 'mound' in the west of the area.

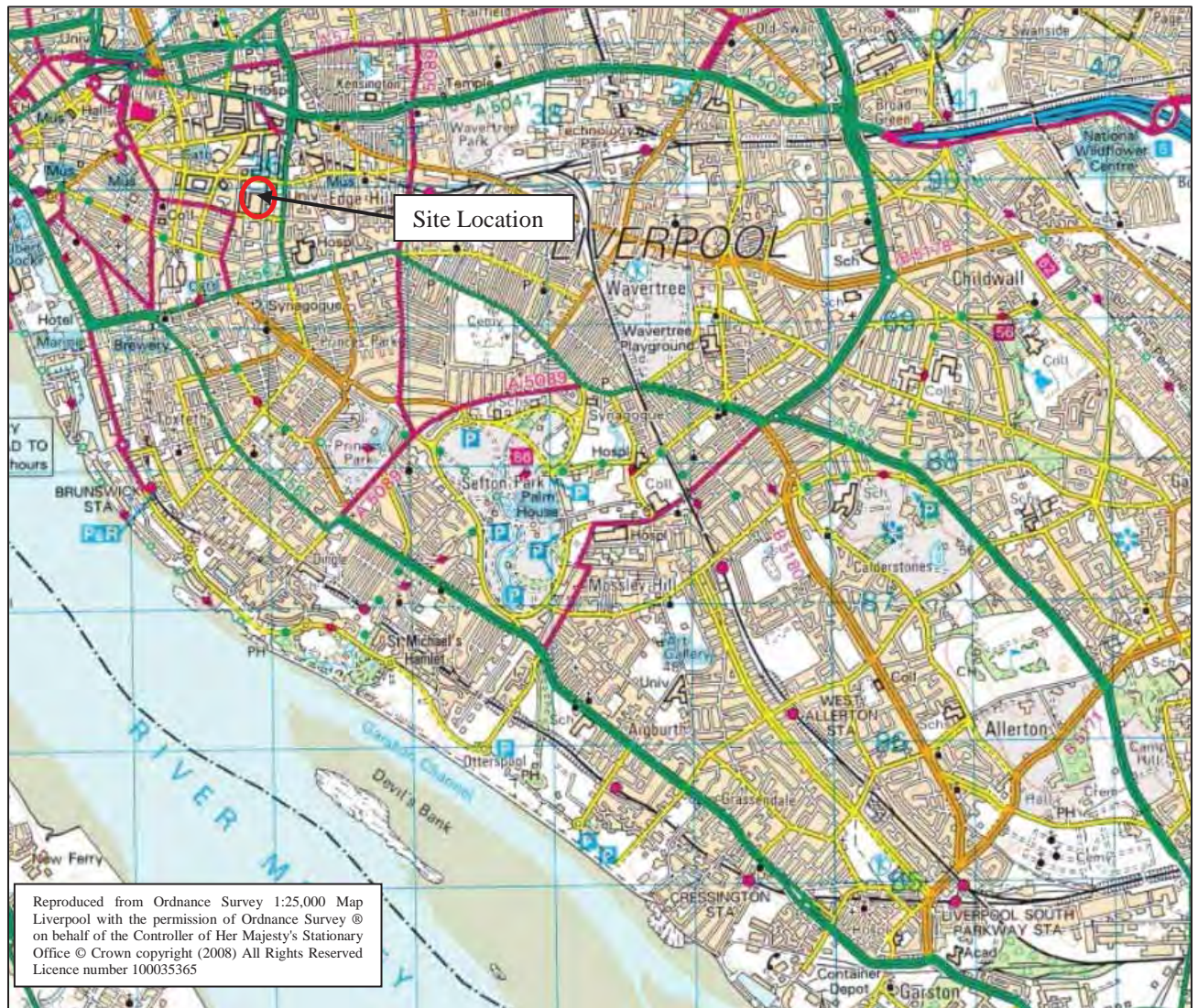


Figure 2: Site Location

2.2 Site Description

- 2.2.1 A site visit was undertaken on 21st October 2017. Photographs of the site are presented in Appendix C and the overall current site layout can be seen below.

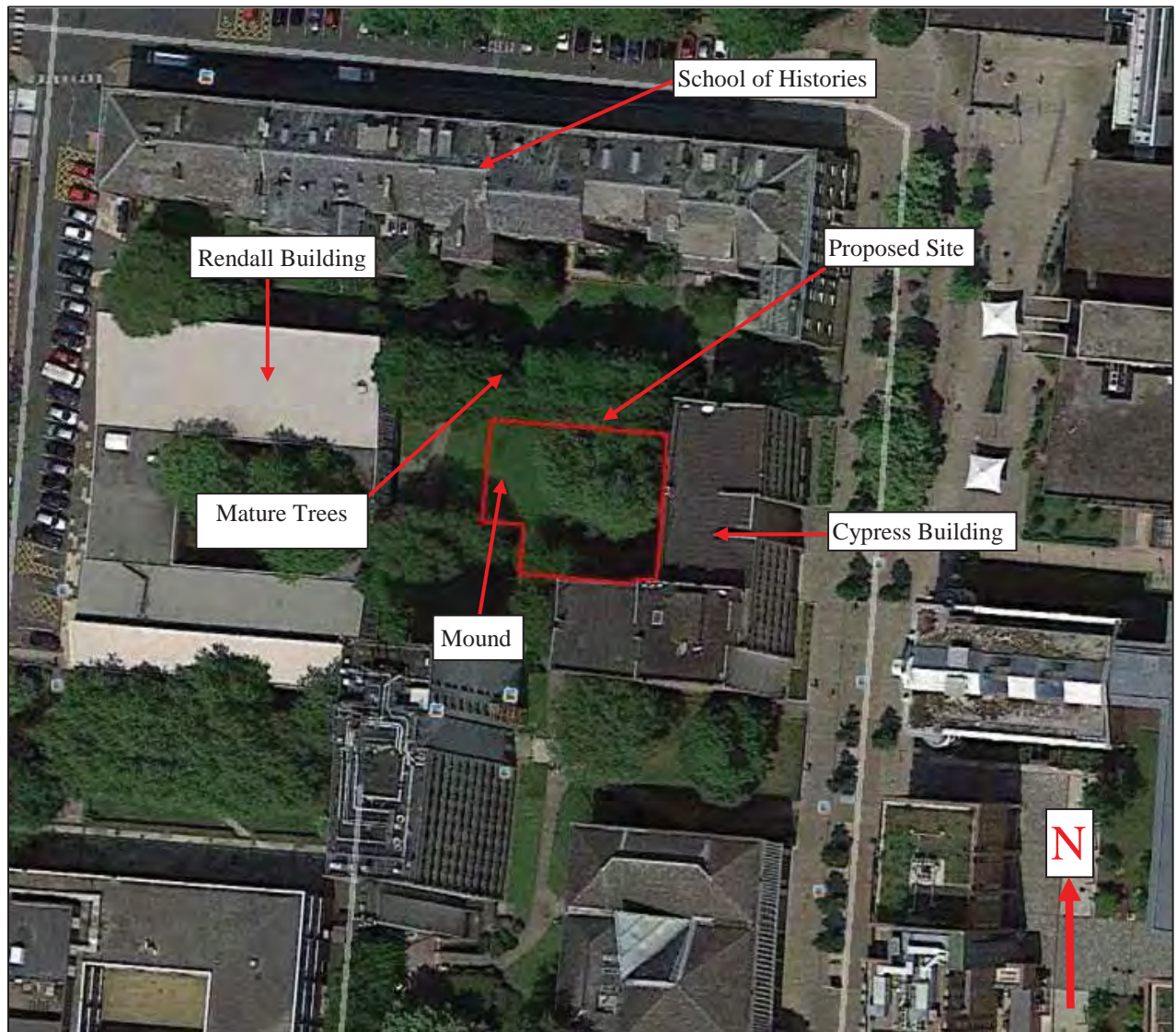


Figure 3: Google Earth Image of the Site

Table 2: Summary of Description of the Site and its Environs	
Current Use:	The proposed area of development is currently a mixture of soft landscaping and walkways. The existing Cypress Building is a teaching block for the University of Liverpool.
Access	Direct off Chatham Street (site is within the University of Liverpool campus so access is restricted to vehicles).
Existing Buildings & Structures	There are no structures in the development area. The current Cypress Building is a 5 storey concrete teaching block. It is suspected that there is also a basement but this has not been confirmed as there was no access inside the building during the walkover. Service covers were noted within the development area within the walkways.
Site Surface	The development area is a mixture of concrete paved walkways (mainly in the east and north of the site) and a soft landscaped area in the central and western part of the site.
Vegetation	Mature & semi-mature trees are present within the soft landscaped area of the site.
Storage Tanks	Below Ground Tanks: No evidence/none suspected. Above Ground Tanks: None present.

Table 2: Summary of Description of the Site and its Environs	
Asbestos	No potential ACMs noted on the ground surface.
Waste Disposal/ Materials Storage	None present
Surrounding Area	Surrounded by other University teaching blocks and walkways.
Ecology	There is no evidence of protected burrowing animals (e.g. badgers) or habitats suitable for protected amphibians (e.g. Great Crested Newts). Trees are present on the site and these should not be cut down during the nesting season. No evidence of invasive plant species were noted. <i>These comments on the ecology are for initial preliminary assessment. They are based on the assessment of personnel who are not trained ecologists and does not constitute a Phase I Habitat Survey or similar.</i>

2.3 Site Ownership

2.3.1 TerraConsult have not been advised of the ownership of the site.

2.4 History

2.4.1 The following information in Table 3 has been gathered to detail relevant land use changes for the site and its surroundings. The maps used are previous editions of the County Series and Ordnance Survey dating back to 1850. These maps are presented in Appendix C.

Table 3: Summary of Examined Ordnance Survey Historical Mapping		
OS Map Edition	On-site Features	Off-site Features
1850 County Series Plan 1:10,560 map 1851 County Series Plan 1:10,560 map	The site was partially residential properties, gardens and partially a road at the southern section of the site.	The surrounding areas are generally residential properties and gardens. There is a cemetery located 250 m west of site. There is an infirmary, lunatic hospital, fever hospital and other medical facilities 500 m to 600 m north of the site. 'Crown Street Railway Station' is located 650 m east of the site. From this station runs a tunnel travelling east to west approximately 250 m south of site at its closest. Another tunnel travelling east to west is located 400 m north of the site.
1893 County Series Plan 1:2,500 map 1891 County Series Plan 1:10,560 map	No significant changes noted.	Surrounding areas are still generally residential properties and gardens. Medical facilities remain but are now referred to as a 'Female Hospital' and 'Medical Institution'. The southern tunnel is no longer indicated on the map.
1908 County Series Plan 1:2,500 map 1906 County Series Plan 1:10,560 map	No significant changes noted.	Medical facilities are no longer indicated and have been replaced by workhouses.

Table 3: Summary of Examined Ordnance Survey Historical Mapping

OS Map Edition	On-site Features	Off-site Features
1927 County Series Plan 1:2,500 map 1928 County Series Plan 1:10,560 map	No significant changes noted.	Tramways now located on many of the roads surrounding the site. Infirmaries are located 200 m - 300 m west of the site. City laboratories are located 300 m north west of the site.
1938 County Series Plan 1:10,560 map	No significant changes noted.	A hospital is located 300 m south west of the site.
1955 National Grid Plan 1:2,500 map 1957 Provisional Plan 1:10,560 map	Fewer residential properties on site.	‘Abercromby Ward’ – ‘Royal Liverpool Children’s Hospital’ and ‘Liverpool Maternity Hospital’ are located 200 m west of the site. Buildings to the north of site, 30 m – 250 m distance, are now university departments. ‘University of Liverpool Nuclear Research Laboratories’ are located 350 m north west of site.
1968 National Grid Plan 1:1,250 map 1968 Provisional Plan 1:10,560 map	Cypress Building now located on the eastern edge of site. Site is now trees and pathways same as present site conditions.	No significant changes noted.
1977 National Grid Plan 1:1,250 map 1978 National Grid Plan 1:10,000 map	No significant changes noted.	Residential buildings 100 m east replaced by university buildings included a library.
1989 National Grid Plan 1:1,250 map 1991 National Grid Plan 1:10,000 map	No significant changes noted.	No significant changes noted.
1993-94 National Grid Plan 1:1,250 map	No significant changes noted.	No significant changes noted.
2002 Raster Plan 1:10,000 map	No significant changes noted.	No significant changes noted.
2010 National Grid Plan 1:10,000 map	No significant changes noted.	No significant changes noted.
2014 National Grid Plan 1:10,000 map	No significant changes noted	No significant changes noted.

2.5 Services Survey

2.5.1 The service information for the site was provided by the client prior to the fieldwork phase. There are numerous services crossing the development area.

3. ENVIRONMENTAL SETTING

3.1 Data Summary

- 3.1.1 A summary of the environmental background information (geology, hydrology, hydrogeology, database information etc.) and regulator consultation information has been tabulated and presented below. The source information for this table is presented in Appendix D or is referred to in Table 4 below. The table below represents the base data used to formulate the conceptual ground model.

Table 4: Data Summary: Environmental Setting & Regulator Contact		
	Data Source	Data Summary
Regional Geology	Groundsure Geo Insight report HMD- 147-4340084 BGS Maps 31/10/2017	The site is shown to be underlain by the 'Wilmslow Sandstone Formation' with the 'Helsby Sandstone Formation' along the western boundary of the site. Drift deposits reported to be absent on site but where they are indicated to be absent there is often 2 or 3 m of drift present. Anticipated superficial thin deposits of Glacial (Devensian) Till. A normal fault striking North-South is located 17 m west of site.
Mining	BGS Maps & Coal Authority Website 31/10/2017 Groundsure Geo Insight report HMD- 147-4340084	The site is not located in a Coal Authority Referral or Standing Advice Area. The site is not in an area affected by historic brine or salt extraction.
Quarrying	Historic OS Plans	From the historic maps, there is no evidence of mineral extraction or quarrying at the site (e.g. brick pits, sand and gravel extraction, etc.).
Hydrogeology	GroundSure Enviro Report HMD-147-4340083 Environment Agency Web Site, 31/10/2017	<u>Source Protection Zone</u> – none underlying the site or within the surrounding area. <u>Aquifer (drift)</u> – Secondary Aquifer - Undifferentiated <u>Aquifer (solid)</u> – Principal Aquifer <u>Soil Leaching Potential</u> – Soil of high leaching potential <u>Groundwater Abstractions</u> – No groundwater abstractions in the area of the site (closest is at the Royal Liverpool University Hospital 840 m north).
Hydrology	BGS Maps & Ordnance Survey	<u>Nearest watercourse</u> – the River Mersey is approximately 2 km west of the site.
	Environment Agency Web Site, 31/10/2017 GroundSure Enviro Report HMD-147-4340083	<u>Flooding</u> - The site is in Flood Zone 1, where the risk of flooding from rivers is classified as low. <u>Water Quality</u> : No information within 1,500 m of the site. <u>Pollution Incidents</u> – none within 250 m of the site. <u>Abstractions (surface & groundwater)</u> – nearest located 840 m. <u>Discharge Consents</u> – none within 500 m of the site
	Drainage Plans	Drainage present in the area for the adjacent buildings.
	Buried Culverts	None currently identified

Radon Potential	GroundSure Enviro Report HMD-147-4340083	The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level. Therefore no radon protective measures are necessary.
Other Radiation	Historic land use (see below) GroundSure Report HMD-147-4340083	No reasonable grounds for believing land to be radioactively contaminated (in accordance with 2005 extension of Part IIA of The Environment Protection Act 1990).
Ordnance	Zetica Bomb Risk Map	A preliminary UXO desk study has been carried out for the site (see Appendix E). The risk has been assessed in the UXO desk study from unexploded ordnance at the site. It is considered to be low for hand and mechanical excavations and medium for drilling, piling or bulk excavations. Liverpool was a target for heavy bombing during the Second World War and the city is designated as being at High risk of unexploded ordnance. Historical maps of the local area that pre and post-date the Second World War show that no changes to the layout of residential development occurred within proximity to the study site during this period. Further assessment is given in Section 3.5.
Environmental Database Information	GroundSure Report HMD-147-4340083	There are six recorded Radioactive Substances Authorisations, located 200 m north west of site at the University of Liverpool. There is one recorded pollution incident, 240 m south west of the site. However, the incident was Category 4 and had no impact. There are no COMAH sites within 500 m of the site. There are no registered Integrated Pollution Control (IPC) Sites, Registered Radioactive Substances sites, Explosives Sites or Notification of Installations Handling Hazardous Substances (NIHHS) within 500 m of the site
Landfill Search	Ordnance Survey Historical Mapping (from GroundSure Report) HMD 147-4340083	<u>Landfills</u> - No landfill sites are recorded within 500 m of the site. <u>Waste Treatment & Transfer sites</u> – There are multiple records of waste treatment, transfer or disposal sites within 500 m of the study site. These records are all located at 400 m east of the site at a scrap metal yard for the processing of scrap metal.
Trade Directories	Trade Directory Entries recorded in 250m radius (from GroundSure Report) HMD 147-4340083	There are seven recorded entries – six are related to electricity substations. The closest is 35 m to the south west. One of the entries is related to Avis Rent A Car hire services 179 m south west. None are considered to be a significant potential contaminative source.
Fuel Stations	Fuel Stations recorded in 500 m radius (from GroundSure Report) HMD 147-4340083	There are no recorded fuel stations within 500 m of site
Ecology	Sites of Ecological Importance (from GroundSure Report) MAGIC website 31/10/2017 http://magic.defra.gov.uk/website/magic/	There are no sites of Special Scientific Interest (SSSI), Special Protection Areas, Conservation Areas, National Nature Reserves, National Parks, Areas of Outstanding Natural Beauty or RAMSAR (wetlands) within 1 km of the site/ Greenbelt land.

Archaeological & Building Heritage	Liverpool City Council 31/10/2017	There are no buildings on the site that have been recorded as being of "local interest."
	Natural England Web Site 31/10/2017	The site/buildings are not within Areas of Outstanding Natural Beauty or a National Park.
	Historic England Web Site 31/10/2017	There are no scheduled ancient monuments buildings in historic parks and gardens on site or buildings within the curtilage of scheduled ancient monuments.
	MAGIC website 31/10/2017 Historic England website 31/10/2017 http://list.english-heritage.org.uk/mapsearch.aspx	There are no sites of archaeological interest on site. University buildings north of site are Grade 2 listed buildings. This will have no impact on the proposed development
Regulator Contact	Liverpool City Council - electronic communication on 22/10/2017	Contact has been made with the Council to enquire if they held any relevant information that wasn't in the public domain (e.g., infilled sandstone quarries, etc.). The council have responded and do not hold any other information. The Phase I site investigation will be submitted as part of the planning process.
	Environment Agency	Contact with the Environment Agency was not made at this stage.

3.2 Geology

- 3.2.1 It is anticipated that Made Ground will be present and this is likely to be relatively thin but it could be as much as 1 to 2 m thick.
- 3.2.2 The 1:50,000 scale BGS Drift map (1999) shows the site to be absent of drift deposits underlying the site. Adjoining the southeast corner of the site Glacial Till deposits are shown as being present. Where the Drift deposits are indicated to be absent on the geological map there is often 2 or 3 m of drift present. Therefore it is anticipated that thin deposits of Glacial Till will be present over the bedrock.
- 3.2.3 The solid geology underlying site is from the Triassic Wilmslow Sandstone Formation consisting of fine- to coarse-grained commonly pebbly cross-stratified sandstone, with conglomerates and sporadic siltstones.
- 3.2.4 Approximately 17 m west of site the underlying solid geology is the Helsby Sandstone Formation consisting of fine- to medium-grained, locally micaceous, cross-bedded and flat-bedded sandstones, weathering to sand near surface. The sandstones are of fluvial (sub-angular to sub-rounded grains) and aeolian (well-rounded grains) facies. Pebbles may be common, particularly near the base of the formation, and thin units of hard conglomerate.
- 3.2.5 The nearest inferred fault is a normal fault 17 m west of site with the eastern side of fault being the downthrown side.
- 3.2.6 There are two borehole records within 250m of site. The first (SJ38NE286) is situated 50 m east of the site, drilled for Liverpool University. The second (SJ38NE285) is situated 60 m east of the site, drilled for Liverpool University. These boreholes show superficial deposits to a depth of 6m over sandstone.

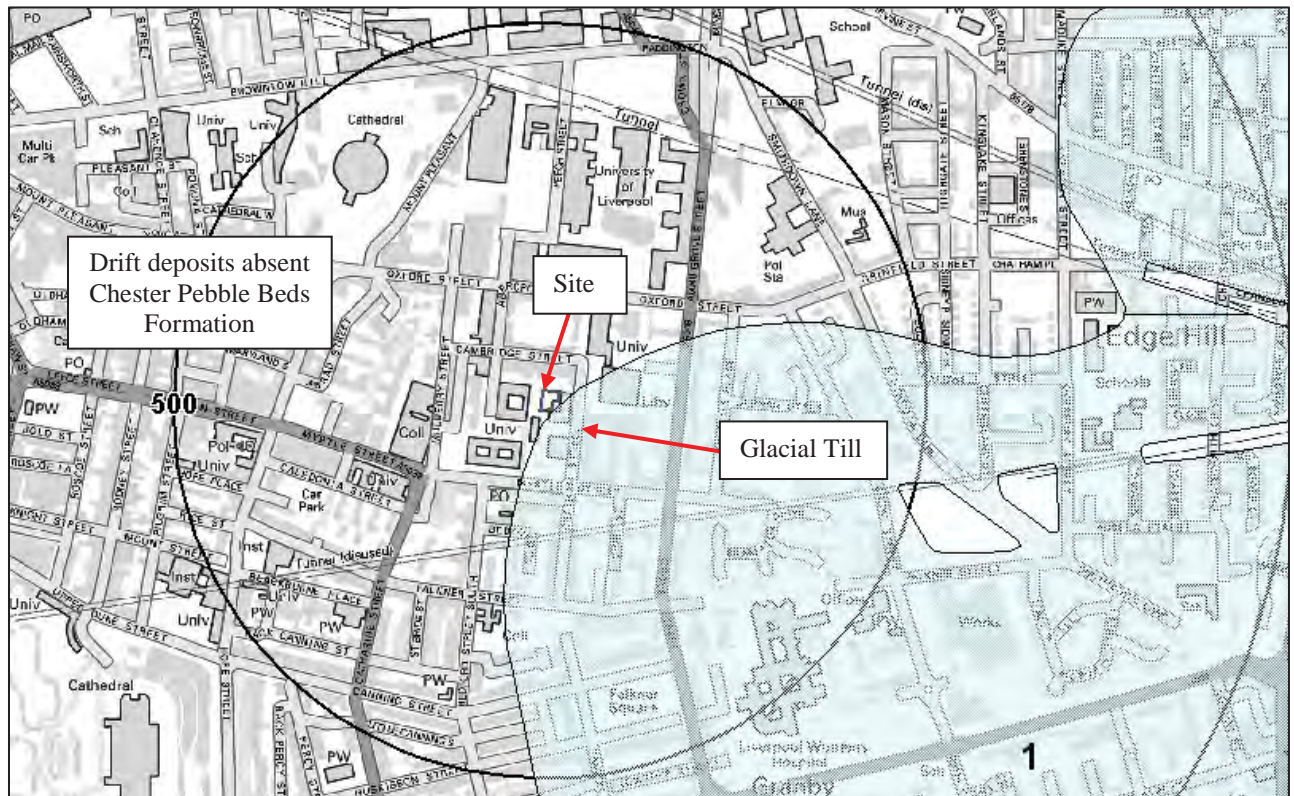


Figure 4: Extract from Groundsure Report -147-4340084 (Superficial Deposits Map)

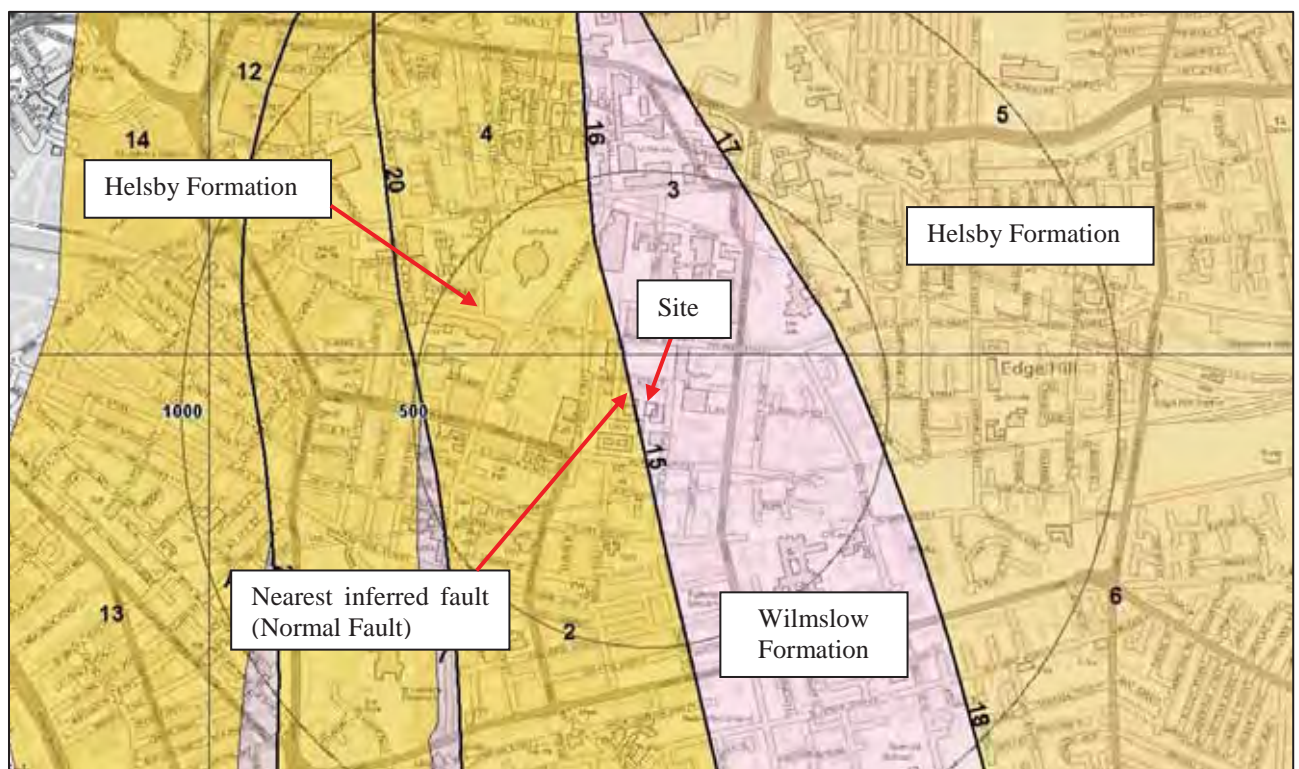


Figure 5: Extract from Groundsure Report -147-4340084 (Bedrock and Faults Map)

3.3 Mining and Quarrying

- 3.3.2 From the historic maps, there is no evidence of mineral extraction or quarrying at the site (e.g. brick pits, sand and gravel extraction, sandstone quarry, etc.). The site is not in a coal mining or brine affected area or an area where there are other mining related activities.

3.4 Hydrogeology

- 3.4.1 The Environment Agency have classified different types of aquifer from which groundwater can be extracted (see Appendix D for definitions). The bedrock (Wilmslow Sandstone Formation) is classified as a Principal Aquifer. Drift deposits are indicated to be absent, however the site is anticipated to have thin glacial clay or sand deposits overlying the bedrock. The drift deposits may have permeable layers within the unit. Therefore, the proposed development will be in contact with the bedrock. . The site lies further than 1 km from the nearest Source Protection Zones.
- 3.4.2 The Environment Agency has also designated a number of surface water features and groundwater bodies with additional protective status and has highlighted areas where the groundwater may be at risk. At this site, the site is:
- Not in a Surface Water Safeguard Zone;
 - Not in a Groundwater Safeguard Zone;
 - Groundwater Drinking Water Protected Areas – Groundwater potentially at risk

3.5 UXO Risk Assessment

- 3.5.1 MACC International Ltd have carried out a preliminary Unexploded Ordnance Risk Assessment for the proposed development (see Appendix E). The methodology used in the assessment complies with the United Nations (IMAS) standards, the CIRIA C681 “Unexploded Ordnance (UXO) – A guide for the Construction Industry” and the recognised best practice advocated by the Health and Safety Executive (HSE). The assessment carried out by MACC has drawn upon archive records which are within the public domain; however these are acknowledged to be incomplete.
- 3.5.2 Liverpool suffered considerable damage as a result of enemy bombing raids during WWII. Although a bomb strike within the site footprint was not confirmed, records indicate several strikes in the immediate surrounding area. Bombing incidents occurred c.a.130m to the north of the site at Oxford Street, c.a.150m to the east at Grove Street and c.a.150m to the south east at Vine Street.
- 3.5.3 A preliminary risk assessment was carried out by MACC international. A summary of the risk assessment is given in Table 5 below:

Table 5: Summary of MACC UXO risk	
Activity	UXO Risk
Hand Dug Excavations	Low
Limited Mechanical Excavations	Low
Drilling, Sampling, Piling or Bulk Excavations	Medium

Bomb Trajectory & Ground Penetration

- 3.5.4 The expected offset from impact point is estimated to be 3.0-5.0m.
- 3.5.5 The fieldwork has shown that bedrock is relatively shallow ranging between 4.3 m to 4.4 m. Due to the fact that the bedrock is shallow, it is more likely that any potential bombs would have exploded on impact and therefore are not buried under the site.
- 3.5.6 Any bombs failing to detonate would not penetrate very deep due to the presence of shallow bedrock. This low penetration depth increases the chance that bombs would have been recovered and diffused at the time.

3.6 Final UXO Risk Assessment and Risk Mitigation Measures

- 3.6.1 The historical mapping (see Figure 6) has shown that the site during WWII was partially Cypress Street in the southern half with the northern half of the site residential properties and rear gardens from Cypress Street. Since then the area has been re-developed on three sides and Cypress Street removed. The post WWII redevelopment of the area further reduces the likelihood of undiscovered UXOs being present on the site.

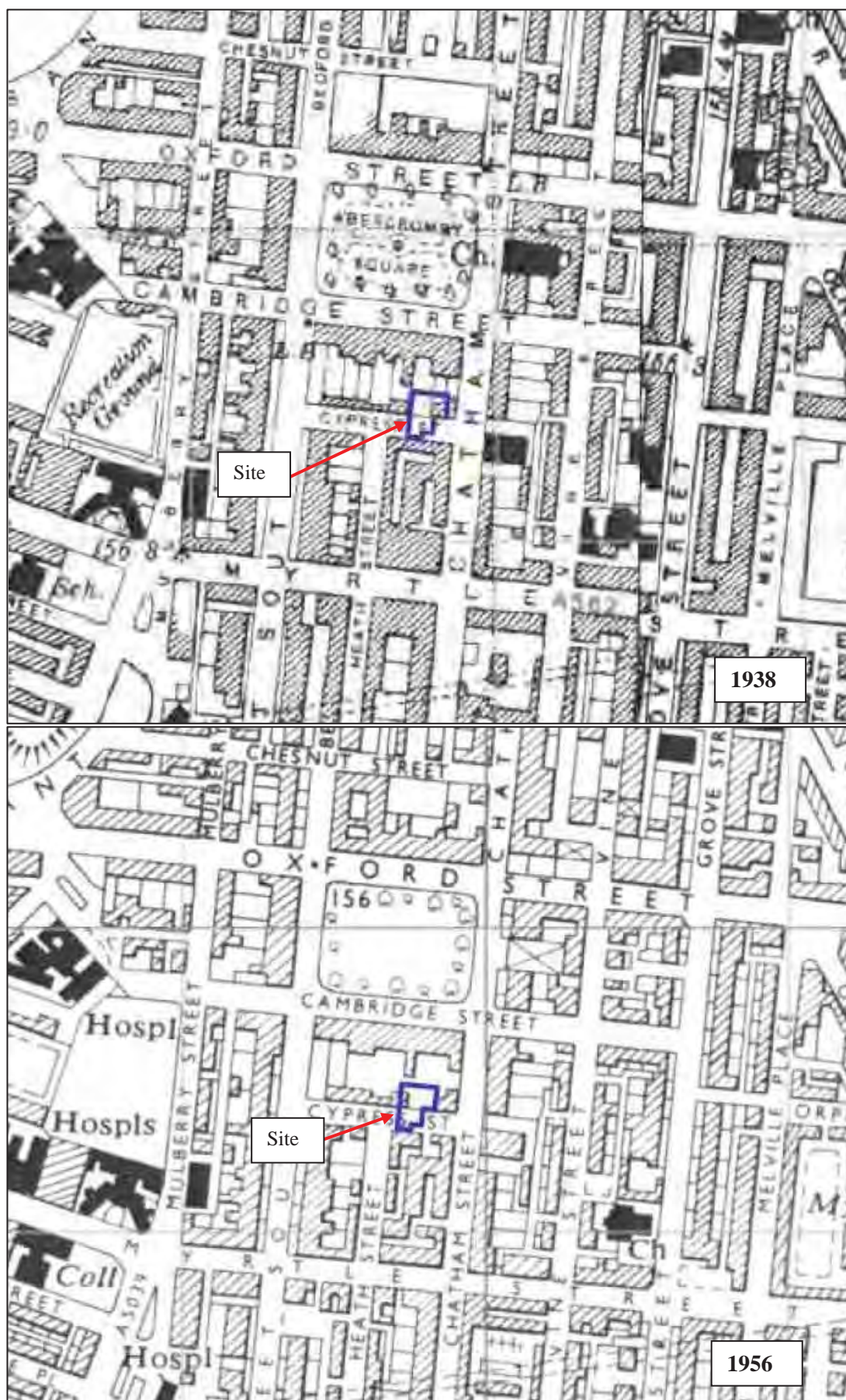


Figure 6: Extracts from Historical Mapping

- 3.6.2 The site is underlain by thin drift deposits (approx.4m) overlying sandstone bedrock. The shallow rockhead would indicate that aerial German WWII bombs are more likely to have detonated on impact and are unlikely to be buried under the site. It is likely that the site would also have been inspected for UXB entry holes following any raids further reducing the likelihood of rediscovered UXOs.
- 3.6.3 Taking into consideration the findings of this study, TerraConsult assess the overall risk across the site is low. Notwithstanding the assessed level of risk, it is recommended that during the construction phase of the proposed development the following measures are implemented:
- ***Operational UXO Risk Management Plan:*** appropriate site management documentation should be held on site to guide and plan for the actions which should be undertaken in the event of a suspected or real UXO discovery
 - ***Site Specific Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works:*** It is an essential component of the Health & Safety Plan for the site and conforms to requirements of CDM Regulations 2015. All personnel working on the site should be instructed on the potential risk from UXO, actions to be taken to alert site management and to keep people and equipment away from the hazard.
 - ***The Provision of Unexploded Ordnance Site Safety Instructions:*** The Construction Phase Plan should contain information detailing actions to be taken in the event that possible unexploded ordnance is discovered. They are to be retained on site and will both assist in making a preliminary assessment of a suspect object and provide guidance on the immediate steps to be taken in the event that ordnance is believed to have been found.

4. HAZARD ASSESSMENT & PRELIMINARY CONCEPTUAL SITE MODEL

4.1 Hazards Identified with the Proposed Development

4.1.1 The hazard identification is based on the assumptions presented below:

- the site will be a residential development;
- landscaped communal areas will be present; and
- drinking water will be from mains supply.

4.2 Potential Sources of Contamination

4.2.1 For the purpose of this assessment the potential contaminants of concern have been considered according to whether they are likely to have originated from on-site or off-site sources.

Potential On-site Sources of Contamination

4.2.2 The history of the site shows there has been no industrial or commercial landuse. The site was previously the grounds of two detached residential property in the east and west boundaries until 1960s with garden areas in the centre of the site and Cypress Street along the southern boundary. Since the mid-1960s the site has been a landscaped area within the University of Liverpool.

4.2.3 It is assumed that the previous houses located on the site would have originally been heated by coal fires. There is potential that coal ashes could have been spread within the shallow soils and hence potential contaminants include metals, sulphates and PAHs. It is considered very unlikely that the house would have been heated by oil. There could be asbestos present from the demolition of buildings. Contamination is not expected to be at high concentrations or extensive at the site.

4.2.4 The Made Ground is anticipated to be relatively thin (<1.0 m) and unlikely to contain significant amounts of organic material. There are no landfills or any evidence of infilled ground within 500 m of the site and the local authority has no records of any areas of significant infilling in the vicinity of the site. The risk from ground gases (carbon dioxide and methane) to the proposed development is considered very low.

Potential Off-site Sources of Contamination

4.2.5 There is an electrical sub-station 35 m to the south west of the site – next to a large detached property. There is the potential for PCB contamination at the sub-station. However, even if there had been a spillage of PCBs at the sub-station it is considered very unlikely to impact onto the development site. This is because the quantities of PCBs at the sub-station would be relatively low and PCBs are not very mobile, particularly given the likely Glacial Till cover.

4.3 Potential Receptors of Contamination

4.3.1 Based on the data previously discussed, the following potential receptors to contamination have been identified:

Table 6: Identified Potential Sensitive Receptors	
A	Humans – Pre development completion, i.e. working on site during demolition and construction.
B	Humans using, working or visiting the site post construction.
C	Offsite Human Health receptors using, working or visiting the surrounding residential/commercial areas, in particular university students/staff.
D	Controlled Waters - Groundwater – Area is underlain by Wilmslow sandstone, which is a Principal Aquifer.
E	Local flora and fauna during and post demolition and construction.
F	Building structure and services (future onsite and present/future adjacent sites).

4.3.2 The possible contaminant linkages are discussed below. It should be noted not all may be formed between all sources and receptors.

4.3.3 The preliminary assessment of risks undertaken for the development considers potential risks to receptors A to F in Table 7 above. The receptors A to F incorporate each of the receptors normally required by the Local Authority to be considered in their planning conditions relating to land contamination;

- Human Health (A, B & C);
- Property (including buildings, crops, livestock, pets, woodland, service lines) (E & F);
- Adjoining land (D & F);
- Groundwater and surface water (D);
- Ecological systems (E); and
- Buildings and structures (F).

4.3.4 It should be noted that there are no archaeological sites or ancient monuments considered to be within the zone of influence of the site. They are therefore not considered in the risk assessment.

4.3.5 The closest of each of the above receptor categories to the site are considered to be;

On-site

- Site users;
- Site workers during construction phase of works;
- Current/future site users & visitors, including maintenance crews for site equipment;
- Flora and fauna; and
- Principal bedrock aquifer / Secondary Aquifer in superficial deposits.

Off-site

- Residential
 - Cypress Building (adjacent east).
 - Garstang Museum of Archaeology Building (<10m north);
 - Department of Geography Building (<10m west); and
 - Roxby Building (<20m south).

4.3.6 The possible contaminant linkages are discussed below. It should be noted not all may be formed between all sources and receptors.

4.4 Identification of Pathways

Pathways to Human Health

4.4.1 There are various routes by which a potential contaminant may reach a receptor. For example, in areas where contaminated material is exposed, dermal contact with the material, inhalation or ingestion of dust may occur.

4.4.2 The site is currently mainly soft landscaped and a quarter of the site is covered by hard standing.

4.4.3 The proposed development extends the existing adjacent building so any demolition work will be minimal.

- 4.4.4 The site contains various trees, vegetation and paved footways; as well as a raised mound of material to be investigated. It is anticipated that these will be removed as part of the groundworks.
- 4.4.5 Inhalation or ingestion of dust and water could occur during the construction and development phase at the site. Pathways from dermal contact with soil and groundwater may also arise. It is considered that the risk of short term exposure for ground workers and other construction workers is low unless there are asbestos fibres in the Made Ground.
- 4.4.6 Post construction, the surface of the development area will be occupied with buildings. Therefore; it is unlikely that a significant number of further potential pathways, such as long term direct contact and dust inhalation/ingestion, will be applicable.
- 4.4.7 The only viable off-site sources of potential contaminants is Made Ground on adjacent sites/vicinity of the site will be unlikely to affect this site which will be similar to the Made Ground on-site so the risk assessment will not need to specifically consider these further.

Pathways from Ground Gas

- 4.4.8 There are no viable sources of ground gas so this does not need to be considered.

Pathways to Controlled Waters

- 4.4.9 Groundwater levels at the site are anticipated to be low and at a depth of more than 5 m within the bedrock. Lateral migration of potentially contaminated groundwater off-site (either via permeable Made Ground or the underlying aquifer) must be considered.
- 4.4.10 The vertical leaching of contaminants from the Made Ground into the groundwater is a potential pathway for contaminants to impact upon groundwater. The presence of thin Glacial Till drift deposits means there is an attenuation layer from potential contaminated Made Ground to the Principal Aquifer (Wilmslow Sandstone), although the till is anticipated to be very thin; and sand and gravel bands within the Glacial Till should be disproved within the Phase 2 investigation.
- 4.4.11 Surface run off from contaminated areas into surface watercourses must also be considered. Due to a lack of a hard standing site surface, this will be uncontrolled prior to and during the groundworks phase when this must be carefully managed. Post construction the majority of the site and surface run-off will be limited and controlled through drains. There are not any viable overland migration pathways for surface run off to reach any controlled waters receptors.

Other Pathways

- 4.4.12 Other potential pathways that are possibly less significant to the site but still require consideration are; potential phytotoxic effects on sensitive landscaping plants; chemical attack on foundations and services and permeation of contaminants through domestic water pipes. The risk to buildings from ground gases has been discussed under human health above.

4.5 Contaminant Linkages

4.5.1 For each contamination source there are potential contaminant linkages with all receptors. However, in the context of this site, not all of the contaminant linkages are plausible. The likelihood of the various pathways linking the contaminants to the receptors is presented in Table 7 below:

Table 7: Matrix of Contaminant Linkages							
Source/ Contaminated Medium	Pathway	Receptor					
		A - Humans using site pre- development	B - Humans working on site post construction	C - Offsite human health receptors	D - Groundwater	E - Flora & fauna	F - Building & Services
Soil/Made Ground	Ingestion	U	U	U	-	U	-
	Dermal Contact/Direct Contact	P	U	U	-	P	P
	Inhalation	P	U	U	-	P	-
	Infrastructure/Drainage	P	U	U	P	P	P
	Groundwater	P	U	P	P	P	P
	Surface water	U	U	U	P	U	P
Groundwater	Ingestion	U	U	U	-	P	-
	Inhalation	U	U	U	-	P	-
	Dermal Contact	P	P	U	-	P	-
	Groundwater	P	U	U	P	P	P
	Surface Water	U	U	U	U	U	P
Gas (CH ₄ CO ₂)	Migration	-	-	-	-	-	-
Key to significance of contaminant linkages S = Significant Pathway P = Possible Pathway U = Unlikely Pathway - =Not Applicable Only Significant and Possible contaminant linkages are taken forwards to the next part of the risk assessment.							

4.6 Conceptual Site Model

4.6.1 In accordance with BS 10175, a schematic section has been developed for the site based on the previously presented data and contaminant linkage assessment:

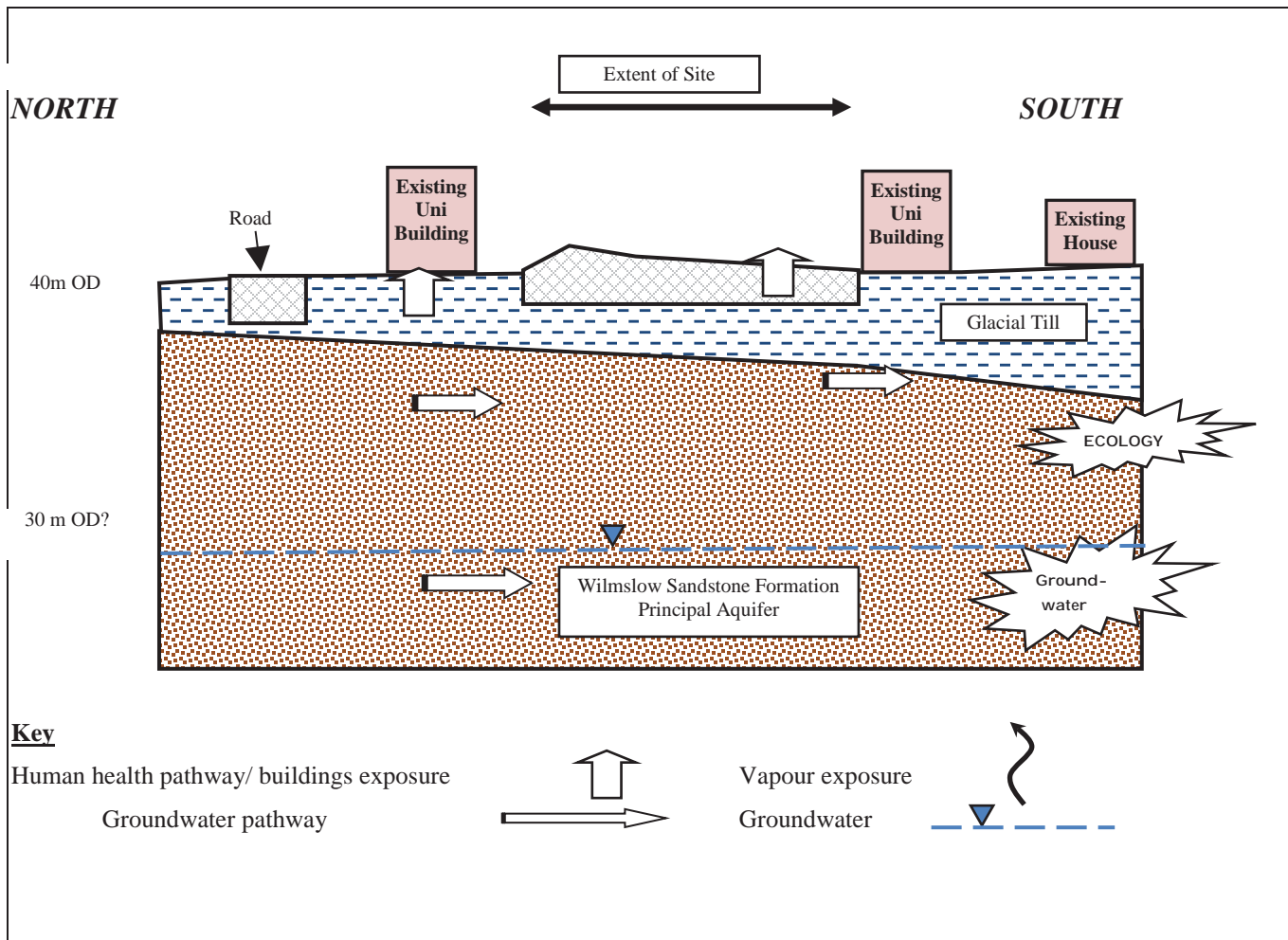


Figure 7: Preliminary Conceptual Ground Model - Schematic Section (not to scale)

- 4.6.2 The model shows the predicted geology and topography, the major on site potential contamination sources and vulnerable receptors. Levels shown are relative to Ordnance Datum and are based on published data, although the drawing may not be considered to scale.
- 4.6.3 The information presented above represents the preliminary conceptual ground model that may need to be revised based on information obtained as part of any future intrusive investigation. A number of sensitive receptors and potential pathways and sources (in association with a list of likely contaminants) have been identified.
- 4.6.4 The ground model and proposed end use described above should be considered broadly representative of the standard housing (with vegetable uptake) as defined in SR3 "Updated Technical Model to the CLEA Model" (SC050021/SR3, 2011) for the purpose of this report.

4.7 Preliminary Contamination Hazard Assessment

4.7.1 The preliminary hazard assessment is based on current available guidance published by a number of sources and is summarised in Appendix B. A preliminary conceptual site model for this site has been established using the desk study information and has been used as a basis for the preliminary hazard assessment. The significant and possible potential pathways are only considered for the hazard assessment.

4.7.2 The preliminary hazard assessment is a qualitative assessment of the risks posed by each viable pollution link identified. The hazard assessment leads to a recommended subsequent activity that could be:

- Action Required (AR) in the short term to break existing contaminant-pathway-receptor (CPR) link;
- Site Investigation Required (SIR) with objectives for risk estimation; or
- No Action Required (NAR) at this stage.

4.7.3 The hazard assessment is summarised in Table 8 below.

Table 8: Preliminary Hazard Assessment							
Hazard Identification				Hazard Assessment			
Link	Contaminant	Pathway	Receptor	Probability	Consequence	Risk	Hazard Assessment
1	Contaminated soil/groundwater	Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	A- Humans using the site during construction.	Low/ Unlikely	Medium	Medium/ Low	SIR - The majority of the site is currently soft landscaping with few sources of contamination during the site's history so the probability of contamination is low. The quantity of Made Ground is also anticipated to be low, however there is a possibility that it may contain potential contaminants of concern, and when removing this material from site, contaminants may be mobilised into the air via dust.
2		Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	B- Humans using the site after development completion.	Low/ Unlikely	Medium	Medium/ Low	Post development, the surface of the development area will be occupied with buildings, thus severing the majority of the remaining, limited pathways to the identified human health receptors. Current ground conditions need to be determined, total soil concentration of relevant contaminants and current groundwater conditions for contractors and designer's risk assessments / geotechnical designs.

Table 8: Preliminary Hazard Assessment							
Hazard Identification				Hazard Assessment			
Link	Contaminant	Pathway	Receptor	Probability	Consequence	Risk	Hazard Assessment
3		Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	C – Present and future off-site users / visitors	Low/ Unlikely	Medium	Medium/ Low	SIR – Off-site human receptors are unlikely to have direct contact with any potential contamination as the material will be predominantly under building footprint post construction.
4		Via service pipes	B- Humans using the site after construction. F- Building structures	Low/ Unlikely	Medium	Low	SIR –To understand the current baseline conditions of the site and understand the potential contamination issues that may be present; an intrusive site investigation will be undertaken.
5		Downward and lateral migration of surface water runoff and direct discharge to surface runoff and/or to receptor	C – Offsite human health receptor D-Groundwater/ Primary Aquifer	Low/ Unlikely	Medium	Medium/ Low	SIR- Potential for migration of any potential Made Ground into underlying stratum, and into any perched groundwater if present. However there does not appear to be a direct pathway to any surface waters due to vegetation and drainage systems along the pathways and roads surrounding all sides of the site. Post site construction, as above, increased presence of building footprint will reduce potential infiltration and therefore mobilisation and migration of potential contamination within Made Ground (if present), remaining surface water will be controlled via drainage. Furthermore, any potential contaminated leachate would have to migrate a significant depth before interacting with the Principal Aquifer groundwater, in that migration, diffusion and dispersion would decrease any significant concentrations of potential.
6	Contaminated soil/ groundwater	Direct contact. Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	E- Ecology (Flora/Fauna)	Low	Negligible/Mild	Near Zero	NAR – Any significant ecological receptors noted on site or in the immediate vicinity of the site are to be removed during construction.
7	Contaminated soil/ groundwater	Direct contact. Aggressive ground conditions in contact with buried structures/ services corridors.	F- Building structures and services	Medium	Medium	Medium/ Low	SIR- Unlikely to contain gross contamination, although local hotspot contamination cannot be ruled out at present, this has to be confirmed via an intrusive ground investigation.

- 4.7.4 From Table 8 a range of risk ranking from low to medium was established. Potentially medium risks require quantification and consideration prior to development. The site investigation objectives described above should represent part of a detailed main stage investigation that should include overall characterisation of the ground in association with obtaining and analysing the information described above.

4.8 Geotechnical Hazards Associated with the Development

- 4.8.1 In addition to the environmental hazards, there are also geotechnical hazards associated with the stability of the ground (including load bearing capacity, slope stability and effects of ground (mining) cavities). Local Authorities follow NPPF (2012) which requires that “site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining.” A summary of the geotechnical considerations is provided in Table 9 below:

Table 9: Summary of Geotechnical Hazards	
Geohazards:	
Highly Compressible Ground	Negligible – less than 1.0 m of Made Ground anticipated
Collapsible Soils	Very low
Swelling Clay	Very Low – anticipated very low volume change potential if clay present
Running Sand	Very low
Ground Dissolution	Negligible
Landslip	No
Mining & Quarrying (see Section 3.3)	There is no evidence of mining or mineral extraction or quarrying at the site.
Geotechnical Design Considerations	
Site Clearance	No buildings currently on site. Mound present within soft landscaped area. All green waste and deleterious material to be removed from site.
Trees	Trees present on site. Foundation design to take into account trees.
Existing Buildings / Obstructions	The proposed building may overlie the historic buildings which were demolished in the 1960s. There is the possibility that previous foundations remain. Some drainage and power services are present and will need to be investigated.
Foundations	Further investigation is required to confirm ground conditions (i.e. thickness and nature of Glacial Till and depth to sandstone bedrock). Anticipated that foundations in the sandstone will be suitable and due to depth these may have to be piled.
Floor Slabs	It may be possible to use ground bearing floor slabs.
Groundwater	Groundwater anticipated to be deep (more than 5m below ground level).
Earthworks	No bulk earthworks are anticipated to enable the proposed redevelopment. Main earthworks will be for foundations and services. If hotspots of contamination are encountered (e.g. possibly the mound), these will need to be excavated and made good.
Chemically aggressive ground conditions	Possibility for low pH and high sulphate concentrations which could be detrimental to below ground concrete.

5. INVESTIGATION METHODOLOGY

5.1 Investigation Strategy

5.1.1 The purpose of the various exploratory holes are in Table 10 below:

Table 10: Purpose of Exploratory Holes	
Exploratory Holes	Target Area
Dynamic Percussive (Window sampler) boreholes. (WS)	To assess shallow ground conditions and allow SPT's to be undertaken and prove depth of bedrock. To allow collection of samples for contamination and geotechnical testing. Located to gain a spread across the site, avoiding underground services.
Rotary cores	To assess bedrock conditions. Two holes to penetrate 3 m of bedrock, one hole to penetrate 9 m of rock To allow collection of cores for logging of bed rock conditions and collection of samples for geotechnical testing. Located to gain a spread across the site, avoiding underground services. To install gas/groundwater monitoring installations.
All trial pits hand dug	To assess shallow ground conditions in the mound. To allow collection of samples for contamination testing. Located to gain a spread across the site, avoiding underground services and inaccessible areas.

5.1.2 Trial pits were excavated to depths to 1.2 m. After inspection and sampling, the trial pits were back-filled with the as-dug excavated material.

5.1.3 The site investigation locations are shown on Figure 7



Figure 8: Extract from Exploratory Hole Location Plan

5.2 Chemical and Geotechnical Testing Strategy

- 5.2.1 The chemical testing allowed for basic suite of contamination testing on the shallow soils including the mound area. The suites included toxic metals, PAH, Total Petroleum Hydrocarbons (TPH) and Asbestos fibres.
- 5.2.2 The geotechnical testing included moisture content and Plasticity Index values of Glacial Till to assess the volume change potential, and rock strength testing within the sandstone bedrock.

5.3 Monitoring Strategy

- 5.3.1 Section 4 of this report indicates that there are negligible sources of ground gases at the site; Characteristic Situation 1 conditions apply. Two monitoring wells were installed primarily to record the groundwater levels but gas monitoring was carried out in these wells in order to confirm whether or not Characteristic Situation 1 conditions apply.

6. FIELDWORK

6.1 General Observations

6.1.1 The fieldwork was carried out between 6th and 7th November 2017. TerraConsult personnel were present to supervise all work, describe the ground encountered, carry out in situ testing and decide on the depths and response zones of monitoring wells. A services survey was provided by the Client and prior to the site work TerraConsult carried out a CAT scan at the location of each exploratory hole location. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- British Drilling Association “Guidance for Safe Intrusive Activities on contaminated or Potentially Contaminated Land” (2008);
- BS5930:2015 "Code of Practice for Site Investigations"; and
- BS10175:2011 + A1 (2013) “Investigation of potentially contaminated sites – Code of practice.”

6.1.2 The investigation comprised the following fieldwork scope:

- Two Trial pits – two hand dug pits into the mound;
- Three dynamic (window) sampling boreholes with SPT tests in each, extended by rotary core drilling; two 3 m into the bedrock, one 9 m into bedrock;
- Two gas/groundwater monitoring wells;
- Sampling and testing of soils and rock cores;
- Description of the ground encountered in accordance with BS5930:2015 "Code of Practice for Site Investigations"; and
- Gas and groundwater monitoring.

6.2 Trial Pits

6.2.1 Two trial pits were excavated by hand across in the mound to depths of between 1.2 m (HDP1) and 0.9 mbgl (HDP2). The trial pit logs are presented in Appendix F.

6.3 Dynamic (Window) Sample Boreholes

6.3.1 Three dynamic sampling boreholes (RC01 to RC03) were carried out using a tracked Comacchio Geo 205 rig. These holes were excavated adjacent to the Cypress Building to depths of between 4.3 mbgl (RC02) to 5.0 mbgl (RC03). All holes were commenced by carrying out hand dug inspection pits to depths of 1.0 and 1.2 m.

6.3.2 Standard Penetration Tests (SPTs) were carried out at 1 m intervals in the holes in general accordance with BS EN ISO 22476-3:2005. The dynamic sample logs and the SPT Calibration Certificate are presented in Appendix F.

6.4 Rotary Boreholes

- 6.4.1 Three rotary coring holes (RC01 to RC03) were completed to maximum depths of 13.5 m bgl (RC02) and 8.3 m bgl (RC01). Boreholes were drilled using a Comacchio Geo 205 rotary drill using water flush. In total, three boreholes were drilled, all to the west of the existing Cypress Building. Cores taken were of H size (76mm) and were taken between 5.0 m and 13.5 m depth.
- 6.4.2 Rotary holes RC02 and RC03 had gas/groundwater monitoring wells installed to 5.0 m bgl. The headworks of the monitoring wells were cemented in place using post mix cement. Rotary hole RC01 was backfilled to surface on completion with sand.

6.5 Samples and Sample Containers

- 6.5.1 Soil samples for chemical analysis each comprised a pair of samples: a plastic tub for metals and inorganics; and an amber glass jar for organics. All samples were stored in a cool box and dispatched directly to the testing laboratory.
- 6.5.2 After completion of the fieldwork, two visits to date has been made to the site to carry out monitoring of groundwater levels and ground gas concentrations. Ground gas monitoring was carried out in accordance with BS8576:2013 and comprised measurement of: landfill gases using a GasData GFM435 infra-red meter to measure gas flow rate, methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.
- 6.5.3 The results of this monitoring are presented in Appendix G, together with details of the instrumentation specifications.
- 6.5.4 It should be noted that no free phase hydrocarbons were encountered in any of the monitoring wells.

7. LABORATORY TESTING

7.1 Chemical Laboratory Testing

- 7.1.1 The samples were submitted to QTS Environmental of Lenham in Kent who are UKAS accredited in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.
- 7.1.2 The selection of samples for laboratory testing and analytes to be determined were made based on the Phase 1 assessment, the excavation records and other observations during the investigations. The sample selection rational was as follows:
- to gain a good coverage across the site and of the various material types and strata encountered; and
 - to characterise samples from the interface of permeable and less permeable horizons within the ground.
- 7.1.3 The selected soil and groundwater samples were tested for a range of typical contamination indicators including specific tests for contaminants suspected as being present from the desk study and from observations made on site. Tests were also performed which were used to support the modelling of contaminant transport and impacts (e.g. TOC) and for waste classification purposes.
- 7.1.4 Each of the soil samples were analysed for the 'total' concentration of a suite of potential contaminants. A number of leachate samples were also prepared from selected soil samples in accordance with BS EN 12457: Part 4 : 2002 with a 10:1 water:soil extract prepared. The results of the leaching are presented in terms of µg/l and also in mg/kg.
- 7.1.5 The results of the laboratory analysis are presented in Appendix H. The various suites of analysis for the soil, leachate and water are in Table 11, below:

Table 11: Suites of Analysis for Soil and Water Samples			
Determinand	Soil Suite 1	Soil Suite 2	Landfill WAC Suite
Number of Samples	3No	2No	1No.
Index Tests			
Asbestos Screen	**	**	-
pH	✓	✓	✓ (L)
Dissolved Solids	-	-	✓ (L)
Metals			
As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn (all totals)	✓	✓	✓ (L)
Ba, Mo, Sb	-	-	✓ (L)
Inorganics			
Cyanide - Total	✓	✓	-
Chloride (2:1 extract on soil samples)	✓	✓	✓ (L)
Fluoride (2:1 extract on soil samples)	-	✓	✓ (L)
Nitrate (2:1 extract on soil samples)	-	✓	✓ (L)

Table 11: Suites of Analysis for Soil and Water Samples			
Determinand	Soil Suite 1	Soil Suite 2	Landfill WAC Suite
Sulfate (2:1 extract on soil samples)	✓	✓	✓ (L)
Organics			
Phenols - Total (monohydric)	✓	✓	✓ (L)
Total Organic Carbon (TOC)	✓	✓	DOC & TOC
PAH (Speciated USEPA 16)	✓	✓	✓ (S)
TPH (C ₈ to C ₃₆) TPH CWG (RBCA) Speciation	-	✓	-
Mineral Oil (C ₁₀ to C ₄₀)	-	✓	✓ (S)
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	-	✓	✓ (S)
Poly Chlorinated Biphenyls (PCBs)	-	-	✓ (S)
NOTE ✓ = Test carried out on all samples **= Test required on selected samples only 2. All soil samples to be tested and reported in accordance with EA MCERTS for Soils Scheme 3. WAC Leachate preparation and reporting in accordance with ISO/EN/BS12457:Part 4 with results reported in terms of both mg/kg and mg/l for a 10:1 extract. 4. (S) test carried out on soil sample, (L) test on leachate prepared from soil sample in accordance with Landfill WAC Criteria			

7.2 Geotechnical Laboratory Testing

7.2.1 Samples were submitted to GSTL based in Carmarthenshire who are UKAS accredited in accordance with ISO17025. The following geotechnical testing was undertaken with the results of this testing presented in Appendix H:

- 2 No. natural moisture contents;
- 2 No. liquid and plastic (Atterberg) limits;
- 13 No. Point Load Strength Tests of Rock (Axial and Diametrical); and
- 2 No. Uniaxial Compressive Strength of Rock.

8. GROUND CONDITIONS

8.1 General

8.1.1 The site investigations have allowed the site specific ground conditions to be described and this information was used to provide an improved conceptual ground model.

8.1.2 The geology encountered during the site investigations was generally consistent with that anticipated from the desk study however, the drift deposits were encountered deeper than indicated on the BGS geology mapping for the area. A summary of the findings are given below.

8.2 Ground Surface

- 8.2.1 Currently, the posed development is part of a grassed landscaped area with mature trees and bushes intersected with concrete footpaths.

8.3 Anthropogenic Materials

- 8.3.1 Thin Made Ground deposits were encountered in all locations. The Made Ground generally comprises of dark brown sandy slightly gravelly clay to 0.15m (Topsoil) overlying dark brown sandy slightly gravelly clay ranging in thickness from 0.5m to 0.9m. Gravel within the clay Made Ground contains varying amounts of brick, concrete, ash and plastics. HD01 terminated at 0.9m on whole bricks.
- 8.3.2 No visual or olfactory evidence of contamination was noted during the fieldwork other than the presence of ash (which can be a source of heavy metals, sulphates, PAHs etc.).

8.4 Drift Deposits

Glacial Sand

- 8.4.1 Loose to medium dense light brown slightly gravelly fine to coarse Sand generally below made ground (0.5m to 0.9m) proven to 3.1m. Gravel is sandstone, fine to coarse. SPT N values range from 6 to 12.

Glacial Clay

- 8.4.2 Firm brown sandy slightly gravelly Clay underlying the upper sand and overlying the sandstone bedrock. Gravel is subangular to subrounded fine to coarse of sandstone and mudstone. Depth ranging from 3.2m to 3.6m (RC02) and 3.1m to 5.0m (RC03).

8.5 Solid Geology

- 8.5.1 Bedrock was encountered below depths of 4.30 and 5.0 m and was found mainly to comprise reddish brown fine grained Sandstone. The upper strata are highly to completely weathered and recovered as sand. The more competent rock was below a depth of 4.45 to 6.50 m and was recorded as extremely weak to weak red/brown black mottled with fractures closely spaced, predominately horizontal and 70 - 80 degrees. There were beds of mudstone up to 60 mm thick within the mudstone. Whilst these beds of mudstone are known to be found in the Wilmslow Sandstone they are not usually as common as encountered at this site.

8.6 Groundwater

- 8.6.1 No groundwater was encountered during the fieldwork.
- 8.6.2 Two visits have been carried out to record groundwater levels within the monitoring wells. Both monitoring wells were recorded as dry on the first visit and the well in RC03 is recorded as dry in the second visit but there was 0.08 m of water in the base of the well

in RC02 in the second visit. This is not the groundwater level but corresponds to some water migrating to depth and being trapped in the base of the well above the end cap of the well.

9. GENERIC QUANTITATIVE RISK ASSESSMENT

9.1 Introduction

9.1.1 The assessment of contamination has been carried out in accordance with the overall guidance presented in CLR11 Model Procedures for the Management of Land Contamination using the procedures as indicated in Appendix B.

9.1.2 Generic risk assessment is a two stage process. Firstly, in the Risk Estimation stage, the measured contaminant concentrations are compared to the relevant GACs or C4SLs/S4ULs where they have been published. Where there is a suitable dataset, this is done after carrying out statistical analysis to determine the upper confidence limit on the true mean. Otherwise, maximum or specific data points are compared directly. The second stage, Risk Evaluation, comprises an authoritative review of the findings with other pertinent information, in cases where the C4SLs or GACs are exceeded, in order to consider if exceedance may be acceptable in the particular circumstances.

9.1.3 The aspects of risk from substances in the ground considered below are as follows:

- human health;
- plant life;
- pollution of Controlled Waters;
- water supply pipes
- below ground concrete; and
- ground gases.

9.2 Assessment for the Protection of Human Health

9.2.1 The Generic Qualitative Risk Assessment (GQRA) is based on a soil with a Soil Organic Matter of 1% was carried in accordance with the methodology for assessing soil samples set out in Appendix B based on a commercial and public open space end use. A full summary of the chemical test results is presented in Appendix J. Exceedance of applicable Generic Assessment Criteria (GAC) threshold concentrations are indicated in yellow (note that the results highlighted in orange do not pose a risk to health but relate to concrete design). A discussion on the various exceedances are presented below.

9.2.2 The selected samples were from the Made Ground including the mound soft landscaped area. The chemical results have shown no exceedance for the relevant GAC for Metals, PAHs or Total Petroleum Hydrocarbons (TPH).

Asbestos

- 9.2.3 Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g. asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our site staff for the presence of bulk ACMs. During the fieldwork no suspected ACMs were identified.
- 9.2.4 Four samples underwent laboratory assessment to determine whether asbestos fibres or ACMs are present. No asbestos fibres were found in any of the samples (note that the laboratory quantification limit for these samples is 0.001%).

9.3 Risk to Plant Life

- 9.3.1 The concentrations of the phytotoxic metals copper, chromium, nickel and zinc have the potential to be harmful to plants. However, all the measured concentrations of these metals are lower than the guideline values for the protection of plants as presented in the MAFF document “Code of Good agricultural practice for the protection of soil”. Therefore there is no risk to plants at the site due to phytotoxicity should any be planted in the ground as part of the proposed development.

9.4 Water Supply Pipe Material Assessment

- 9.4.1 Plastic pipe materials are potentially vulnerable to attack from elevated levels of hydrocarbons, which can potentially lead to contamination of potable water supplies and water supply companies also require the risk to their workers from other contaminants in the ground to be assessed. The assessment has been completed in accordance with the current UK Guidance for the Specification of Water Supply Pipes to be used in Brownfield Sites (UK Water Industry Research Ltd. UKWIR, 2014) together with guidance from United Utilities. This guidance provides threshold concentrations for different pipe material for various chemical groups.
- 9.4.2 The pipeline materials considered by the guidance are PE, PVC, wrapped steel, wrapped ductile iron or copper pipe and barrier pipe. PE are assessed using threshold concentrations for various chemical groups including volatile organic compounds (VOC) with tentatively identified compounds (TICs), semi-volatile organic compounds (SVOC) with TICs, mineral oils, aldehydes, ketones etc. Wrapped steel, wrapped ductile iron and copper pipe are assessed using corrosive properties. The default recommendation for water supply pipes is to use PE with other types of pipework only used if the limits for PE pipes are exceeded. When assessing the ground for water supply pipes the suite of potential contaminants to be tested only needs to be those contaminants that are potentially present on site based on the desk study. At this site the desk study did not identify there to be a risk from SVOCs (including chlorinated phenols, cresols), aldehydes, ketones, ethers, nitrobenzene and amines so no analysis was carried out for these compounds.

9.4.3 The available data indicates no exceedances for the PE water supply pipe are present and as such the use of PE pipe is deemed permissible with the following caveats:

- should areas of unexpected contamination be found during construction and any water supply pipes are routed through those areas, additional sampling and testing will be required.
- Following confirmation of the water supply pipe route, the water supplier for the area should be contacted and written approval sought. They may require additional chemical data along any proposed potable water supply pipe routes.

9.5 Chemical Attack on Below Ground Concrete

9.5.1 Below ground concrete structures are potentially at risk in areas of elevated sulphates and where there is low pH. An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) indicates that ACEC Class AC-1s conditions prevail. Therefore no special precautions are required at the site for the design of concrete in terms of the durability and structural performance.

9.5.2 Gross hydrocarbon contamination can also have an adverse impact on the setting of concrete, which may affect foundation construction and piling. Based on the measured concentrations of hydrocarbons at the site there is no risk of these affecting the setting of concrete.

9.6 Permanent Ground Gases

Measured Gas Concentrations

9.6.1 Two rounds of gas monitoring carried have been carried out to date by TerraConsult in the gas monitoring wells in RC02 and RC03 with atmospheric conditions at 1015 mbar.

9.6.2 One further monitoring visit will be carried out to complete the risk assessment.

9.6.3 The highest flow rates, methane and carbon dioxide concentrations, together with the lowest oxygen levels (i.e. a combination of the worst case temporal conditions recorded) from the monitoring visits are summarised in the table below:

Borehole	Response Zone mbgl	Contamination evidence	No. of monitoring occasions	Steady State Flow (l/hr)	Methane (% v/v)	Carbon Dioxide (% v/v)	Oxygen (% v/v)	Carbon Monoxide (ppm)	Hydrogen sulphide (ppm)	PID Readings (ppm)	Water Level mbgl	Atmospheric pressure readings mb
RC02	2.0-5.0	N	2	<0.1	<0.1	2.1 & 6.5	18.3 & 14.2	<1	<1	<1	Dry	1015 998
RC03	2.0-5.0	N	2	<0.1	<0.1	3.5 & 4.5	17.0 & 15.5	<1	<1	<1	Dry	1015 998

Ground Gas Assessment

- 9.6.4 Background information relating to the origin and production of landfill and ground gases are presented in Appendix K, together with current guidance on the assessment of ground gases. In accordance with this approach and the above measured ground gas levels, it is considered that the worst case temporal conditions may not have been measured during the monitoring period. However, it is anticipated that the worst case temporal conditions will not be significantly worse than those presented in Table 12 in the second round of monitoring when there was atmospheric pressure of 998 mbar and the highest carbon dioxide concentrations were measured. However, the carbon dioxide concentrations may increase further under low pressure conditions but would not be expected to increase to more than 10 % carbon dioxide and it is extremely unlikely that any methane will be recorded in the wells at this site. The gas flow rates measured across in both wells during all of the monitoring visits was less than the instrument detection limit of 0.1 l/hr.
- 9.6.5 Based on the Ground Gas Assessment it can be seen that the carbon dioxide conditions at the site are the main risk driver regarding the gas conditions. The Gas Screening Value suggests Characteristic Situation 1 conditions but because the carbon dioxide concentration is greater than 5% on the second round of monitoring the risk level should be moved up one category. Therefore it is recommended that Characteristic Situation 2 gas protection measures are adopted for the development in line with BS8485:2015.
- 9.6.6 From BS8485:2015 Table 3 the new building can be classed as a Building Type C (public building with full control over any structural alterations) and from Table 4 of this standard a Score of 2.5 points of protection will be required. The standard does not provide set requirements but it provides a menu of different options which in combination can be used to provide an appropriate Score as set out in Table 4 of this standard. An example of appropriate protection measures are:
- Floor Slab:
 - Block and beam ground floor slab – Score 0, or
 - Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement) – Score 0.5; or
 - Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement– Score 1.0;
 - Passive sub floor dispersal layer
 - Very good performance– Score 2.5;
 - Good performance– Score 1.5;

Media used to provide the dispersal layer are:

 - Clear void
 - Polystyrene void forming blanket
 - Geocomposite void former blanket
 - No-fines gravel layer with gas drains
 - No-fines gravel layer
 - gas resistant membrane meeting all of the following criteria:
 - Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method);

- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, dropping tools etc);
- capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- verified in accordance with CIRIA C735.

9.7 Updated Conceptual Site Model

9.7.1 The conceptual site model initially developed from the desk study and walk-over survey (Section 4.6) has been updated using the findings of the Phase 2 ground investigation.

9.7.2 The site investigation revealed the following general downward succession:

Site surface: grass, concrete footpaths.

Topsoil (0.1 to 0.2 m thick). Present only in soft landscaped areas.

Made Ground (0.7 to 0.9m thick) of dark brown sandy clay with brick.

Glacial Till: Loose / medium dense brown slightly gravelly fine to medium sand to 3.0m overlying Firm brown slightly sandy slightly gravelly clay to 4.3m.

Bedrock: Extremely weak to weak reddish brown mottled black fine grained Sandstone – highly weathered at rockhead.

Groundwater: at depth of more than 13.5 m below ground level.

9.7.3 The results of site investigation and laboratory analysis indicates that there is low concentrations of potential contaminants at the site and there are no potential off-site sources that will affect the development. Therefore there is a negligible risk to:

- (i) *human health,*
- (ii) *controlled waters,*
- (iii) *property (existing or proposed) including buildings, crops, livestock, pets, woodland and service lines and pipes,*
- (iv) *adjoining land,*
- (v) *ecological systems, and*
- (vi) *archaeological sites and ancient monuments.*

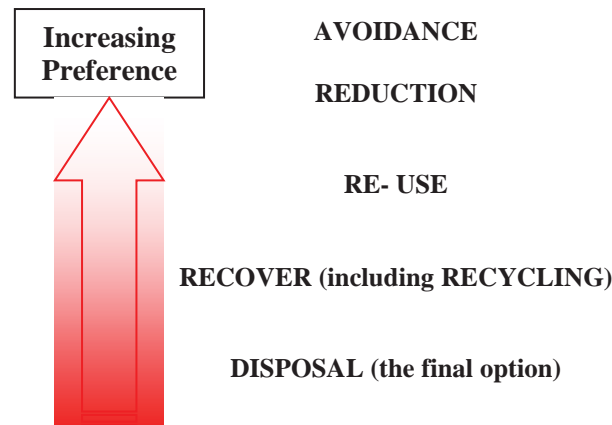
9.7.4 The building should be designed to meet the requirements of Characteristic Situation 2 ground gas conditions. No specific precautions are required with respect to radon or hydrocarbons vapours for the development.

- 9.7.5 All below ground concrete should be designed to meet the requirements of ACEC Class AC-1s.
- 9.7.6 The risk assessments have concluded that no remediation measures are required to address risks to any potential receptors. However, as with any project on a Brownfield site there is the possibility of encountering unexpected contamination. If this occurs then the procedures set out in Appendix M should be implemented.

10. WASTE ASSESSMENT

10.1 Waste Hierarchy

- 10.1.1 In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



- 10.1.2 As with most developments, there will be waste materials produced from excavations for drainage/services and the removal of material within the existing mound area on the site. Where possible, these arisings should be incorporated into other soft landscaping with the arisings being separated into Made Ground and Glacial Till as they are excavated in order to facilitate the re-use.

10.2 Waste Characterisation and Classification

- 10.2.1 If there is a portion of excess soil this will then have to be sent to a suitable landfill site. A summary of current relatively complex guidance on categorising waste from earthworks is presented in Appendix N. A two phase approach is required comprising comprises:

- Waste Characterisation; and
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

- 10.2.2 The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that none of the materials encountered during the investigation can be classified as hazardous.

Waste Classification

- 10.2.3 In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. One WAC test

has been carried out from within the mound area (HD1). There is only one result which exceeds the inert waste limit for fluoride. Therefore the mound material will be classified as being non-hazardous waste rather than inert. All the natural soils will be classified as being inert waste.

- 10.2.4 As an alternative location for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Environmental Permits for site Reclamation and can accept certain categories of inert and non-hazardous wastes.
- 10.2.5 Note that the above assessment should only be seen as an initial guide. Defining the class of waste is carried out on the actual waste being disposed of and the destination landfill site will have the final decision on acceptability of the waste. Therefore, it is recommended that if soils are to be removed from the site, the appointed contractor should approach a landfill site with the available chemical data and seek a formal waste characterisation.

11. GEOTECHNICAL ASSESSMENT & RECOMMENDATIONS

11.1 Fieldwork and Laboratory Data Review

- 11.1.1 In general there was only a thin coverage of Topsoil or hard standing or Made Ground at the site which was 0.10 to 0.90 m thick and will not be considered further in this section.
- 11.1.2 Below the Made Ground there is a variable sequence of glacial materials of loose / medium dense fine to medium Sand overlying firm slightly sandy slightly gravelly Clay to 4.3m (Glacial Till).
- 11.1.3 Bedrock was encountered below depths of 4.30 and 5.0 m and was found mainly to comprise reddish brown fine grained Sandstone. The upper strata are highly to completely weathered and recovered as sand. The more competent rock was below a depth of 4.45 to 6.50 m and was recorded as extremely weak to weak red/brown black mottled with fractures closely spaced, predominately horizontal and 70 - 80 degrees. There were beds of mudstone up to 60 mm thick within the mudstone. Whilst these beds of mudstone are known to be found in the Wilmslow Sandstone they are not usually as common as encountered at this site. The presence of the mudstone beds will reduce the shaft friction of piles and the end bearing capacity compared to sandstone without the mudstone beds.
- 11.1.4 SPT N-values were recorded throughout each borehole within the drift deposits and are summarised below. The listed N-values have been corrected to the standard Energy Ratio of 60% and are therefore reported below as N_{60} values:

Table 13: Summary of SPT N₆₀-Values				
Hole No	Test Depth (m)	SPT Values	SPT N₆₀-Values	Stratum
RC01	1.20	6	6.4	Glacial Sand
	2.20	7	7.5	
	3.20	11	11.7	Glacial Clay
	4.20	46	49.1	Sandstone
RC02	1.20	11	11.7	Glacial Sand
	2.20	12	12.8	
	3.20	13	13.9	Glacial Clay
	4.10	50	>50	Sandstone
RC03	1.20	7	7.5	Glacial Sand
	2.20	6	6.4	
	3.20	7	7.5	Glacial Clay
	4.20	12	12.8	
	5.00	50	>50	Sandstone

11.1.5 The SPT N values have shown relatively consistent blow counts in all three boreholes and stratum types. The depth to rockhead is slightly deeper in RC03. A summary of the SPT N₆₀ values are given in Figure 8 below (SPT N 60 vs Depth Graph).

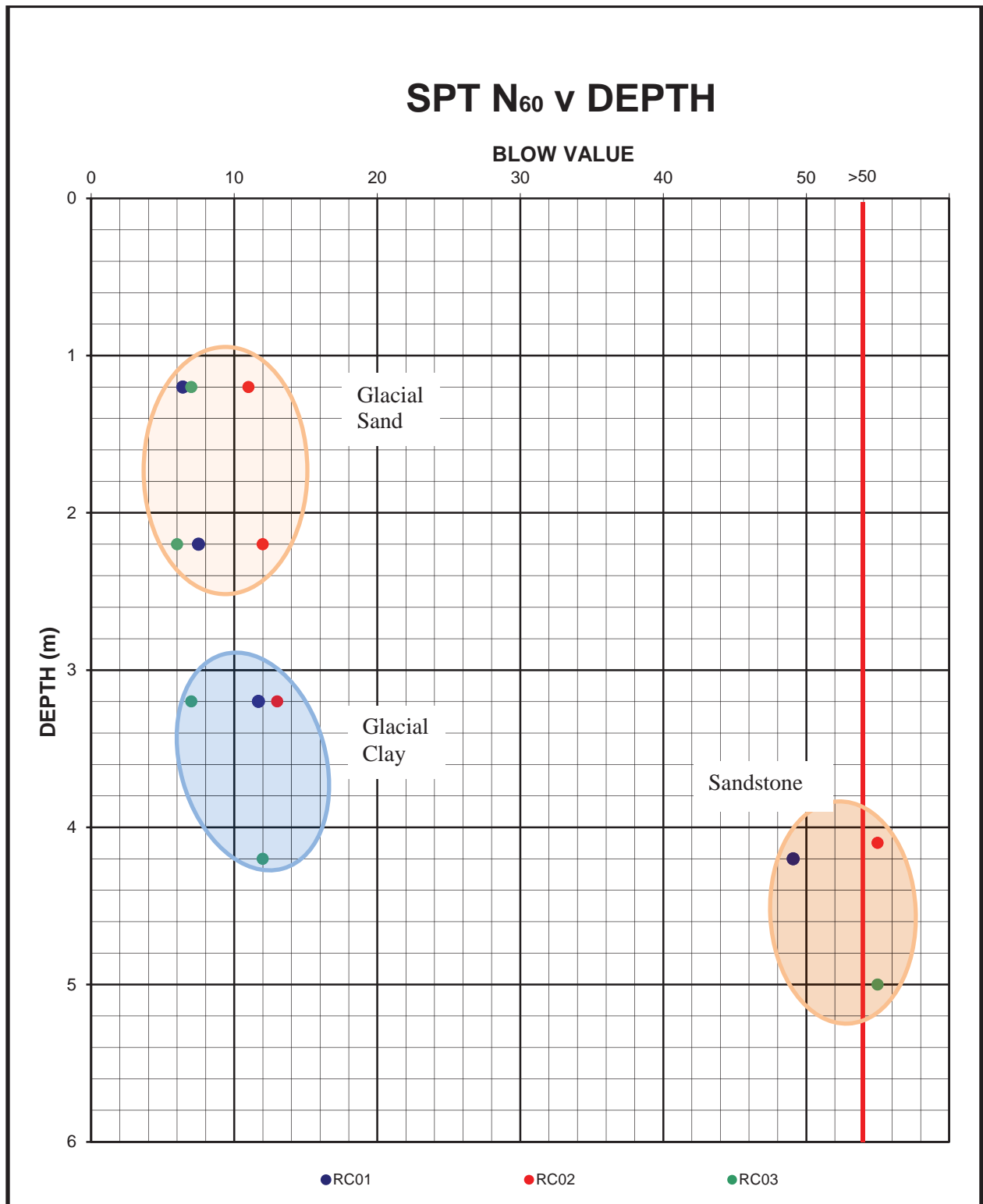


Figure 9: SPT N 60 vs Depth Graph

11.1.6 The volume change potential of the clays will have to be considered in the design. The classification test results on the clay strata are summarised below:

Table 14: Summary of Geotechnical Laboratory Classification Testing – Glacial Clay

Hole	Depth (m)	Moisture Content (%)	% passing 425um sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Modified Plasticity Index	Plasticity	Volume Change Potential
RC01	3.80	22	100	42	24	18	18.0	Low - CI	Low
RC02	3.20	14	95	28	16	12	11.4	Low - CL	Low

11.1.7 The two samples tested indicate evidence of desiccation with the moisture contents lower than the plastic limits. The volume change potential has been recorded as low.

11.1.8 Undisturbed rock core samples were taken where possible and samples were selected for Point Load and Unconfined Compressive Strength (USC). Due to the closely spaced and sub-vertical fractures, samples for UCS testing were limited to two. The results are summarised below:

Table 15: Summary of Unconfined Compressive Strength (UCS)

Hole	Depth (m)		Moisture Content (%)	Dry Density	Bulk Density	Maximum Strength U.C.S. MN/m ²	
RC02	9.50	9.78	9.2	2.09	1.91	11.5	Weak
RC02	11.95	12.22	8.7	2.18	2.00	7.4	Weak

11.1.9 The point load tests are summarised below:

Table16: Summary of Rock Core Point Load Results

Hole	Depth (m)	Axial / Diametrical	Moisture Content (%)	Point Load Index Is(50) MN/m ²	Assessed Unconfined Compressive Strength (MN/m ²)	Strength Descriptor
RC01	6.85	d	13.1	0.11	2.4	Very Weak
	7.86	d	9.4	0.11	2.4	Very Weak
RC02	8.40	d	9.1	0.36	7.9	Weak
	8.65	d	10.5	0.12	2.6	Very Weak
		d	10.1	0.15	3.3	Very Weak
		a	11.0	0.19	4.2	Very Weak
		a	10.3	0.24	5.3	Weak
	9.20	d	9.1	0.20	4.4	Very Weak
	9.90	d	9.8	0.31	6.8	Weak
	10.00	d	9.3	0.15	3.3	Very Weak
RC03	13.1	d	9.7	0.65	14.3	Weak
	5.65	d	10.9	0.06	1.3	Very Weak
	7.65	d	9.2	0.23	5.1	Weak
Minimum			9.1	0.06	1.3	Very Weak
Average			10.1	0.22	4.8	Weak
Maximum			13.1	0.65	14.3	Weak

- 11.1.10 The rock core UCS test results of 7.4 and 11.5 MN/m² is at the upper end of the range from the point load tests because the samples for UCS testing tend to be the better quality sandstone because the required larger samples required for the test means these tend to be the better rock.
- 11.1.11 It should be noted that sections of extremely weak sandstone were also encountered, however these sections were difficult to sample for testing. There were also the beds of mudstone present which were too thin to test and are again of lower strength than the sandstone which was tested.

11.2 Trees

- 11.2.1 Numerous mature trees were located on or adjacent to the site boundaries, as well as along hedges within the site and as copses. A comprehensive tree survey of those trees within the site boundary, and up to 20m beyond the site boundary (assuming mature high water demand trees are not present along the boundary) will be required to determine the effect of existing trees to proposed development.
- 11.2.2 It is not known whether any Tree Preservation Orders are applicable to any trees within the development area, Discussions should also be held with the council's tree preservation officer to determine whether there are any tree preservation orders on the site. Any proposed felling or removal of trees or hedgerows should be agreed with the Local Authority as part of the pre-planning discussions for development and should be carried out outside the bird nesting season (it may be possible that tree felling can be carried out during the bird nesting season under the direction of an ecologist).
- 11.2.3 Care must be taken to ensure that any existing trees scheduled for retention are not adversely affected by construction operations. Further guidance on this aspect of site works is given in the British Standards "Guidance for Trees in Relation to Constructions", BS5837.

11.3 Foundation Recommendations

- 11.3.1 The proposed development is for a 6 story structure with high column loads and will not have a basement, therefore the foundations will have to be piled into the sandstone bedrock.
- 11.3.2 It should be noted that brick foundations from previous buildings were encountered at 0.9m in one area of the site. Obstructions like this should be taken into account during the piling works and pre-excavation across the whole area to the top of the natural deposits is recommended in order to remove any potential obstructions.
- 11.3.3 A specialist piling contractor should be contacted with regards to the selection of appropriate pile design and construction method. Geotechnical information within this report should be provided to give design parameters. However, given the proximity of the adjacent buildings and potential issues with noise and vibration it is anticipated that

either rotary bored piles or CFA piles will be suitable and with care there should not be significant problems with vibration and noise will be lower than for driven piles.

- 11.3.4 The piles should be designed to take into account of potential heave from the natural clay which could swell/heave after the trees have been removed. Note that the clay was desiccated with the moisture content 2% lower than the plastic limit.
- 11.3.5 According to the BGS mapping for the area, there is a normal fault located approximately 17m from the western site boundary, orientated NW-SE. It is possible (however unlikely) that this fault could lie below the site and form a zone of lower strength and more fractured rock than encountered in the three rotary holes drilled as part of the investigation. Therefore if the piles intersect the fault it is likely that the piles will have to be deeper where the fault is intersected.
- 11.3.6 An assessment of the risk to groundwater from carrying out piling at this site has been carried out in accordance with Environment Agency guidance and this indicates that the piling will not cause a significant risk to groundwater at depth within the underlying Principal Aquifer and no mitigation measures are required for the piling in relation to protection of the aquifer.
- 11.3.7 It is recommended that suspended ground floors are adopted for the building to prevent any effects of heave on the ground floor slabs.
- 11.3.8 Any piling works undertaken from existing ground levels will require a suitable piling mat/platform constructed in accordance with BRE Report 470 (2004). A geotextile may be incorporated into the platform to reduce the required thickness and the platform could be designed as part of the engineering fill required for any earthworks to alter final site levels

11.4 Groundwater & Excavations

- 11.4.1 It is not expected that groundwater will be encountered in any excavations at this site but limited seepages could be encountered at the base of the Made Ground after periods of heavy rain. It is anticipated that any groundwater in excavations can be controlled by sump pumping. If inflows are relatively localised, this may cause softening/slumping of the ground and require localised excavation support in order to prevent instability of the sides of excavations.
- 11.4.2 When planning any excavations the presence of the adjacent buildings should be taken into account to ensure that there is no adverse effect. All excavations should be carried out in accordance with CIRIA Report 97 “Trenching Practice” and BS6031: 2009: Code of Practice for Earthworks. Further guidance on this aspect of site works is given in the British Standards for “Workmanship on Building Sites”, BS 8000, Parts 1 and 14, and in the Construction Industry Training Board’s Site Safety Note 10.

11.5 Buried Concrete and Pipework

- 11.5.1 The results of laboratory pH and sulphate content indicate that ACEC Class AC-1s conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore no special precautions are required at the site for the design of concrete in terms of the durability and structural performance.

12. CONCLUSION

12.1 Environmental Risk Assessment

- 12.1.1 A preliminary risk assessment has been carried out based on the contaminant-pathway-receptor model as defined in Statutory Guidance to Part IIA of the Environment Protection Act, 1990, and in accordance with BS 10175: 2011 +A1 2013 “Investigation of Potentially Contaminated Sites – Code of Practice”. In order to make a more detailed assessment of the potential hazards, a Phase 2 intrusive investigation was carried out to develop a more comprehensive conceptual ground model of the site. This detailed the characteristic ground conditions and elements of the surrounding environment and has assisted with identifying the potential contaminants of contamination, the potential receptors of the contamination and the potential pathways between them.
- 12.1.2 The results of the risk assessments indicate that there is no significant source of contaminants present at the site so there is a negligible risk to all receptors including humans, controlled waters and ecological receptors.
- 12.1.3 The building should be designed to meet the requirements of Characteristic Situation 2 ground gas conditions. No specific precautions are required with respect to radon or hydrocarbons vapours for the development. Further gas monitoring is required to fully assess the ground gas risk but it is unlikely that this will show an increased level of risk above Characteristic Situation 2 conditions.
- 12.1.4 There is a small mound area <1.0m within the area of the proposed development. This material along with soil from other excavations will require removing from the site. The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that none of the materials encountered during the investigation can be classified as hazardous. One WAC test has been carried out from within the mound area (HD1). There is only one result which exceeds the inert waste limit due to fluoride. Therefore the Made Ground may be disposed of at a landfill site which has an Environmental Permit for non-hazardous waste. It should be able to sort and segregate the waste materials so that some of it can be disposed as inert waste (e.g. bricks etc.) with the fines disposed of as non-hazardous material. All the natural soils will be classified as being inert waste.
- 12.1.5 As an alternative location for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Environmental Permits for site Reclamation and can accept certain categories of inert and non-hazardous wastes.

12.2 UXO Risk Assessment

- 12.2.1 The historical mapping has shown that the site during WWII was partially a road in southern part of the site and residential properties and rear gardens in the northern half of the site. The historical mapping has shown there has been little to no change on the site before and immediately after WWII. This further limits the likelihood of undiscovered UXOs on the site.
- 12.2.2 The site is underlain by thin drift deposits (approx.4m) overlying sandstone bedrock. The shallow rockhead would indicate that aerial German WWII bombs are more likely to have detonated on impact and are unlikely to be buried under the site. It is likely that the site would also have been inspected for UXB entry holes following any raids further reducing the likelihood of rediscovered UXOs.
- 12.2.3 Taking into consideration the findings of this study, TerraConsult assess the overall risk across the site is low. Notwithstanding the assessed level of risk, it is recommended that during the construction phase of the proposed development the following measures are implemented:
- **Operational UXO Risk Management Plan:** appropriate site management documentation should be held on site to guide and plan for the actions which should be undertaken in the event of a suspected or real UXO discovery
 - **Site Specific Explosive Ordnance Safety and Awareness Briefings:** These should be to all personnel conducting intrusive works: It is an essential component of the Health & Safety Plan for the site and conforms to requirements of CDM Regulations 2015. All personnel working on the site should be instructed on the potential risk from UXO, actions to be taken to alert site management and to keep people and equipment away from the hazard.
 - **The Provision of Unexploded Ordnance Site Safety Instructions:** The Construction Phase Plan should contain information detailing actions to be taken in the event that possible unexploded ordnance is discovered. They are to be retained on site and will both assist in making a preliminary assessment of a suspect object and provide guidance on the immediate steps to be taken in the event that ordnance is believed to have been found.

12.3 Geotechnical Design

- 12.3.1 There are no known geotechnical hazards associated with mining or quarrying at the site. The proposed development is for a 6 story structure with high column loads and will not have a basement, therefore the foundations will have to be piled into the sandstone bedrock.
- 12.3.2 It should be noted that brick foundations from previous buildings were encountered at 0.9m in one area of the site. Obstructions like this should be taken into account during the piling works and pre-excavation across the whole area to the top of the natural deposits is recommended in order to remove any potential obstructions.

- 12.3.3 A specialist piling contractor should be contacted with regards to the selection of appropriate pile design and construction method. Given the proximity of the adjacent buildings and potential issues with noise and vibration it is anticipated that either rotary bored piles or CFA piles will be suitable and with care there should not be significant problems with vibration and noise will be lower than for driven piles.
- 12.3.4 The piles should be designed to take into account of potential heave from the natural clay which could swell/heave after the trees have been removed. Note that the clay was desiccated with the moisture content 2% lower than the plastic limit.
- 12.3.5 The assessed uniaxial compressive strengths of the sandstone are lower than for many areas of Liverpool. According to the BGS mapping for the area, there is a normal fault located approximately 17m from the western site boundary, orientated NW-SE. It is possible (however unlikely) that this fault could lie below the site and form a zone of lower strength and more fractured rock than encountered in the three rotary holes drilled as part of the investigation. Therefore if the piles intersect the fault it is likely that the piles will have to be deeper where the fault is intersected.
- 12.3.6 An assessment of the risk to groundwater from carrying out piling at this site has been carried out in accordance with Environment Agency guidance and this indicates that the piling will not cause a significant risk to groundwater at depth within the underlying Principal Aquifer and no mitigation measures are required for the piling in relation to protection of the aquifer.
- 12.3.7 It is recommended that suspended ground floors are adopted for the building to prevent any effects of heave on the ground floor slabs.
- 12.3.8 Based upon BRE Special Digest 1 (2005) all below ground concrete should be designed to meet the requirements of ACEC Class AC-1s. Any fill material to be imported onto the site should be tested and should not exceed the classifications given above.

12.4 Health and Safety

- 12.4.1 As outlined within the HSE publication “Successful Health and Safety Management – HSG65” this report should inform your development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.
- 12.4.2 In accordance with the Construction Design and Management (CDM) Regulations 2015, TerraConsult has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report TerraConsult has discharged and completed all contractual and legal requirements for these positions and we have no further involvement with the project.

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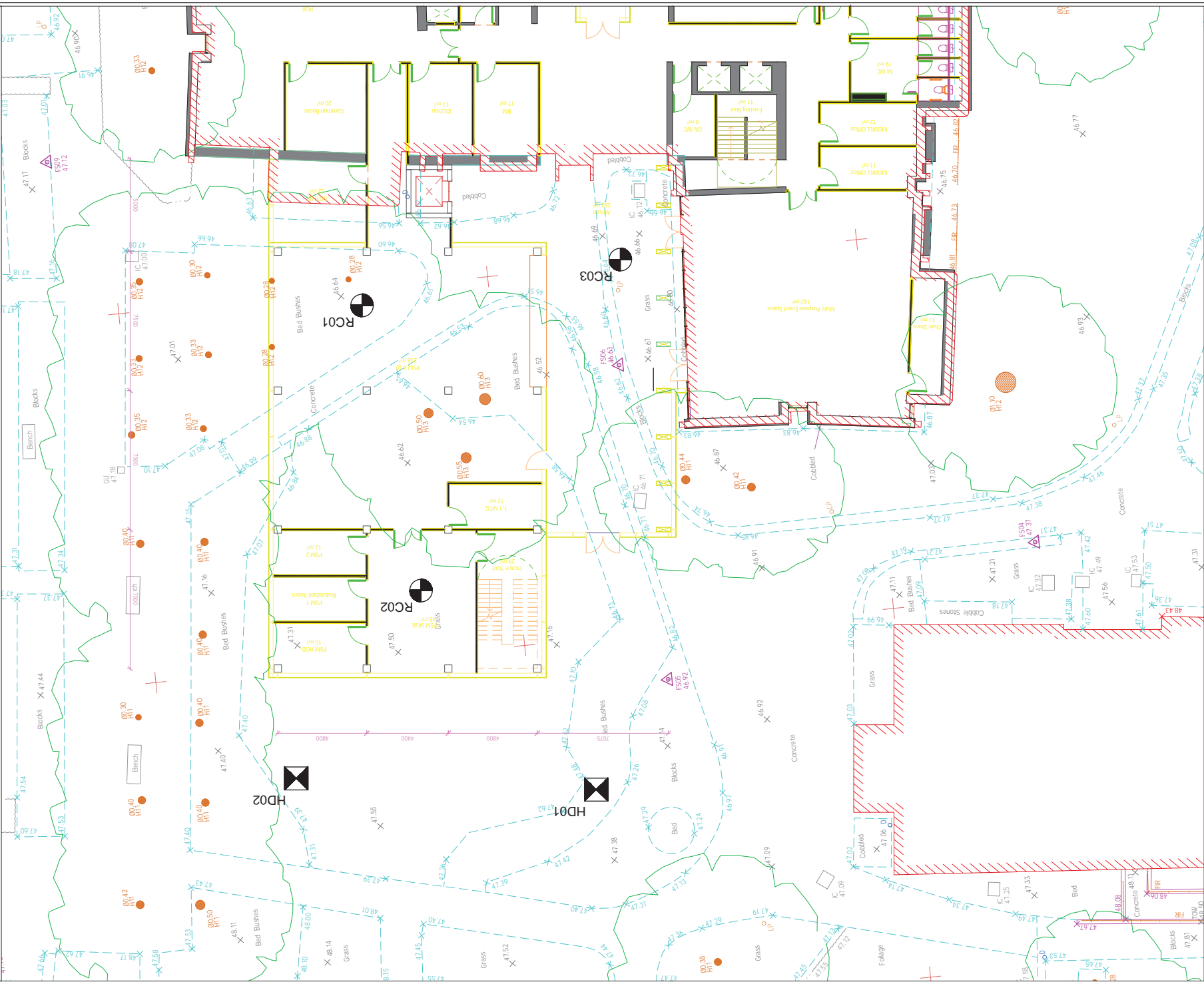
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DRAWINGS

List of Drawings

3571/1/001	Exploratory Hole Location Plan
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Key		HD02	TP Position
		RC01	BH Position
Client		Alan Johnson Partnership	
Site		Cypress Building Extension	
Title		Exploratory Location Plan	
Scale		1:16,000 @ A3	
Drawing No.		3571/1/001	
Rev		Date	
Description			
File		3571-1-001 - Cypress Building, Liverpool	
Date		10/1/17	
PP GH		Checked	
DRAFT			

APPENDICES

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APPENDIX A

Service Constraints, Report Limitations & Planning

Service Constraints, Report Limitations & Planning Requirements

This consultancy contract, report and the site investigation (together comprise the "Services") were compiled and carried out by TerraConsult Limited (TCL) for Liverpool University (the "client") on the basis of a defined programme and scope of works and the terms of a contract between TCL and the "client." The Services were performed by TCL with all reasonable skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by TCL taking into account the limits of the scope of works required by the client, the prevailing site conditions, the time scale involved and the resources, including financial and manpower resources, agreed between TCL and the client. TerraConsult Ltd cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered outwith the agreed scope of works.

Other than that expressly contained in the above paragraph, TCL provides no other representation or warranty whether express or implied, is made in relation to the Services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of TCL. If a third party relies on this report, it does so wholly at its own and sole risk and TCL disclaims any liability to such parties.

It is TCL's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without TCL's review and advice shall be at the client's sole and own risk.

The information contained in this report is protected by disclosure under Part 3 of the Environmental Information Regulations 2004 pursuant to the provisions of Regulation 12(5) without the consent in writing of a Director of TerraConsult Limited.

The report was written in November 2017 and should be read in light of any subsequent changes in legislation, statutory requirements and industry practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of TCL. In the absence of such written advice of TCL, reliance on the report in the future shall be at the client's own and sole risk. Should TCL be requested to review the report in the future, TCL shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between TCL and the client.

The observations and conclusions described in this report are based solely upon the Services that were provided pursuant to the agreement between the client and TCL. TCL has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report. TCL is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, TCL did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, radon gas or other radioactive or hazardous materials.

The Services are based upon TCL's observations of existing physical conditions at the site gained from a walkover survey of the site together with TCL's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst TerraConsult Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report. Further TCL was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. TCL is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to TCL and including the doing of any independent investigation of the information provided to TCL save as otherwise provided in the terms of the contract between the client and TCL.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and TCL] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

Throughout the report the term 'geotechnical' is used to describe aspects relating to the physical nature of the site (such as foundation requirements) and the term 'geoenvironmental' is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. The geoenvironmental sections are written in broad agreement with BS 10175:2011+A1 2013. For the geotechnical aspects of the report, the general requirements of Eurocode 7 (BS EN 1997-2:2007) are to produce a Ground Investigation Report (GIR) which shall form part of the Geotechnical Design Report (GDR). The geotechnical section of this report is intended to fulfil the general requirements of the GIR as outlined in BS EN 1997-2, Section 6. The GIR contains the factual information including geological features and relevant data, and a geotechnical evaluation of the information stating the assumptions made in the interpretation of the test results. This report shall not be considered as being a GDR.

Planning Requirements

The National Planning Policy Framework (NPPF, 2012) has twelve core land-use planning principles, two of which directly relate to the potential for pollution and contaminated land:

- Requirement to “*contribute to conserving and enhancing the natural environment and reducing pollution*” and setting out of a preference for developments to be on land of “*lesser environmental value*”; and
- “*encourage the effective use of land by re-using land that has been previously developed (brownfield land), providing that it is not of high environmental value.*”.

In accordance with the core principles of NPPF, Paragraph 109 clarifies that enhancing the natural environment includes:

- “*preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability; and*
- *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.*”.

Paragraph 121 of NPPF states that planning policies and decisions for developments should also ensure that:

- “*the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
- *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
- *adequate site investigation information, prepared by a competent person, is presented.*”.

This report has been prepared and authorised by staff that are competent as defined in the NPPF.

Unexploded Ordnance

Clients have a legal duty under the CDM 2015 Regulations to provide designers and contractors with project-specific health and safety information needed to identify hazards and risks. This includes the possibility of unexploded ordnance (UXO) being encountered on the site. Further details are given in CIRIA Report C681 (Stone et al 2009). A non-UXO specialist screening exercise has been carried out for the site by considering any evidence of UK defence activities on or near the site evident from the gathered desk study information and the unexploded aerial delivered bomb (UXB) regional risk maps produced by Zetica. Other data sources are available, but as a first stage screening exercise the freely available Zetica maps have been used. The level of risk stated is that determined by Zetica, a company experience in the desk study, field investigation and clearance of UXO/UXB.

APPENDIX B

Environmental Risk Assessment Methodology & Terminology

ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY & TERMINOLOGY

LEGISLATION OVERVIEW

This report includes hazard identification and environmental risk assessment in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a “suitable for use approach,” which is relevant to both the current use of land and also to any proposed future use. The contaminated land regime is the statutory regime for remediation of contaminated land that causes an unacceptable level of risk and is set out in Part 2A of the Environmental Protection Act 1990 (“EPA 1990”). The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

“any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:

- (a) Significant harm is being caused or there is a significant possibility of such harm being caused;*
- or*
- (b) Pollution of controlled waters is being, or is likely to be, caused.”*

In order to assist in establishing if there is a “significant possibility of significant harm” there must be a “contaminant linkage” for potential harm to exist. That means there must be a source(s) of contamination, sensitive receptors present and a connection or pathway between the two. This combination of contaminant-pathway-receptor is termed a “contaminant linkage or CPR linkage.”

Part IIA of The Environmental Protection Act 1990 is supported by a substantial quantity of guidance and other Regulations. Key implementing legislation of the Part 2A regime includes the Contaminated Land (England) Regulations 2006 (SI 2006/1380) as amended by the overarching legislation for the contaminated land regime, which implements the provisions of Part IIA of the Environmental Protection Act 1990 (as inserted by section 57 of the Environment Act 1995), came into force on 14th July 2000 together with recent amended regulations: Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263). Revised Contaminated Land Statutory Guidance was published by DEFRA in April 2012. Part IIA defines the duties of Local Authorities in dealing with it. Part IIA places contaminated land responsibility as a part of planning and redevelopment process rather than Local Authority direct action except in situations of very high pollution risk.

In the planning process guidance is provided by National Planning Policy Framework (NPPF) of March 2012 which requires that a site which has been developed shall not be capable of being determined “contaminated land” under Part IIA. In practice, Planning Authorities require sites being developed to have a lower level of risk post development than the higher level of risk that is required in order to determine a site as being contaminated in accordance with Part IIA. This is to ensure that there is a suitable zone of safety below the level for Part IIA determination and prevent recently developed sites becoming reclassified as contaminated land if there are future legislative or technical changes (e.g. a substance is subsequently found to be more toxic than previously assessed this increases its hazard).

The criteria for assessing concentrations of contaminants and hence determining whether a site represents a hazard are based on a range of techniques, models and guidance. Within this context it is relevant to note that Government objectives are:

- (a) to identify and remove unacceptable risks to human health and the environment;
- (b) to seek to bring damaged land back into beneficial use;
- (c) to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

These three objectives underlie the “suitable for use” approach to risk management and remediation of contaminated land. The “suitable for use” approach focuses on the risks caused by land contamination. The approach recognises that

the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Risks therefore should be assessed on a site-by-site basis.

The "suitable for use" approach then consists of three elements:

- (a) *ensuring that land is suitable for its current use* - in other words, identifying any land where contamination is causing unacceptable risks to human health and the environment, assessed on the basis of the current use and circumstances of the land, and returning such land to a condition where such risks no longer arise ("remediating" the land); the contaminated land regime provides the regulatory mechanisms to achieve this;
- (b) *ensuring that land is made suitable for any new use, as planning permission is given for that new use* - in other words, assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before official permission is given for the development and, where necessary to avoid unacceptable risks to human health and the environment, remediating the land before the new use commences; this is the role of the town and country planning and building control regimes; and
- (c) *limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought* - in other words, recognising that the risks from contaminated land can be satisfactory assessed only in the context of specific uses of the land (whether current or proposed), and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby running the risk of distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

The mere presence of contaminants does not therefore necessarily warrant action, and consideration must be given to the scale of risk involved for the use that the site has, and will have in the future.

OVERALL METHODOLOGY

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in the CLR 11 Model Procedures for the Management of Land Contamination (Environment Agency, 2004), and BS10175:2011+A1 2013. Important aspects of the risk assessment process are transparency and justification. The particular rationale behind the risk assessments presented is given in this appendix.

The first stage of a two-staged investigation and assessment of a site is the Preliminary Investigation (BS 10175:2011), often referred to as the Phase 1 Study, comprising desk study and walk-over survey, which culminates in the Preliminary Risk Assessment. A preliminary conceptual site model (CSM) is developed which identifies potential geotechnical and geo-environmental hazards and the qualitative degree of risk associated with them. From the geo-environmental perspective, the Hazard Identification process uses professional judgement to evaluate all the hazards in terms of potential contaminant linkages (of contaminant source-pathway-receptor). Potential contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and generic risk assessment.

The second stage is the Ground Investigation, Generic Risk Assessment and Geotechnical Interpretation. This represents the further assessment mentioned above. The scope of the Ground Investigation is based on the findings of the Preliminary Risk Assessment and is designed to reduce uncertainty in the geotechnical and geo-environmental hazard identification. The Ground Investigation comprises fieldwork, laboratory testing and usually also on-site monitoring. The Ground Investigation may include the Exploratory, Main and Supplementary Investigations described in BS 10175:2011+A1 2013. The results of the Ground Investigation reduces uncertainty in the geotechnical and geo-environmental risks. Depending on the findings more detailed investigations or assessments may be required.

PRELIMINARY RISK ASSESSMENT

Current practice recommends that the determination of potential liabilities that could arise from land contamination be carried out using the process of risk assessment, whereby “risk” is defined as:

- “(a) The probability, or frequency, or occurrence of a defined hazard; and*
- (b) The magnitude (including the seriousness) of the consequences.”*

The UK’s approach to the assessment of environmental risk is set out in by the Department of the Environment Transport and the Regions (2000) publication “A Guide to Risk Assessment and Risk Management for Environmental Protection” (also called Greenleaves II). This established an iterative, systematic staged process which comprises:

- (a) Hazard identification;
- (b) Hazard assessment;
- (c) Risk estimation;
- (d) Risk evaluation;
- (e) Risk assessment;

At each stage during the development process, the above steps are repeated as more detailed information becomes available for the site.

For an environmental risk to be present, all three of the following elements must be present:

- Source/Contaminant: hazardous substance that has the potential to cause adverse impacts;
- Receptor: target that may be affected by contamination: examples include human occupants/users of site, water resources (rivers or groundwater), or structures;
- Pathway: a viable route whereby a hazardous substance may come into contact with the receptor.

The absence of one or more of each component (contaminant, pathway, receptor) would prevent a contaminant linkage being established and there would be no significant environmental risk.

The identification of potential contaminant linkages is based on a Conceptual Model of the site, which is subject to continual refinement as additional data becomes available. As part of a Preliminary Risk Assessment (Desk Study and site walk over) a Preliminary Conceptual Site Model (PCSM) is formed. Based on the PCSM, potential contaminant linkages can be assessed. If the PCSM and hazard assessment indicate that a contaminant linkage is not of significance then no further assessment or action is required for this linkage. For each significant and potential linkage a risk assessment is carried out. The linkages which potentially pose significant risks may require a variety of responses ranging from immediate remedial action or risk management or, more commonly, further investigation and risk assessment. This next stage is termed a Phase II Main Site Investigation and should provide additional data to allow refinement of the Conceptual Site Model and assess the level of risk from each contaminant linkage.

Definition of Risk Assessment Terminology

The criteria used for risk assessment are broadly based on those presented in DETR’s “A Guide to Risk Assessment and Risk Management for Environmental Protection” (2000). The Severity of the risk is classified according to the criteria in Table B.1 below:

Table B.1 Severity/Consequence of Risk	
Severe	Acute risks to human health. Catastrophic damage to buildings/property (e.g. by explosion). Direct pollution of sensitive water receptors or serious pollution of other controlled water (watercourses or groundwater) bodies.
Medium	Harm to human health from long-term exposure. Slight pollution of sensitive controlled waters (surface waters or aquifers) or pollution of other water bodies. Significant effects on sensitive ecosystems or species.
Mild	No significant harm to human health in either short or long term. No pollution of sensitive controlled waters, no more than slight pollution of non-sensitive waters. Significant damage to buildings or structures. Requirement for protective equipment during site works to mitigate health effects.
Negligible	Damage to non-sensitive ecosystems or species. Minor damage to buildings or structures. No harm or pollution of water.

The probability of the risk occurring is classified according to criteria given in Table B.2 below:

Table B.2: Probability of Risk Occurring	
High likelihood	Contaminant linkage may be present, and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.
Medium/Reasonably Foreseeable	Contaminant linkage may be present, and it is probable that the risk will occur over the long term.
Low/Unlikely	Contaminant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Negligible/Not credible	Contaminant linkage may be present but the circumstances under which harm would occur are improbable.

An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in Table B.3 below:

Table B.3: Comparison of Severity and Probability					
		Severity			
		Severe	Medium	Mild	Negligible
Probability	High likelihood	Very High Risk	High Risk	Medium/Low Risk	Low Risk
	Medium/Reasonably Foreseeable	High Risk	Medium Risk	Low Risk	Near Zero
	Low/Unlikely	High/Medium Risk	Medium/Low Risk	Low Risk	Near Zero
	Negligible/Not credible	Medium/Low Risk	Low Risk	Low Risk	Near Zero

The various risk rankings provide guidance for recommended actions, whether this is:

- AR - Action Required, Remediation or mitigation or site investigation works required
- SIR - Site Investigation Required, further assessment is required.
- NAR - No Action Required.

A description of the evaluated risk is as follows:

Table B.4 – Description of the Classified Risks and Likely Action Required	
Evaluated Risk	Recommended Actions
Very High Risk	AR: There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	AR: Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the long term.
Medium Risk	SI: It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	NAR: It is possible that harm could arise to a designated receptor from an identified hazard, but there is a low likelihood of this hazard occurring and if realised, harm would at worst normally be mild.
Near Zero	NAR: There is a negligible possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

GENERIC QUANTITATIVE RISK ASSESSMENT

In the following sections the current UK guidance on risks to the following receptors are discussed: human health, plant life and controlled waters

• Human Health

The overall methodology for assessing the risk to human health from potential contaminants in soil is set out in the Environment Agency's guidance "Using Soil Guideline Values" SC050021/SGV Introduction, March 2009 and using the CLEA 1.06 model software (and CLEA 1.071 for nickel). The generic assessment criteria are in accordance with the following:

- Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil;
- Science Report SC050021/SR3: Updated technical background to the CLEA model;
- Science Report SC050021/SR4: CLEA Software (Version) Handbook;
- Toxicological reports and SGV technical notes;
- Toxicological data published by LQM/CIEH (2009) and CL:AIRE/EIC/AGS (2009)
- DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
- LQM/CIEH Suitable 4 Use Levels (S4ULs) for Human Health Risk Assessment
- Toxicology review published by the European Food Safety Authority for nickel (2015)

In March 2014 six 'proposed' Category 4 Screening Levels (pC4SL) were issued by Defra. These screening values are considered to be within Category 4 as defined in the Contaminated Land Statutory Guidance and indicate safe levels for new developments passing through the planning system. The SGV for lead has been withdrawn, and the pC4SL for lead has been derived using current best practice. In January 2015 LQM/CIEH published S4ULs for 89 contaminants in accordance with the C4SL methodology.

Note that groundwater contamination may pose a risk to human health but that there are no relevant generic assessment criteria available for comparison. TerraConsult has derived our own assessment criteria for this.

• Phytotoxic Risks

Generic assessment of phytotoxicity is by comparison with guideline values presented in the British Standard for Topsoil and the MAFF document "Code of Good agricultural practice for the protection of soil", October 1998. This is in accordance with CLR's reference to DEFRA notice CLAN 4/04.

- **Controlled Waters**

Risks to controlled waters (groundwater and surface waters) from contaminants are assessed in accordance with the EA documents “The Environment Agency’s Approach to Groundwater Protection” (2017) and Remedial Targets Methodology (RTM, 2006). Pollutant inputs from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Environment Agency’s ‘limit’ pollution objective. Acceptable water quality targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)). The risk posed to controlled waters from total soil concentrations cannot be directly assessed. The risk is assessed either by comparison of results of leachate tests carried out on soil samples, or from the direct testing of samples of groundwater to screening criteria. Leachate testing generally forms a conservative assessment and is not appropriate for organic contaminants.

CURRENT GUIDANCE ON INTERPRETATION OF CHEMICAL ANALYSIS OF SOILS

Contaminated land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995. This supports a ‘suitable for use’ based approach to the risk assessment of potentially contaminated land. The site specific risk assessment is based upon assessment of plausible contaminant linkages, referred to as the contaminant-pathway- receptor model, based upon the current or proposed use of the site.

Before undertaking a risk assessment a conceptual site model is devised in order to identify the potential contaminants, pathways and receptors. The individual contaminants, pathways and receptors then need to be further investigated in order to refine the initial assessment and risk assessment undertaken.

In March 2002, the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency published the Contaminated Land Exposure Assessment (CLEA) Model and a series of related reports. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. These reports (CLR7-10) together with associated “SGV” documents were withdrawn and the following documents have been published as revised guidance to the CLEA assessment:

- Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.
- Environment Agency : 2008: Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
- Environment Agency : 2008: Science Report SC050021/SR3: Updated technical background to the CLEA model.
- Environment Agency : 2008 : Compilation of Data for Priority Organic Contaminants for Derivation of Soil Guideline Values Science report SC050021/SR7
- Environment Agency : Science Report SC050021/SR4: CLEA Software (Version 1.05) Handbook.
- Environment Agency : CLEA Software Version 1.071, September 2015
- DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
- LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment

Additional guidance on statistical assessment replacing CLR 7 is partly provided in:

- CL:AIRE: 2009: Guidance on Comparing Data With a Critical Concentration

A different approach to the statistical appraisal of data is required depending on whether the assessment of risk is to assess whether land is Contaminated Land in accordance with regulations, or whether the assessment is to assess whether the site is suitable for new development in according with Planning guidance. This is discussed further in CL:AIRE: 2009 “Guidance on Comparing Data With a Critical Concentration”.

Soil Guideline Values

- heavy metals and other inorganic compounds: arsenic, cadmium, chromium, cyanide, lead (now withdrawn), mercury nickel (now withdrawn), and selenium;
- benzene, ethylbenzene, toluene and xylenes;
- phenol;
- dioxins and dioxin-like polychlorinated biphenyls (PCBs);
- polycyclic aromatic hydrocarbons (PAHs) – 11 substances.

In addition CIEH through LQM and the EIC have published generic assessment criteria (GACs) for a wide variety of other parameters including metals, hydrocarbons, chlorinated aliphatic compounds, PAHs and explosive substances for three standard land uses. These have been produced to supplement the Environment Agency guidance. These GACs will be replaced by SGVs when or if the Environment Agency publishes any more SGVs.

The diagram illustrates four scenarios of exposure pathways and migration of contamination:

- Scenario 1 (Indoor):** A person is seated at a table, eating contaminated vegetables and soil adhering to them. This leads to **Ingesting dust** and **Inhaling indoor dusts and vapours**. **Rising vapours** are shown moving upwards.
- Scenario 2 (Indoor):** A person is standing and handling soil. This leads to **Inhaling indoor dusts and vapours**. **Tracking back of soil/dust from garden into house** is shown as a wavy arrow entering the house. **Skin contact with dust** is indicated.
- Scenario 3 (Outdoor):** A person is standing in a garden. This leads to **Ingesting soil** and **Inhaling outdoor dusts and vapours**. **Rising vapours** are shown moving upwards. **Skin contact with soil** is indicated.
- Scenario 4 (Outdoor):** A person is standing near a fence. **Wind-blown dust** is shown as a wavy arrow moving towards the person. **Plant uptake** is indicated by arrows pointing into the ground.

Legend:

- Exposure Pathways
- ~ Migration of contamination

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- ingestion of indoor dust;
- ingestion of home grown vegetables;
- ingestion of soil attached to home grown vegetables.
- **Dermal Contact**
 - dermal contact with outdoor soil;
 - dermal contact with indoor dust.
- **Inhalation**
 - inhalation of outdoor dust;
 - inhalation of indoor dust;
 - inhalation of outdoor soil vapour;
 - inhalation of indoor soil vapour.

It should be noted that there are other potential exposure pathways on some sites not included in the CLEA model e.g. certain organic compounds can pass through plastic water pipes into drinking water supply.

The presence and/or significance of each of the above exposure pathways are dependent on the type of land use being considered and the nature of the contaminant under scrutiny. Accordingly, the CLEA model considers for principle 'default' land use types and makes a series of 'default' assumptions with regard to human exposure frequency, duration and critical human target groups for each land use considered:

- residential land use;
- allotments;
- commercial and industrial land use.

The land use categories defined in the CLEA are detailed below.

Residential: This land use category assumes that people live in a variety of dwellings including terraced, detached and semi-detached houses up to two storeys high. The structure of buildings varies. Default parameters for building materials and building design are included in CLEA documents to calculate the relevant multi-layer diffusion coefficients for vapour intrusion and to model indoor vapour intrusion. The CLEA model assumes that regardless of the style of housing the residents will have access to either a private garden or community open space nearby, and that soil tracked into the home will form indoor dust. It allows for the ingestion pathways from home grown vegetables.

Allotments: The CLEA model incorporates an assessment of land provided by local authorities specifically for people to grow fruit and vegetables for their own consumption. Consumption of such fruit and vegetables present several exposure pathways; plants absorb contaminants mainly via water uptake through roots, the contaminants move to edible portions of plants via translocation and contaminated soil particles become trapped in the skin and between leaves. At present the model fails to account for exposure through the consumption of animals, and their products (e.g. eggs), which have been reared on contaminated land.

Commercial/Industrial: Although there are a wide variety of workplaces and work-related activities, the CLEA assessment of this land-use assumes that work occurs in a permanent, three-storey structure, where employees spend most time indoors, conducting office-based or light physical work. The model assumes employees sit outside during breaks for most of the year. Limitations in applying this land-use to different industries is detailed in EA publication "Updated technical background to the CLEA model" (2011). The generic model assumes that the site would not be covered by hard standing. Risk of exposure to contaminants would be clearly less where commercial land is essentially all buildings and hard standing.

Based on the assumptions of each land use and the associated applicable exposure pathways, a 'Soil Guideline Value' (SGV) may be calculated for each contaminant under consideration for a particular land use in order to determine whether certain contaminant soil concentrations pose a significant risk to human health. The primary purpose of the CLEA SGVs are as 'trigger values' – indicators to a risk assessor that soil concentrations below this level require no further assessment as it can be assumed that the soil is suitable for the proposed use. Where soil concentrations occur above the SGV then further assessment of the results is required. The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April

2012 provides new clarity on the assessment of risk where soil concentrations exceed the SGV. The guidance introduces a four stage classification system relating to concentration of contaminants and the assessed risk which indicates appropriate actions. Category 1 and 2 sites are classified as “Contaminated Land” as defined in Part IIA of The Environmental Protection Act (1990). Category 3 and 4 sites are not considered as “Contaminated Land” in accordance with the Act. This can be explained using the figure on the following page.

There are also difficulties in establishing soil concentrations of contaminants beyond which risks from exposure to these contaminants would be ‘unacceptable’ and that they would lead to “significant possibility of significant harm” as defined in Part IIA of The Environmental Protection Act (1990) and determine that the land is “contaminated.” This ultimately requires detailed ‘toxicological’ information of the health effects of individual contaminants and also a scientific judgement on what constitutes an ‘unacceptable’ risk. It is for local authorities or the Environment Agency to determine whether a particular site is contaminated land and it is for local Planning Authorities to determine whether land affected by contamination can be redeveloped.

Given the SGVs have been derived only for a limited number of contaminants and there was little prospect of further SGVs being published, two professional groupings have produced Generic Assessment Criteria (GACs) in accordance with the CLEA model for a large number of additional contaminants. These GACs were recognised in the new Contaminated Land Statutory Guidance (DEFRA, 2012) and have been produced as follows:

LQM/CIEH : 2009 Nathaniel CP, McCaffrey C, Ashmore MH, Cheng NPS GROUP, Gillett A, Ogden R & Scott D : 2009 . The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition). Land Quality Press, Nottingham.

CL:AIRE/EIC/AGS: 2009 : Soil Generic Assessment Criteria (GAC) for Human Health Risk Assessment. Contaminated Land: Applications in Real Environments, Environment Industries Commission & Association of Geotechnical and Environmental Specialists. December 2009.

Category 4 Screening Levels and LQM/CIEH Suitable 4 Use Levels

For new developments progressing through the planning regime, it is desirable that the soil concentrations are within Category 4 where there is a valid contaminant linkage. The upper boundary between Category 4 and 3 is not defined in the guidance. This boundary can also be better defined by carrying out a Detailed Quantified Risk Assessment (DQRA) and this is discussed later in this appendix.

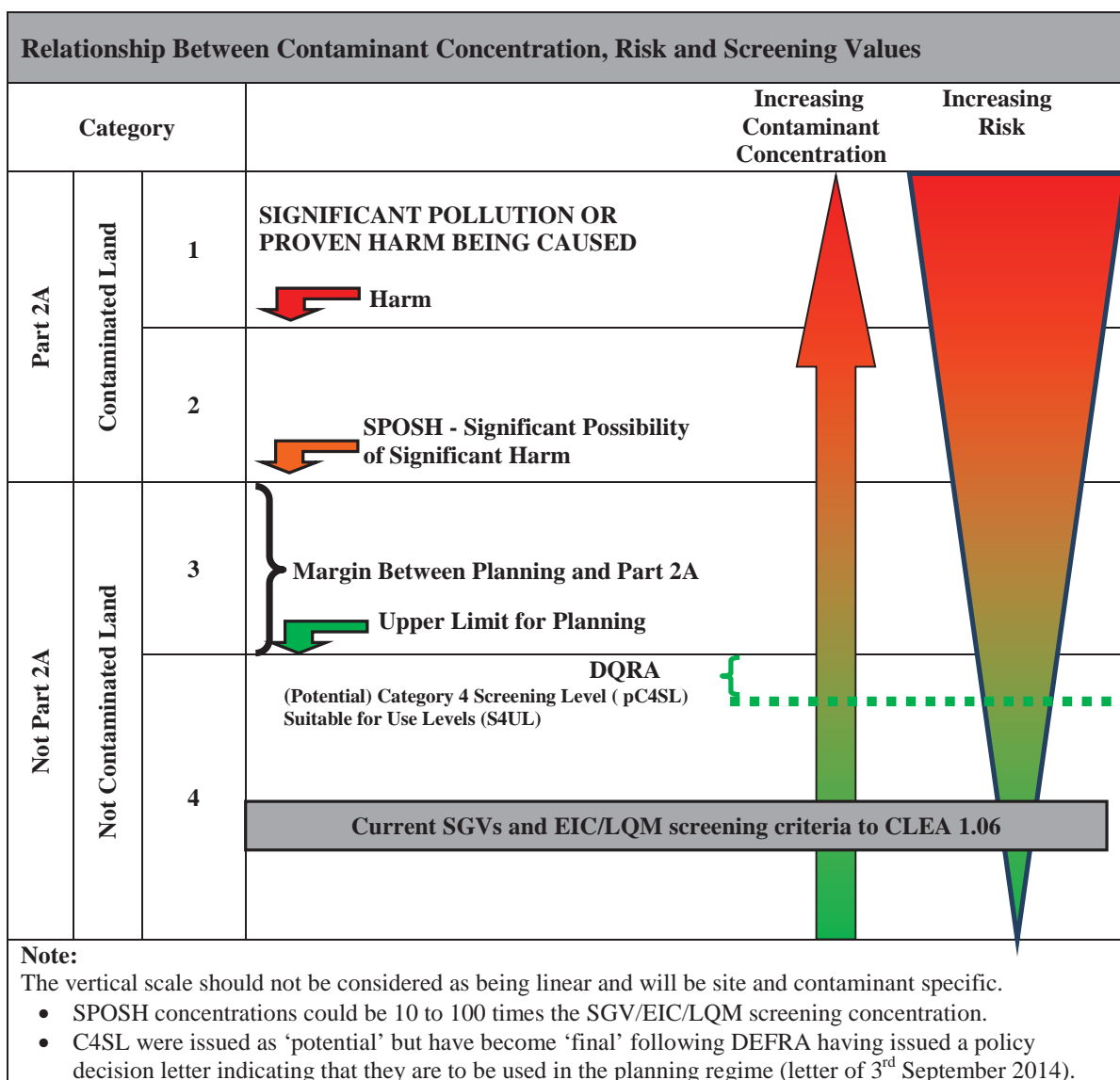
In December 2013 Defra issued the findings of a research project undertaken by CL:AIRE to set out the framework by which potential Category 4 Screening Levels (pC4SL) may be derived. The report was not designed to produce ‘final’ C4SL as the steering group producing the report believes that final C4SL should be set by a ‘relevant authority’ (e.g. Defra), the toxicological framework proposed has not been reviewed by the Committee on Toxicity and the document has yet to be subject to peer review.

In March 2014, appendices to the main Defra report were published detailing the derivation of pC4SL for 6 contaminants and other appendices regarding a review of the CIEH/CL:AIRE statistics guidance and sensitivity analysis. For each contaminant, a range of pC4SL have been produced relating to modifying toxicological parameters only, modifying exposure parameters only or by modifying both. It should be noted that the pC4SL produced for lead (the SGV was withdrawn in 2011) has undertaken a relatively large toxicological review in relation to modelling blood lead concentrations. pC4SL have been produced for:

- Arsenic;
- Benzene;
- Benzo(a)pyrene (as a surrogate marker for PAHs);
- Cadmium;
- Chromium (VI); and
- Lead

As previously discussed the values were initially published as ‘potential’ C4SL but have become ‘final’ following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014). It is considered that the pC4SL provide a simple test for deciding whether land is suitable for use without any remediation. The pC4SL represent a new set of screening levels that are more pragmatic (but strongly

precautionary) compared to the existing soil guideline values (SGVs and the other GACs calculate in accordance with the existing CLEA methodology). The pC4SL provide cautious estimates of contaminant concentrations in soil that are still considered to present an acceptable level of risk, within the context of Part 2A, by combining information on toxicology, exposure assessment and normal levels of exposure to these contaminants. pC4SL values should not be seen as 'SPOH values.' Exceeding a pC4SL means that further investigation is required, not that the land is necessarily contaminated. In January 2015, LQM published Suitable 4 Use Levels (S4ULs) for a further 89 contaminants using the Defra C4SL methodology. In a similar manner to the pC4SLs, no authoritative review has been undertaken although the approach and quality of the work undertaken is widely accepted as being of high quality.



Lead

The SGV for lead was withdrawn in 2011 and is not used in this report. The pC4SL for lead provides a technically robust and conservative assessment tool using significantly updated toxicological modelling in line with current scientific understanding of lead toxicology.

Nickel

The SGV for nickel was withdrawn in 2015 and is not used in this report. In-house GACs for nickel have been produced using the updated toxicological review by the EFSA and the CLEA 1.071 software.

Public Open Space

The Defra report (December 2013) has also introduced exposure scenarios for two other commonly occurring land uses which require assessment (under the planning and Part 2A regimes) on a relatively frequent basis. These exposure scenarios are:

- Public Open Space – Space Near Residential Housing (POS_{resi}); and
- Public Open Space – Public Park (POS_{park}).

Potential use of pC4SL relating to Public Open Space (POS) require care due to the significant variability in exposure characteristics. For example, POS may include:

- Children's play areas, public parks where children practise sport several times a week and teenagers only once a week;
- Grassed areas adjacent to residential properties which are rarely used;
- Dedicated sports grounds where exposure is only to players and groundworkers; and
- Nature reserves or open ground with low level activity (for example, dog walking).

Within the Defra report (December 2013) the following exposure scenarios have been modelled as these are considered the most important for potential exposure for the critical receptor i.e. young children:

- Green open space close to housing, including tracking back of soil (POS_{resi}); and
- Park-type scenario where distance is considered sufficient to discount tracking back of soil (POS_{park}).

Detailed Quantified Risk Assessment (DQRA)

SGVs, GACs, pC4SL and S4ULs are based on a number of basic assumptions. There are two main options for developing Site Specific Assessment Criteria (SSAC) by adjusting the CLEA model so that they have greater relevance to the site:

- **Simple adjustment of the generic SGV / C4SL model.** Such adjustment is restricted to the choice of exposure routes selected for the generic land use, building type, soil type and soil organic matter content within the CLEA software.
- **Detailed adjustment.** It may be relevant to make greater modifications to the model due to the specific use of the land in question. This can include modification to any parameter value, including exposure assumptions, building parameters, and the choice and application of fate and transport models. This is equally relevant to site-specific modifications of existing generic land uses, the development of new land uses, and the inclusion of additional exposure pathways. Much of this can be undertaken using the CLEA software. Depending on the complexity of the detailed adjustments required, it may be necessary to use other tools either alone or in conjunction with the CLEA software. Both options should follow established protocols for DQRA and require sufficient justification and supporting information for the adjustments made. Detailed adjustments are likely to require substantially greater technical justification and supporting documentation, especially if modifications are based on information not contained within the SGV framework documents.

The two choices present the risk assessor with three options/decisions:

- (1) Use a published SGV/GAC/pC4SL/S4UL if it can be demonstrated that the assumptions inherent in the value are appropriate to the site in question. If they are not, proceed to either option 2 or 3 below.

- (2) Make simple site-specific adjustments to the generic exposure model used to derive the SSAC. Three examples of when this could be appropriate are:
 - a. High density residential development with no exposed contaminated soil at surface. It is appropriate in this case to consider the relevance of direct contact pathways and consumption of homegrown produce.
 - b. Soil type is significantly different (specifically when soil type is likely to be less protective e.g. made ground) to that assumed in the SGV/GAC/pC4SL/S4UL.
 - c. Soil organic matter content is significantly different to that assumed in the derivation of the SGV/GAC/pC4SL/S4UL.
- (3) If simple adjustments are not sufficient to reflect site conditions, undertake a DQRA. This may be undertaken using the CLEA software or by using an alternative risk assessment methodology that is relevant, appropriate, authoritative and scientifically based. Changes to toxicological end points may also be considered, although this should only be undertaken by a toxicology expert. In the context of this guidance, simple adjustments of a generic land use scenario for soil type or SOM content for example are not considered sufficient to be classed as a DQRA.

DQRAs should be conducted with the agreement of the local authority (or the Environment Agency) since it is the authority that determines whether land is Contaminated Land or whether Planning Permission for a new development may be granted.

Representative Data

The type, quantity and quality of the available soil data influence the method chosen to obtain a site representative soil concentration that is compared with a SGV/GAC/pC4SL/S4UL in the screening process. The soil data should be representative of the exposure scenario being considered. This can include factors such as:

- averaging area over which exposure occurs;
- sample depth;
- heterogeneity of soil

where the 'averaging area' is defined as:

That area (together with a consideration of depth) of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions'.

Site investigations take discrete samples from a given area (and to a certain depth). It has to be assumed that these samples are to some degree representative of the contaminant concentration throughout that volume of soil. The critical soil volume (taking into account area and depth) which might be usefully compared with a SGV/GAC/pC4SL/S4UL is a site-specific decision, but a starting point is the generic land use scenarios used in the derivation of the SGV/GAC/pC4SL/S4UL. The critical soil volume depends on two factors:

- Contaminant distribution and vertical profile (bands of highly contaminated material or lateral hot spots should not necessarily be averaged out with more extensive cleaner areas of soil without justification)
- Contribution to average exposure underpinning the SGV. Direct contact exposure pathways depend on the adult or child coming into contact with near-surface soils and the area over which that exposure occurs is usually important (i.e. the averaging area). Vapour pathways are less dependent on surface area, for example vapour intrusion may result from a highly concentrated hot spot beneath a building leading to elevated average indoor air concentrations. For the three standard land uses for which SGVs are derived, relevant considerations are:
 - For the standard **residential or allotment land use**, the critical soil volume is the area of an individual garden, communal play area or working plot from the surface to a depth of between 0.5m and 1.0m. This is the ground over which children are most likely to come into contact with soil or from which vegetable and

fruit produce will be harvested. In the case of volatile contaminants, it may also be appropriate to consider the volume of soil underneath the footprint of the building although vapour intrusion may be driven by a soil volume much smaller than this if the contaminant source is highly concentrated.

- For the standard **commercial land use**, the critical soil volume has to be decided on a case-by- case basis due to the wide range of possible site layouts. However, for non-volatile contaminants, landscaped and recreational areas around the perimeter of office buildings are likely to be most important. For volatile contaminants, the footprint occupied by the building itself should also be considered.
- For **most exposure pathways**, the contamination is assumed to be at or within one metre of the surface.

The use of averaging areas must be justified on the basis of relevance to the exposure scenario. SGVs are relevant only when the exposure assumptions inherent in them are appropriate for the identified exposure averaging area. Further guidance on critical soil volumes and the consideration of averaging exposure areas can be found in:

- *Secondary model procedure for the development of appropriate soil sampling strategies for land contamination* (Environment Agency, 2000);
- *Guidance on comparing soil contamination data with a critical concentration* (CIEH/CL:AIRE, 2009); and
- *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Appendix I* (Defra December 2013, March 2014)

It is the mean soil concentration for the individual contaminant within an individual averaging area, which is compared to the SGV. However, as contaminant concentrations vary across a site, and sampling and analysis will introduce measurement errors, the comparison between measured mean concentration and the SGV must take this uncertainty into account.

There are two principal options available to obtain site representative soil concentrations from a site investigation dataset; statistical and non-statistical methods. Data objectives, quality and quantity are likely to determine which approach is most appropriate. If statistical methods such as those presented in CIEH/CL:AIRE (2011) are to be used, sufficient data need to be available or obtained. No one single statistical approach is applicable to all sites and circumstances. The wider range of robust statistical techniques developed by organisations including the US Environmental Protection Agency (USEPA) are also important tools. Risk assessors should choose an appropriate statistical approach on the basis of the specific site and the decision that is being made. For further guidance on the appropriate use of statistical approaches, refer to USEPA 2006 or good environmental monitoring statistics textbooks.

When statistical approaches are inappropriate (this will depend on the objectives of the site investigation), individual or composite samples should be compared directly to the SGV. Guidance on use of alternative data handling approaches such as the use of composite sampling can be found in documents such as:

- *Verification of remediation of land contamination* (Environment Agency, 2010);
- *Sampling and testing of wastes to meet landfill Waste Acceptance Criteria* (Environment Agency, 2005);
- *Guidance on choosing a sampling design for environmental data collection* (USEPA, 2002);
- *Soil Quality – Sampling, ISO 10381 series* (ISO, 2002–2007).

The statistical tests should not be used as arbiters for decisions under Part 2A. They are an additional, useful line of evidence to assist in decision-making. The implications of the basis for the derivation of the site representative soil concentration must be taken into account in any decision-making process and clearly documented.

Where the statistical tests are conducted in accordance with the method described in CL:AIRE 2009:

- For the Planning situation, it has to be demonstrated that the concentration of contaminants is low compared to the pC4SL/S4UL or SSAC. All of the test data should be below the screening criteria and no statistical analysis is required or if there are exceedances of the criteria then a statistical assessment is required. For the statistical assessment this decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is lower than the screening criteria.

- For the Part 2A scenario the regulator needs to determine whether the concentration of contaminants is greater than the SGV/GAC/pC4SL/S4UL or SSAC. This decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is higher than the SSAC. However, the regulator may proceed with determination if there is just a 51% probability, “on the balance of probabilities.”

If the screening levels are exceeded then more sophisticated quantitative risk assessment can be undertaken or remedial action may be taken to break the contaminant linkages. The benefits of undertaking a quantitative risk assessment must be weighed against the likelihood that it will bring about cost savings in the proposed remediation. Further information about the use of soil guideline values is provided in Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.

GENERIC RISK ASSESSMENT CRITERIA FOR RISK TO PLANTS

Soil contaminants, if present at sufficient concentrations, can have an adverse effect on the plant population. Phytotoxic effects can be manifested by a variety of responses, such as growth inhibition, interference with plant processes, contaminant-induced nutrient deficiencies and chlorosis (yellowing of leaves). All chemicals are probably capable of causing phytotoxic effects. Thus the phytotoxic potential of substances is dependent on the concentrations capable of having adverse effects on plants and the concentrations likely to be found at contaminated sites. Phytotoxicity is a difficult parameter to quantify given that experimental techniques vary widely and variations exist in plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Contaminants may be taken up and accumulated by plants through a range of mechanisms. The principal pathways are active and/or passive uptake through the plant root, adsorption to root surfaces and volatilisation from the soil surface followed by foliar uptake. After plant uptake, contaminants may be metabolised or excreted, or they may be bioaccumulated and this is highly species dependant. Many of the substances capable of adversely affecting vegetation exert this effect because of their water solubility, a characteristic that could result in their transport from contaminated sites into adjacent locations where the chemical may generate a phytotoxic response. This could be important if, for example, the adjacent site has important conservation status.

The concentration in soil at which substances become phytotoxic depend on a range of factors including plant type, soil type, pH, the form and availability of the contaminant and other vegetation stress factors that may be present (such as drought). Some plants (including some rare plants will only grow in soils where there are relatively high concentrations which would be phytotoxic to other species. Whilst many contaminants may be phytotoxic, data are limited. Some heavy metals are essential as trace elements for plant growth but may become toxic at higher concentrations.

TerraConsult has carried out a review of a number of current and former guidance documents and other texts on phytotoxicity. It is not possible to produce a definitive list of phytotoxic substances on account of the variables mentioned above. However, a number of metals are repeatedly cited as commonly occurring priority pollutants. As a result, the following list is adopted by TerraConsult as indicators of the potential for phytotoxicity: As, Cr, Cu, Ni and Zn (note that Boron has been excluded from this list because the more modern studies do not assess this).

As the CLEA framework is a risk based approach, applied to humans, an alternative strategy is required to assess the risk to plants from substances that are phytotoxic. Reference to published criteria and background concentrations can help put site data into context. Published assessment criteria for the protection of plant life from a number of countries are given in the following Table. The most authoritative source is the British Standard for topsoil, but this only lists three elements. CLR 11 states that the ICRCL Guidance Note 70/90 can be used for initial screening criteria. This approach has been adopted by TerraConsult where BS3882 is lacking, but where an ICRCL 70/90 criterion is lacking, the lowest criterion in Table below from, firstly UK, and, secondly, European and then other worldwide criteria. The adopted criteria are highlighted in the table 3.8. The MAFF value of 250 mg/kg has been chosen for As over the ICRCL value of 50 mg/kg as MAFF explains the 50 is applicable to vegetables and human health, whereas 250 is applicable to the plants themselves.

Table B.5: Published Assessment Criteria for Phytotoxic Elements (mg/kg)							
Reference	As	CR (Total)	Cr (III)	Cr (VI)	Cu	Ni	Zn
British Standard for topsoil (BS3882:2007)	-	-	-	-	200 (pH >7) 135 (pH 6-7) 100 (pH 5.5-6.0)	110 (pH >7) 75 (pH 6-7) 60 (pH 5.5-6.0)	300 (pH >7) 200 (pH 6-7) 200 (pH 5.5-6.0)
MAFF Code of Good Agricultural Practice for the Protection of Soil (1998)	250	-	400 for sites containing sewage and sludge	-	500 (grass) but may fall to 250 for clover and sensitive species (at pH >6)	110 (pH >7) 75 (pH 6-7) 60 (pH 5.5-6.0)	1000 (clover & grass at pH 6), may fall to 300 for sensitive species (at pH 6-7)
ICRCL 59/83 (1987) now withdrawn for human health assessment	-	-	-	-	130	70	300
ICRCL 70/90 (1990) threshold trigger value	50	-	-	25 *	250	-	1000
Dutch ecotoxicological intervention value (Swartjes 1993 & 1994)	40	230	-	7	190	-	-
Australian Guideline B(1) (1999), Interim Urban Ecological Investigation Level (EIL). Soils not generally considered phytotoxic below these EILs.	20	-	400	1	100	60	200
New Zealand guidelines for timber treatment sites (1977), estimated based on Cu bioavailability *	-	-	-	-	500 - 1000 clay soils	-	-
New Zealand guidelines for timber treatment sites (1977), soil criteria for protection of plant life (residential/ agricultural setting)	10-20	-	600	25	130	-	-
Note: * Cr (VI) is only likely to be present in as a significant proportion of total Cr where pH >12 so this does not routinely need to be tested for regarding plant health.							

CURRENT GUIDANCE FOR CONTROLLED WATERS RISK ASSESSMENT

Summary of Regulatory Context

Government policy is based upon a “suitable for use approach,” which is relevant to both the current use of land and also to any proposed future use. When considering the current use of land, Part IIA of the Environment Protection Act 1990^[4] (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995^[5], which came into force in England on 1 April 2000. The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health, controlled waters or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

“any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:

- (a) Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- (b) Pollution of controlled waters is being, or is likely to be, caused.”*

Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as:

*“the entry into controlled waters of **any** poisonous, noxious or polluting matter or **any** solid waste matter”*

Part IIA is supported by a substantial quantity of guidance and other Regulations, especially for England, The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012. The document re-confirms the duties of Enforcing Authorities in dealing with contamination including the role of the Environment Agency which has powers under Part 7 of The Water Resources Act (1991) to take action to prevent or remedy the pollution of controlled waters, including circumstances where the pollution arises from contamination in the land.

Part IIA introduces the concept of a contaminant linkage; where for potential harm to exist there must be a connection between the source of the hazard and the receptor via a pathway. Risk assessment in contaminated land is therefore directed towards identifying the contaminants, pathways and receptors that can provide contaminant linkages. This is known as the contaminant-pathway-receptor link (CPR or contaminant linkage).

Part IIA places contaminated land responsibility as a part of the planning and redevelopment process rather than Local Authority or Environment Agency taking direct action except in situations of very high pollution risk or where harm is occurring. In the planning process guidance is provided by National Planning Policy Framework (NPPF) of March 2012. This requires that a site which has been developed shall not be capable of being determined “contaminated land” under Part IIA. Therefore, appropriate risk-based investigation is required to identify the contaminant linkages that can then be assessed, and then mitigated using methods that can be readily agreed with the planners.

Environment Agency Guidance

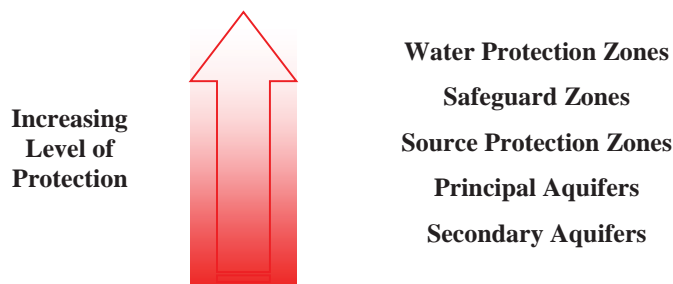
Legislation and guidance surrounding the protection of controlled waters in the UK is numerous and can be complex. The Environment Agency’s overall position on groundwater is “*To protect and manage groundwater resources for present and future generation in ways that are appropriate for the risks that we identify*” (The Environment Agency’s Approach to Groundwater Protection, 2017). In brief, the core objectives of the existing legislation serve to enforce this position.

In 1992, the National Rivers Authority published their Policy and Practice for the Protection of Groundwater (PPPG), this document was influential as it provided a focus for key developments such as Source Protection Zones (SPZs) and Groundwater Vulnerability Maps. The Policy was then revised in 1998, since which there have been substantial changes in legislation, driven by Europe. Key European Directives relating to groundwater include the Groundwater

Directive (80/68/EEC) and the Water Framework Directive (2000/60/EC). Aspects of these directives are controlled by primary UK legislation such as the Water Resources Act 1991 as amended by the Water Act 2003. Further to legislative changes, gaps identified in the 1998 PPPG required addressing. These changes are reflected in the Environment Agency Policy document *The Environment Agency's Approach to Groundwater Protection* of March 2017. The following diagram indicates the three main parts of this approach:



The Environment Agency follows a tiered, risk based approach to drinking water protection and this should be taken into account when carrying out controlled waters risk assessment:



Tools available for Risk Assessment of Controlled Waters

In order for a developer of a potentially contaminated site to fulfil their obligations under the legislation, a site assessment would be required to be undertaken in order to identify any potential risks to controlled waters and to derive suitable clean-up criteria if necessary to ensure the protection of controlled waters. A number of tools are available for this purpose.

Three main stages apply to any risk assessment of controlled waters, these are:

- i) Risk Screening (devise Conceptual Site Model, making reference to groundwater vulnerability maps, site setting etc)
- ii) Generic Risk Assessment (using the EA Remedial Targets Methodology – Tier 1 - Comparison of groundwater data with relevant standards)
- iii) Detailed Quantitative Risk Assessment (Consideration of aquifer properties and site specific parameters, using the EA Remedial Targets Methodology - Tiers 2 & 3)

The process is summarised below (Taken from the Environment Agency GP3 draft consultation document, 2006):

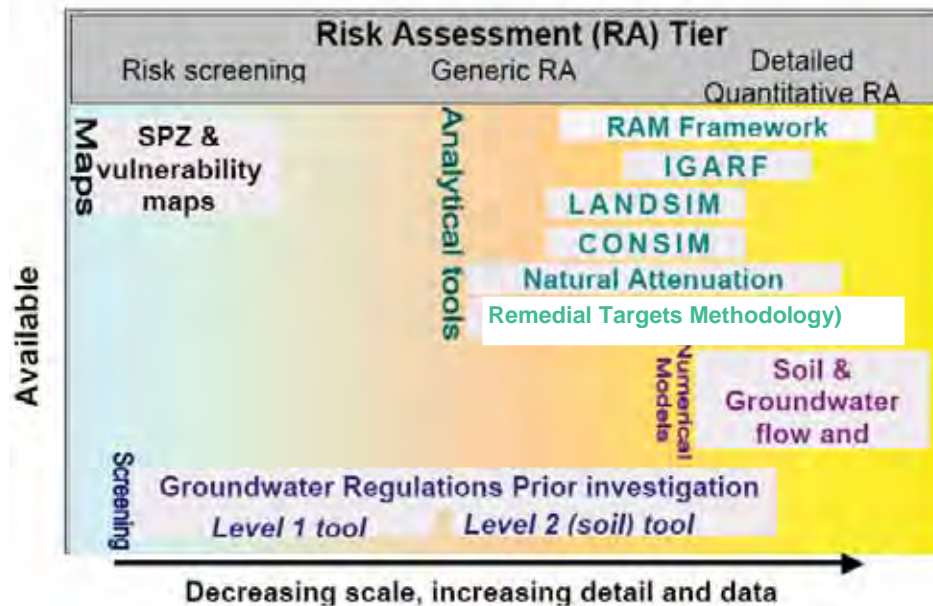


Figure 1-1 Environment Agency groundwater assessment tools, mapped against the different levels of risk assessment.

When assessing groundwater impact the Environment Agency advocate the application of their framework methodology “Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination” Environment Agency (2006). The methodology has four tiers of assessment:

Tier 1 utilises either a soil concentration (calculation of pore water concentrations based on partitioning calculations), leaching test or pore-water concentration of perched water as a source concentration input and these are contrasted directly to water quality standards. No dilution or attenuation is considered at Level 1.

Tier 2 (groundwater) considers dilution of the contaminant within the underlying receiving groundwater or surface water body. To determine a dilution factor the infiltration rate of pore water and the discharge of groundwater beneath the source must be determined. Level 2 Assessment is comprises a comparison between measured groundwater concentrations with to water quality standards.

Tier 3 considers natural attenuation in the form of dispersion, retardation and degradation of the contaminant. As the levels are progressed, the assessment becomes increasingly more detailed and less conservative as the data requirements are increased with each successive tier. The Environment Agency has released Excel Worksheets to carry out basic calculations using a conservative approach up to Tier 3. However, in this case the conceptual model is a simple one and assumes there is a simple migration of contaminants from the source zone into the aquifer receptor. Using these worksheets requires a sensitivity analysis showing how by varying each parameter, what effect it might have on the outcome of the assessment. Groundwater conceptual models are not always this simple.

Tier 4 is for more complex conceptual models where multiple sources, multiple pathways, multiple receptors and complex water balances can be assessed.

The Environment Agency developed a spreadsheet based code to support the Remedial Target Methodology, and the code is capable of undertaking assessments for Tiers 1 to 3. Tier 4 assessment is not supported by the spreadsheet based code.

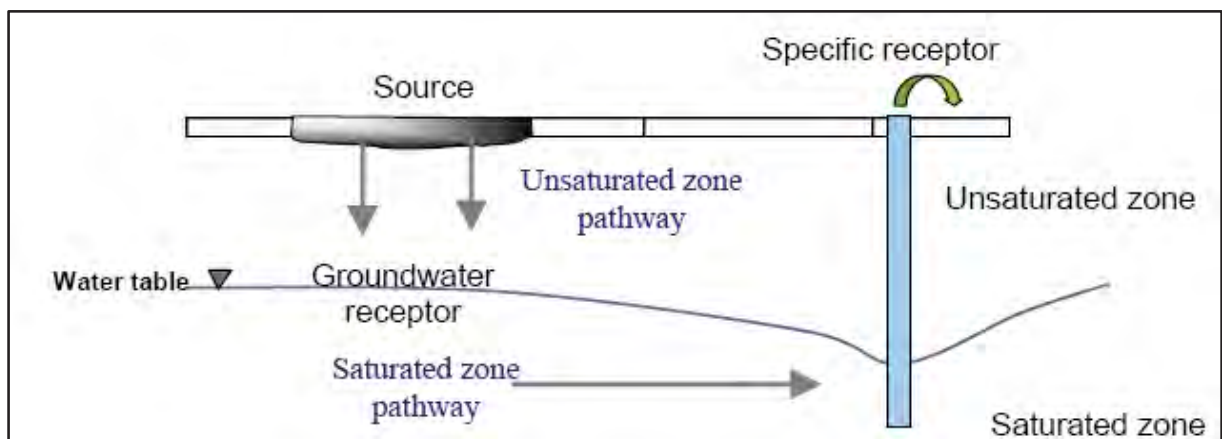
A more advanced code, ConSim 2, developed on behalf of the Environment Agency to support the Remedial Targets Methodology, allows for the introduction of additional geological horizons and is used mainly to determine the concentrations reaching a receptor and the timescales over which this may happen.

The codes assess only the dissolved phase contaminants. There are many further codes commercially available for use in controlled waters risk assessment, particularly for more complex situations, however, these should be used with caution and only once agreement has been obtained from the Environment Agency. All have the overall aim of the estimation of risk from contaminant linkages and the protection of controlled waters.

General notes on each stage of the controlled waters risk assessment process

Risk Screening

The understanding of the Conceptual Site Model (CSM) is the key to assessing any site. Using a robust CSM, potential pathways or receptors may be screened out from any further assessment at an early stage. For example if the pathway through the unsaturated zone is blocked by the presence of a significant thickness of low permeability clay. A greater understanding of the CSM is achieved with each tier of risk assessment. An example of a basic Source-Pathway-Receptor concept is given below (taken from the Environment Agency GP3, 2006):



Generic Risk Assessment

When undertaking the Generic Hydrogeological Risk Assessment (EA Remedial Targets Methodology Tier 1), comparison of chemical analytical results is made with screening criteria. Published values of screening criteria with which chemical test results can be compared are published in the following guidance:

There is a hierarchy of screening criteria which is as follows:

- Updated Recommendations on Environmental Technical Standards, River Basin Management (2015-21), April 2012 by the UK Technical Advisory Group on the Water Framework Directive;
- Environmental Quality Standards (EQS) for freshwaters based on The EC Dangerous Substances Directive (76/464/EEC and Daughter Directives);
- Surface Waters (Abstraction for Drinking Water)(Classification) Regulations (1996)
- Surface Waters (Fishlife) (Classification) Regulations (1997)
- UK Drinking Water Standards (DWS) (Water Supply (Water Quality) Regulations 2000);
- Dutch Ministry of Housing, Spatial Planning and Environment (2001) Intervention Values and Target Values – soil quality standards;
- World Health Organisation Guidelines for Drinking Water (2004)

Should the Level 1 or 2 assessments indicate threshold levels to be exceeded, then there are three alternative ways in which to proceed:

- To devise suitable remedial solutions;
- To carry out more investigation, sampling and analysis;
- To conduct a site-specific Detailed Quantitative Risk Assessment (DQRA) to whether or not the soil materials are suitable for their site-specific intended use or to devise a site-specific clean-up level.

Detailed Quantitative Risk Assessment (DQRA)

The decision to carry out a DQRA will be dependent on the extent and implications of the initial qualitative and generic assessment. The scope of any such assessment will be accurately defined by the outcomes of the former two stages. The CSM will be sufficiently refined by this stage that only certain contaminants of concern, certain pathways and certain receptors will require further assessment, the remainder having been screened out.

Additional site specific data is normally required for this stage of assessment, as explained above, more processes that are capable of affecting contaminant concentrations are considered (such as dilution and attenuation).

Remediation criteria derived will therefore be specific to each site and will be based on a detailed assessment of the potential impact at the identified receptor or *compliance point*. A greater level of confidence can be placed on the predicted impact on the compliance point following a DQRA.

Definition of Controlled Waters

The term ‘controlled waters’ is defined in Section 104 of the Water Resources Act 1991 as:

“Territorial Waters...which extend seawards for three miles..., coastal waters..., inland freshwaters, waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata.”

Note that the definition of groundwater under the Water Resources Act 1991 includes all water within underground strata (including soil / pore water in the unsaturated zone). The definition of groundwater under the Groundwater Directive however is limited to water in the saturated zone. For the purposes of Part IIA of the Environmental Protection Act 1990, the Environment Agency recommends that the groundwater within the saturated zone only is considered as the receptor (rather than soil / pore water).

Environment Agency’s Aquifer Designations

The Environment Agency have classified different types of aquifer from which groundwater can be extracted. The aquifer designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey.

The maps are split into two different types of aquifer designation:

- **Superficial (Drift)** – permeable unconsolidated (loose) deposits.
- **Bedrock (Solid)**– solid permeable formations e.g. sandstone, chalk, limestone.

The aquifer designations displayed on the Environment Agency maps are as follows:

- **Principal Aquifers (formerly termed Major Aquifers)** – These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as a major aquifer.
- **Secondary Aquifers (formerly termed Minor Aquifers)** – These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:
 - **Secondary A** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;
 - **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
 - **Secondary Undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
- **Unproductive Strata (formerly termed Non-Aquifer)** – These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Hazardous and Non Hazardous Substances

The Groundwater (England and Wales) Regulations 2009 control the disposal to the hydrogeological environment of potentially polluting substances which are divided into Hazardous Substances and Non-hazardous Contaminants (this roughly approximates to the former List 1 and List 2 substances).

Hazardous Substances are the most damaging and toxic and must be prevented from directly or indirectly entering the groundwater environment. Hazardous Substances include mineral oils and hydrocarbons, pesticides, biocides, herbicides, solvents and some metals. Discharge of Hazardous Substances to Controlled Waters must be prevented.

Non-hazardous Pollutants are any contaminants other than Hazardous Substances. Non-hazardous Pollutants are potentially toxic but are less harmful than Hazardous Substances, but their direct discharge to groundwater is generally not permitted and any indirect discharge to groundwater must be limited and be controlled by technical precautions in order to prevent pollution. Non-hazardous Pollutants include ammonia and nitrites, many metals and fluorides.

MANAGEMENT OF CONTAMINATED LAND

When risk assessment of the site has been completed and this indicates that remedial works are required, the main guidance in managing this process is set out in the DEFRA/EA publication CLR11 (2004) "Model Procedures for the Management of Land Contamination." The stages of managing remediation are as follows:

- (a) Options Appraisal and develop Remediation Strategy;
- (b) Develop Implementation Plan and Verification Plan;
- (c) Remediation, Verification and Monitoring.

The Remediation Strategy sets out the remediation targets, identifies technically feasible remedial solutions and presents an evaluation of the options so that these can be assessed enabling that the most suitable solution is adopted.

An outline of the proposed remedial method should be presented. Agreement should be sought of the appropriate statutory bodies for the Remediation Strategy before proceeding to the next stage.

The Implementation Plan is a detailed method statement setting out how the remediation is to be carried out including stating how the site will be managed, welfare procedures, health and safety considerations together with practical measures such as details of temporary works, programme of works, waste management licences and regulatory consents required. Agreement should again be sought of the appropriate statutory bodies for this Plan.

The Verification Plan sets out the requirements for gathering data to demonstrate that the remediation has met the required remediation objectives and criteria. The Verification Plan presents the requirements for a wide range of issues including the level of supervision, sampling and testing regimes for treated materials, waste and imported materials, required monitoring works during and post remediation, how compliance with all licenses and consents will be checked etc. Agreement should again be sought of the appropriate statutory bodies for the Verification Plan. On completion of the remediation a Verification Report should be produced to provide a complete record of all remediation activities on site and the data collected as required in the Verification Plan. The Verification Report should demonstrate that the remediation has met the remedial targets to show that the site is suitable for the proposed use.

GLOSSARY

TERMS		UNITS	
AST	Above Ground Storage Tank	m	Metres
BGS	British Geological Survey	km	Kilometres
BSI	British Standards Institute	%	Percent
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes	% v/v	Percent volume in air
CIEH	Chartered Institute of Environmental Health	mb	Milli Bars (atmospheric pressure)
CIRIA	Construction Industry Research Association	l/hr	Litres per hour
CLEA	Contaminated Land Exposure Assessment	ha	Hectare (10,000 m ²)
CSM	Conceptual Site Model	µg/l	Micrograms per Litre (parts per billion)
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)	ppb	Parts Per Billion
DWS	Drinking Water Standard	mg/kg	Milligrams per kilogram (parts per million)
EA	Environment Agency	ppm	Parts Per Million
EQS	Environmental Quality Standard	mg/m ³	Milligram per metre cubed
GAC	General Assessment Criteria	Mg/m ³	Megagram per metre cubed
GL	Ground Level	µg/m ³	Microgram per metre cubed
GSV	Gas Screening Value	m bgl	Metres Below Ground Level
HCV	Health Criteria Value	m bcl	Metre Below Cover Level
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel)	mOD	Metres Above Ordnance Datum (sea level)
ND	Not Detected	kN/m ²	Kilo Newtons per metre squared
LMRL	Lower Method Reporting Limit	kPa	Kilo Pascal – same as kN/m ²
NR	Not Recorded	µm	Micro metre
OD	Ordnance Datum		
PAH	Poly Aromatic Hydrocarbon		
PCB	Poly-Chlorinated Biphenyl		
PID	Photo Ionisation Detector		
PCSM	Preliminary Conceptual Site Model		
SGV	Soil Guideline Value		
TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)		
SPT	Standard Penetration Test		
SVOC	Semi Volatile Organic Compound		
UST	Underground Storage Tank		
VCCs	Vibro Concrete Columns		
VOC	Volatile Organic Compound		
VSCs	Vibro Stone Columns		

APPENDIX C

Site Photographs





Photo1



Photo2



Photo3



Photo4



Photo5



Photo6



Photo7



Photo8



Photo9

APPENDIX D

Groundsure EnviroInsite Report

(Historical Maps & Environmental Data on the Site and Surrounding Land Use)



Terra Consult

Bold Business Centre, Bold Lane,
Bold Lane,
Sutton, WA9 4TX

Groundsure
Reference:

HMD-147-4340084

Your Reference: 3571-PO-001978

Report Date 11 Oct 2017

Report Delivery Method: Email - pdf

Geo Insight

Address: Cypress Building, LIVERPOOL, L7 7EL

Dear Sir/ Madam,

Thank you for placing your order with Groundsure. Please find enclosed the **Groundsure Geo Insight** as requested.

If you need any further assistance, please do not hesitate to contact our helpline on 08444 159000 quoting the above Groundsure reference number.

Yours faithfully,

A handwritten signature in black ink, appearing to be 'J. O.', followed by a small dot.

Managing Director
Groundsure Limited

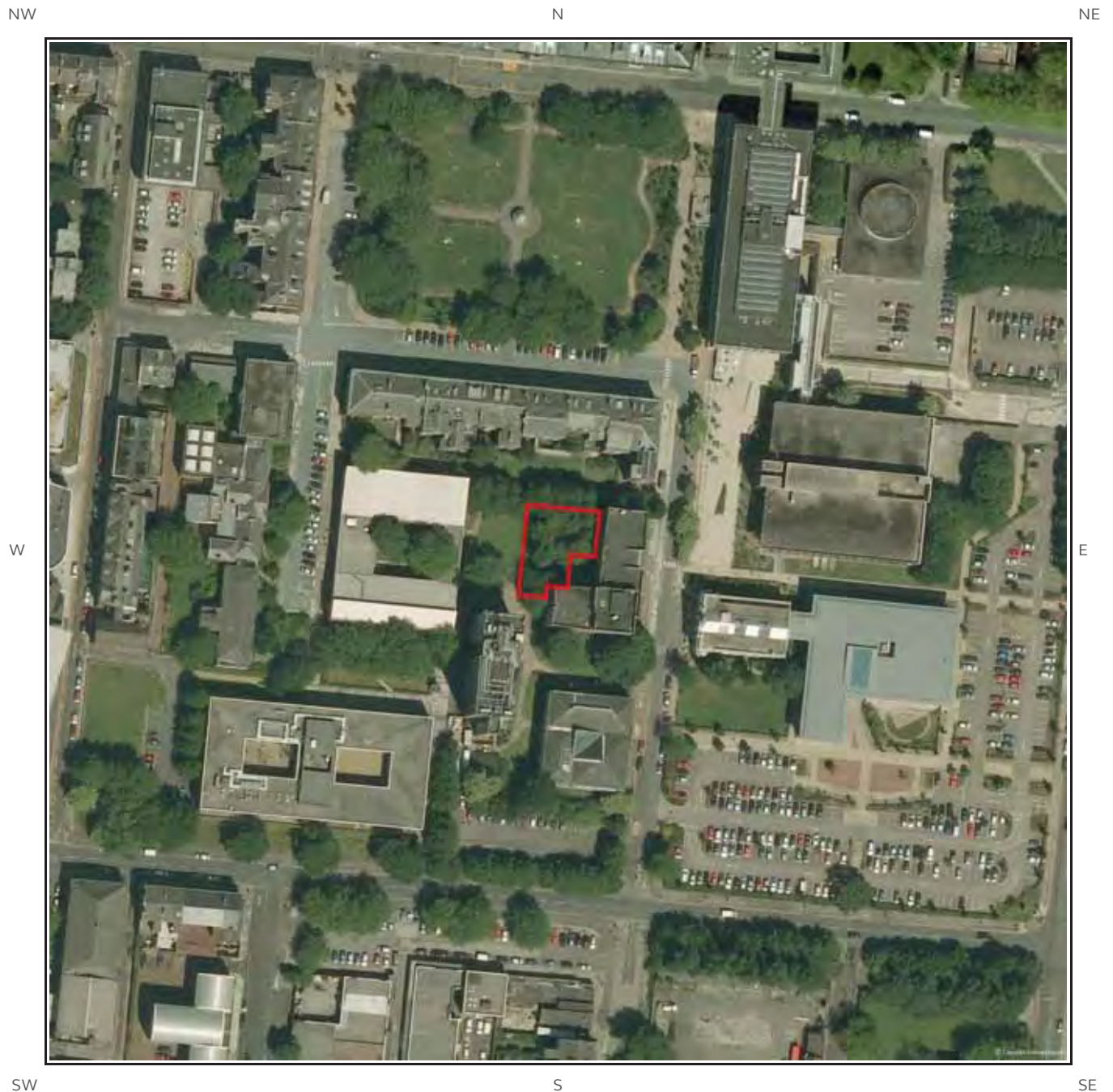
Enc.
Groundsure Geo Insight

Address: Cypress Building, LIVERPOOL, L7 7EL

Date: 11 Oct 2017

Reference: HMD-147-4340084

Client: Terra Consult



Aerial Photograph Capture date: 24-Jun-2009

Grid Reference: 335954,389892

Site Size: 0.05ha

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Overview of Findings

The Groundsure Geo Insight provides high quality geo-environmental information that allows geo-environmental professionals and their clients to make informed decisions and be forewarned of potential ground instability problems that may affect the ground investigation, foundation design and possibly remediation options that could lead to possible additional costs.

The report is based on the BGS 1:50,000 and 1:10,000 Digital Geological Map of Great Britain, BGS Geosure data; BRITPITS database; Non-coal mining data and Borehole Records, Coal Authority data including brine extraction areas, PBA non-coal mining and natural cavities database, Johnson Poole and Bloomer mining data and Groundsure's unique database including historical surface ground and underground workings.

For further details on each dataset, please refer to each individual section in the report as listed. Where the database has been searched a numerical result will be recorded. Where the database has not been searched '-' will be recorded.

Section 1: Geology 1:10,000 Scale

1.1 Artificial Ground	1.1 Is there any Artificial Ground/ Made Ground present beneath the study site at 1:10,000 scale?	No
1.2 Superficial Geology and Landslips	1.2.1 Is there any Superficial Ground/Drift Geology present beneath the study site at 1:10,000 scale?*	Yes
	1.2.2 Are there any records of landslip within 500m of the study site boundary at 1:10,000 scale?	No
1.3 Bedrock, Solid Geology and Faults	1.3.1 For records of Bedrock and Solid Geology beneath the study site* see the detailed findings section.	
	1.3.2 Are there any records of faults within 500m of the study site boundary at 1:10,000 scale?	Yes

Section 2: Geology 1:50,000 Scale

2.1 Artificial Ground	2.1.1 Is there any Artificial Ground/ Made Ground present beneath the study site?	No
	2.1.2 Are there any records relating to permeability of artificial ground within the study site*boundary?	No
2.2 Superficial Geology and Landslips	2.2.1 Is there any Superficial Ground/Drift Geology present beneath the study site?*	Yes
	2.2.2 Are there any records of permeability of superficial ground within 500m of the study site?	Yes
	2.2.3 Are there any records of landslip within 500m of the study site boundary?	No
	2.2.4 Are there any records relating to permeability of landslips within the study site* boundary?	No

Section 2: Geology 1:50,000 Scale

2.3 Bedrock, Solid Geology and Faults

2.3.1 For records of Bedrock and Solid Geology beneath the study site* see the detailed findings section.

2.3.2 Are there any records relating to permeability of bedrock ground within the study site boundary?

Yes

2.3.3 Are there any records of faults within 500m of the study site boundary?

Yes

Section 3: Radon

3. Radon

3.1 Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level?

The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

3.2 Radon Protection

No radon protective measures are necessary.

Section 4: Ground Workings

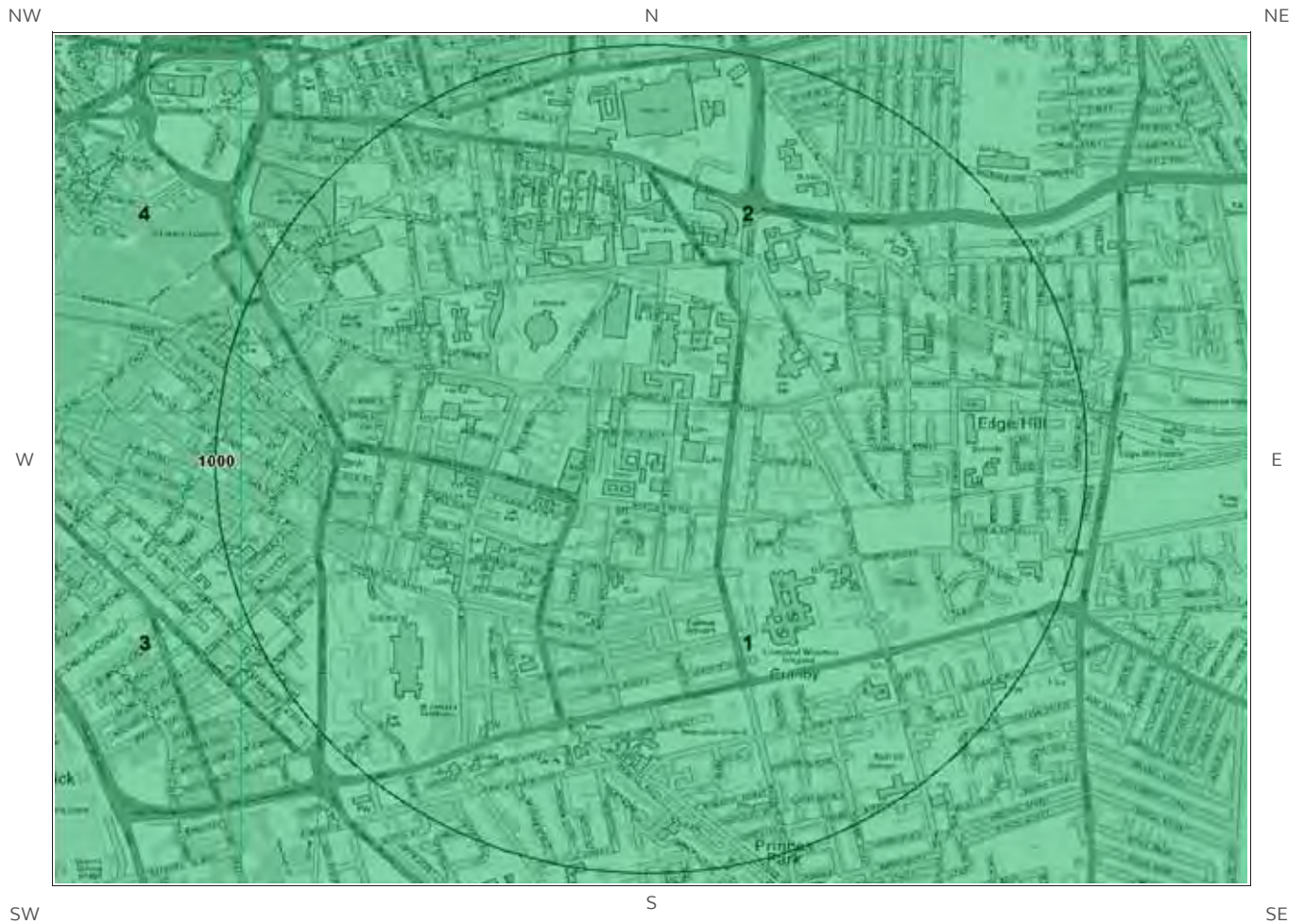
	On-site	0-50m	51-250	251-500	501-1000
4.1 Historical Surface Ground Working Features from Small Scale Mapping	0	0	0	Not Searched	Not Searched
4.2 Historical Underground Workings from Small Scale Mapping	0	0	9	19	38
4.3 Current Ground Workings	0	0	0	3	2

Section 5: Mining, Extraction & Natural Cavities

	On-site	0-50m	51-250	251-500	501-1000
5.1 Historical Mining	0	0	0	4	8
5.2 Coal Mining	0	0	0	0	0
5.3 Johnson Poole and Bloomer Mining Area	0	0	0	0	0
5.4 Non-Coal Mining*	0	0	0	0	0
5.5 Non-Coal Mining Cavities	0	0	0	0	1
5.5 Natural Cavities	0	0	0	0	0

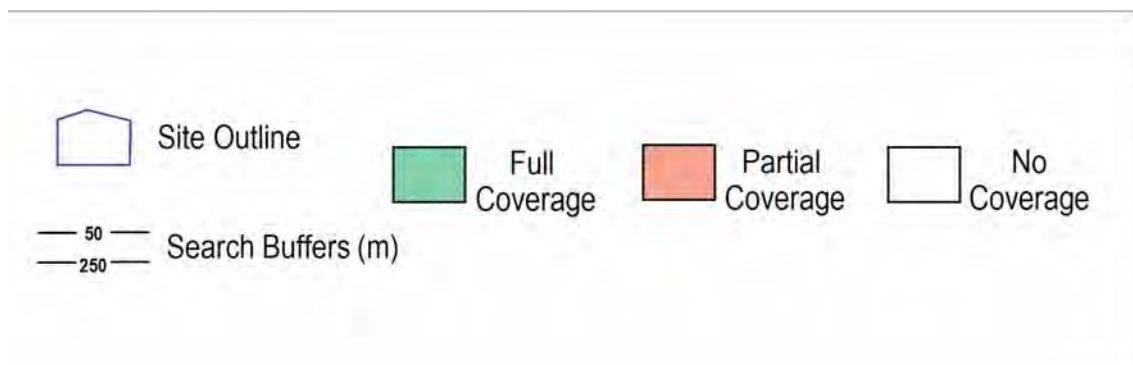
Section 5: Mining, Extraction & Natural Cavities	On-site	0-50m	51-250	251-500	501-1000
5.6 Brine Extraction	0	0	0	0	0
5.7 Gypsum Extraction	0	0	0	0	0
5.8 Tin Mining	0	0	0	0	0
5.9 Clay Mining	0	0	0	0	0
Section 6: Natural Ground Subsidence	On-site				
6.1 Shrink-Swell Clay	Very Low				
6.2 Landslides	Very Low				
6.3 Ground Dissolution of Soluble Rocks	Negligible				
6.4 Compressible Deposits	Negligible				
6.5 Collapsible Deposits	Very Low				
6.5 Running Sand	Very Low				
Section 7: Borehole Records	On-site	0-50m	51-250		
7 BGS Recorded Boreholes	0	1	11		
Section 8: Estimated Background Soil Chemistry	On-site	0-50m	51-250		
8 Records of Background Soil Chemistry	2	5	0		
Section 9: Railways and Tunnels	On-site	0-50m	51-250	250-500	
9.1 Tunnels	0	0	0	Not Searched	
9.2 Historical Railway and Tunnel Features	0	0	38	Not Searched	
9.3 Historical Railways	0	0	1	Not Searched	
9.4 Active Railways	0	0	0	Not Searched	
9.5 Railway Projects	0	0	0	0	

1:10,000 Scale Availability



1_10,000 Availability Legend

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Availability of 1:10,000 Scale Geology Mapping

The following information represents the availability of the key components of the 1:10,000 scale geological data.

ID	Distance	Artificial Coverage	Superficial Coverage	Bedrock Coverage	Mass Movement Coverage
1	0.0	Some deposits are mapped	Full	Full	No coverage
2	103.0	Some deposits are mapped	Full	Full	No coverage
3	941.0	Some deposits are mapped	Full	Full	Some deposits are mapped
4	950.0	Some deposits are mapped	Full	Full	No coverage

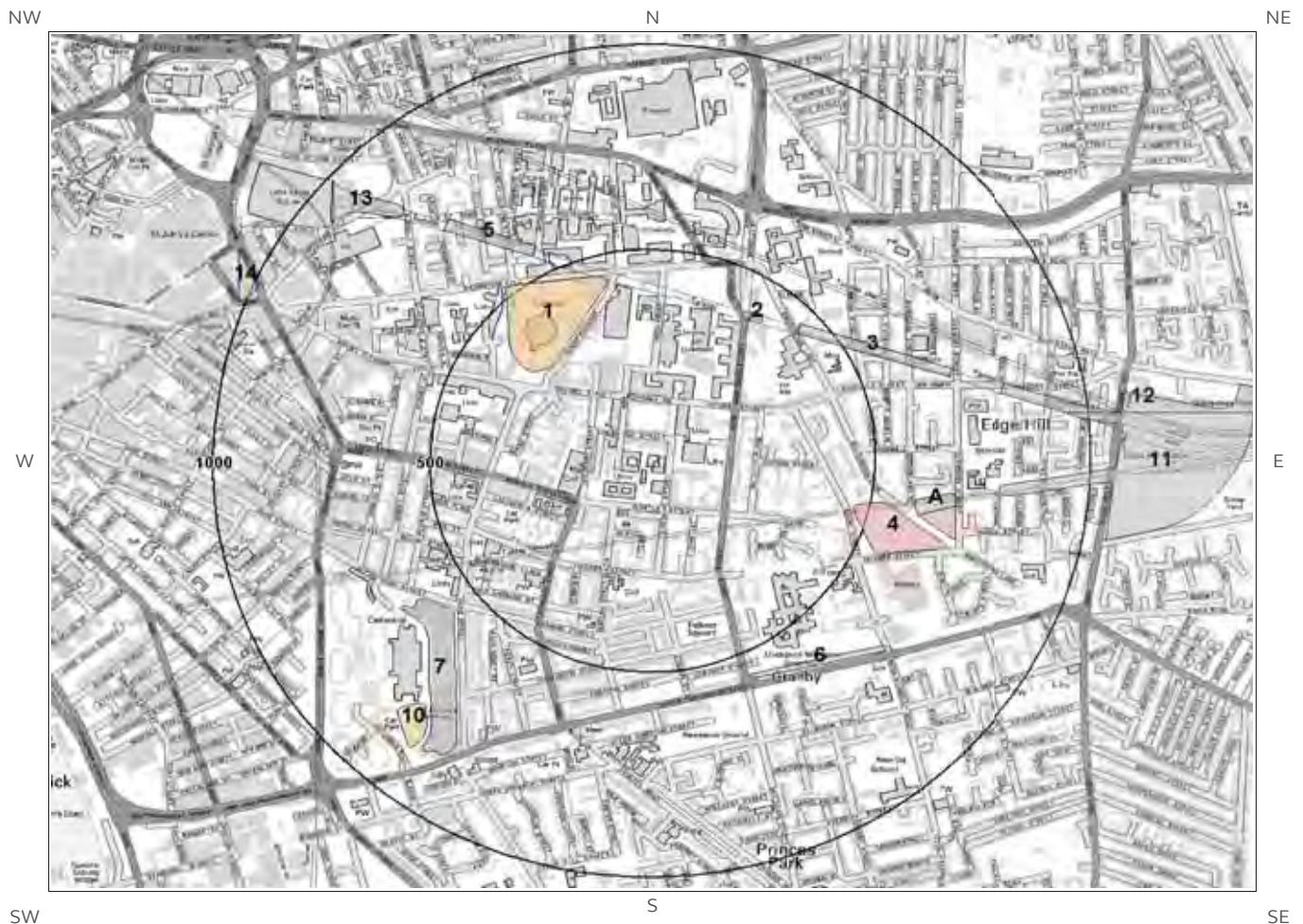
Guidance: The 1:10,000 scale geological interpretation is the most detailed generally available from BGS and is the scale at which most geological surveying is carried out in the field. The database is presented as four types of geology (artificial, mass movement, superficial and bedrock), although not all themes are mapped or available on every map sheet. Therefore a coverage layer showing the availability of the four themes is presented above.

The definitions of coverage are as follows:

Geology	Full Coverage	Partial Coverage	No Coverage
Bedrock	The whole tile has been mapped	Some but not all the tile has been mapped	No coverage
Superficial	The whole tile has been mapped	Some but not all of the tile has been mapped	No coverage
Artificial	Some deposits are mapped on this tile	-	No deposits are mapped
Mass Movement	Some deposits are mapped on this tile	-	No coverage

1 Geology (1:10,000 scale).

1.1 Artificial Ground Map (1:10,000 scale)



Artificial Ground Legend

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	Site Outline		Made Ground (undivided)		Disturbed Ground (undivided)
	Search Buffers (m)		Worked Ground (undivided)		Landscaped Ground (undivided)
			Infilled Ground		Reclaimed Ground

1. Geology 1:10,000 scale

1.1 Artificial Ground

The following geological information represented on the mapping is derived from 1:10,000 scale BGS Geological mapping.

Are there any records of Artificial/ Made Ground within 500m of the study site boundary at 1:10,000 scale? Yes

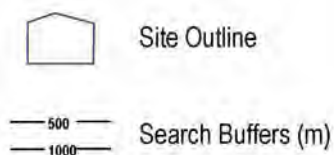
ID	Distance	Direction	LEX Code	Description	Rock Description
1	312.0	NW	MGR-FILLU	Made Ground (Undivided)	Fill
2	392.0	NE	WGR-VOID	Worked Ground (Undivided)	Void
3	436.0	NE	WGR-VOID	Worked Ground (Undivided)	Void
4	465.0	E	WMGR-FILLU	Infilled Ground	Fill

1.2 Superficial Deposits and Landslips Map (1:10,000 scale)



Artificial Ground Legend

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1.2 Superficial Deposits and Landslips

The following geological information represented on the mapping is derived from 1:10,000 scale BGS Geological mapping

1.2.1 Superficial Deposits/ Drift Geology

Are there any records of Superficial Deposits/ Drift Geology within 500m of the study site boundary at 1:10,000 scale? Yes

ID	Distance (m)	Direction	LEX Code	Description	Rock Description
1	2.0	SE	TILLD-CSVL	Till, Devensian - Sandy Gravelly Cobbly Clay	Clay, Sandy, Gravelly, Cobbly

1.2.2 Landslip

Are there any records of Landslip within 500m of the study site boundary at 1:10,000 scale?

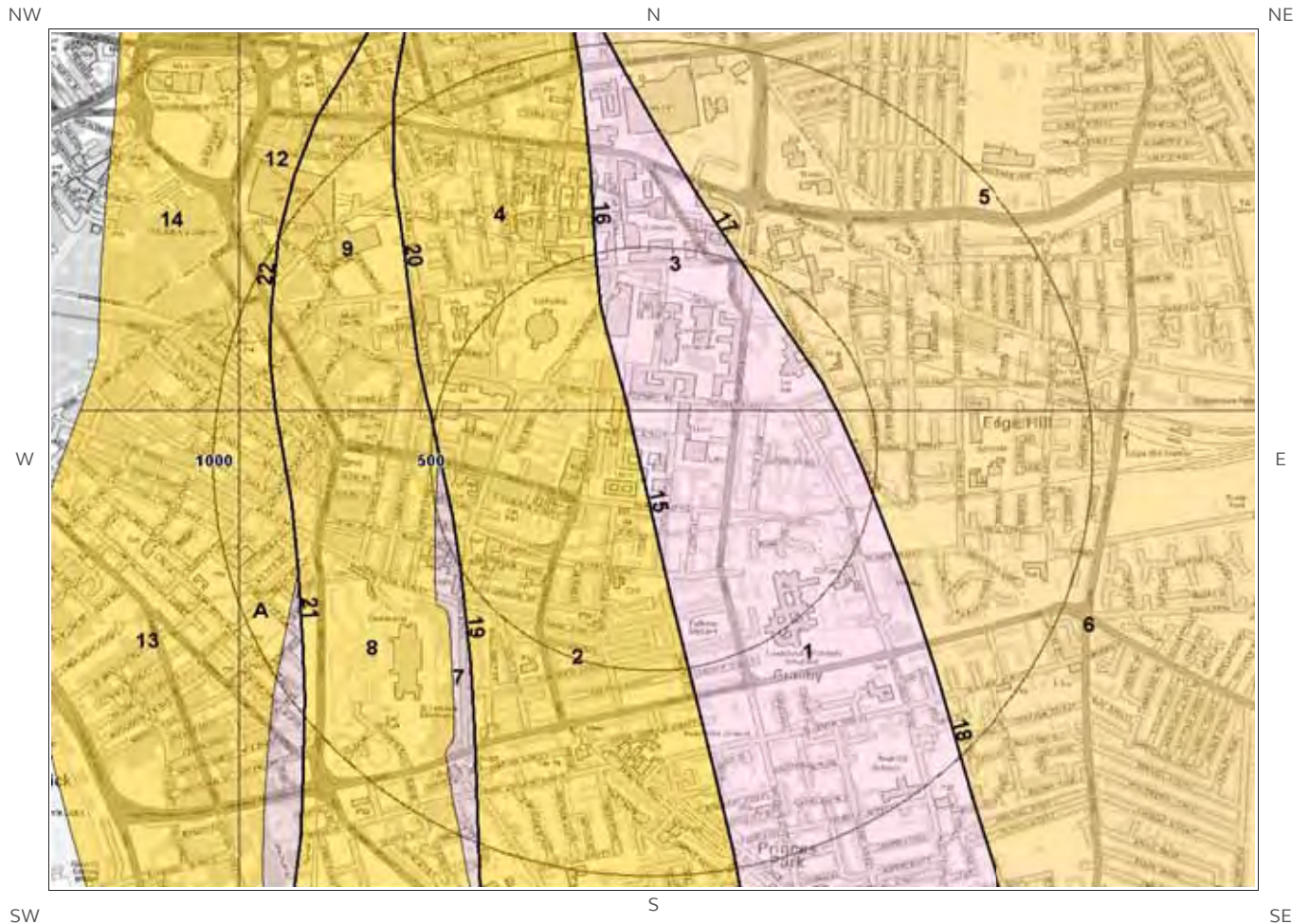
No

Database searched and no data found.

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of Great Britain at 1:10,000 scale

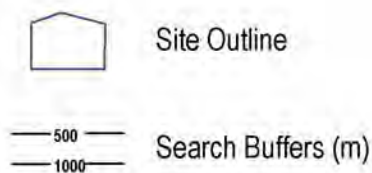
This Geology shows the main components as discrete layers, these are: Artificial / Made Ground, Superficial / Drift Geology and Landslips. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

1.3 Bedrock and Faults Map (1:10,000 scale)



Bedrock and Faults Legend

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1.3 Bedrock and Faults

The following geological information represented on the mapping is derived from 1:10,000 scale BGS Geological mapping.

1.3.1 Bedrock/ Solid Geology

Records of Bedrock/Solid Geology within 500m of the study site boundary at 1:10,000 scale.

ID	Distance (m)	Direction	LEX Code	Description	Rock Age
1	0.0	On Site	WLSF-SDST	Wilmslow Sandstone Formation - Sandstone	Early Triassic Epoch
2	17.0	W	HEY-SDST	Helsby Sandstone Formation - Sandstone	Anisian Age - Early Triassic Epoch
3	103.0	N	WLSF-SDST	Wilmslow Sandstone Formation - Sandstone	Early Triassic Epoch
4	114.0	NW	HEY-SDST	Helsby Sandstone Formation - Sandstone	Anisian Age - Early Triassic Epoch
5	408.0	NE	CPB-SDST	Chester Pebble Beds Formation - Sandstone	Early Triassic Epoch
6	421.0	E	CPB-SDST	Chester Pebble Beds Formation - Sandstone	Early Triassic Epoch
7	466.0	W	TPSF-SIMS	Tarporley Siltstone Formation - Siltstone, Mudstone And Sandstone	Anisian Age - Olenekian Age
8	483.0	W	HEY-SDST	Helsby Sandstone Formation - Sandstone	Anisian Age - Early Triassic Epoch

1.3.2 Faults

Are there any records of Faults within 500m of the study site boundary at 1:10,000 scale? Yes

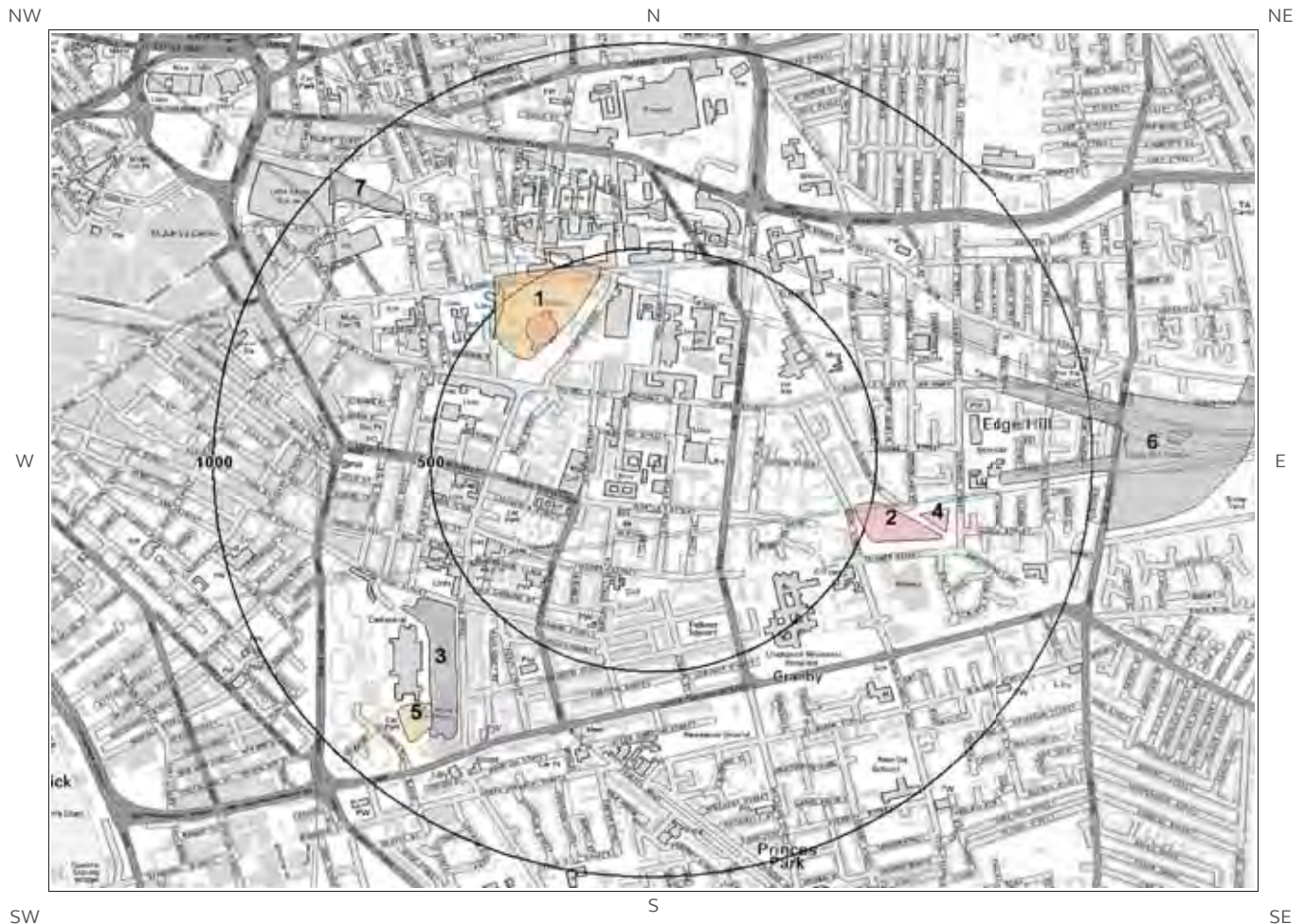
ID	Distance (m)	Direction	Category Description	Feature Description
15	17.0	W	FAULT	Normal fault, inferred
16	114.0	NW	FAULT	Normal fault, inferred
17	408.0	NE	FAULT	Normal fault, inferred
18	421.0	E	FAULT	Normal fault, inferred
19	466.0	W	FAULT	Normal fault, inferred

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of great Britain at 1:10,000 scale.

This Geology shows the main components as discrete layers, these are: Bedrock/ Solid Geology and linear features such as Faults. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

2 Geology 1:50,000 Scale

2.1 Artificial Ground Map



Ground Workings Legend

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2. Geology 1:50,000 scale

2.1 Artificial Ground

The following geological information represented on the mapping is derived from 1:50,000 scale BGS Geological mapping, Sheet No: 096

2.1.1 Artificial/ Made Ground

Are there any records of Artificial/ Made Ground within 500m of the study site boundary? Yes

ID	Distance (m)	Direction	LEX Code	Description	Rock Description
1	356.0	NW	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT
2	464.0	E	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT

2.1.2 Permeability of Artificial Ground

Are there any records relating to permeability of artificial ground within the study site boundary? No

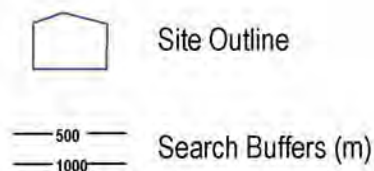
Database searched and no data found.

2.2 Superficial Deposits and Landslips Map (1:50,000 scale)



Ground Workings Legend

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2.2 Superficial Deposits and Landslips

2.2.1 Superficial Deposits/ Drift Geology

Are there any records of Superficial Deposits/ Drift Geology within 500m of the study site boundary? Yes

ID	Distance	Direction	LEX Code	Description	Rock Description
1	2.0	SE	TILLD-CSVL	TILL, DEVENSIAN	CLAY, SANDY, GRAVELLY, COBBLY

2.2.2 Permeability of Superficial Ground

Are there any records relating to permeability of superficial ground within the study site boundary? Yes

Distance (m)	Direction	Flow Type	Maximum Permeability	Minimum Permeability
2.0	SE	Mixed	High	Low

2.2.3 Landslip

Are there any records of Landslip within 500m of the study site boundary? No

Database searched and no data found.

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of Great Britain at 1:50,000 scale.

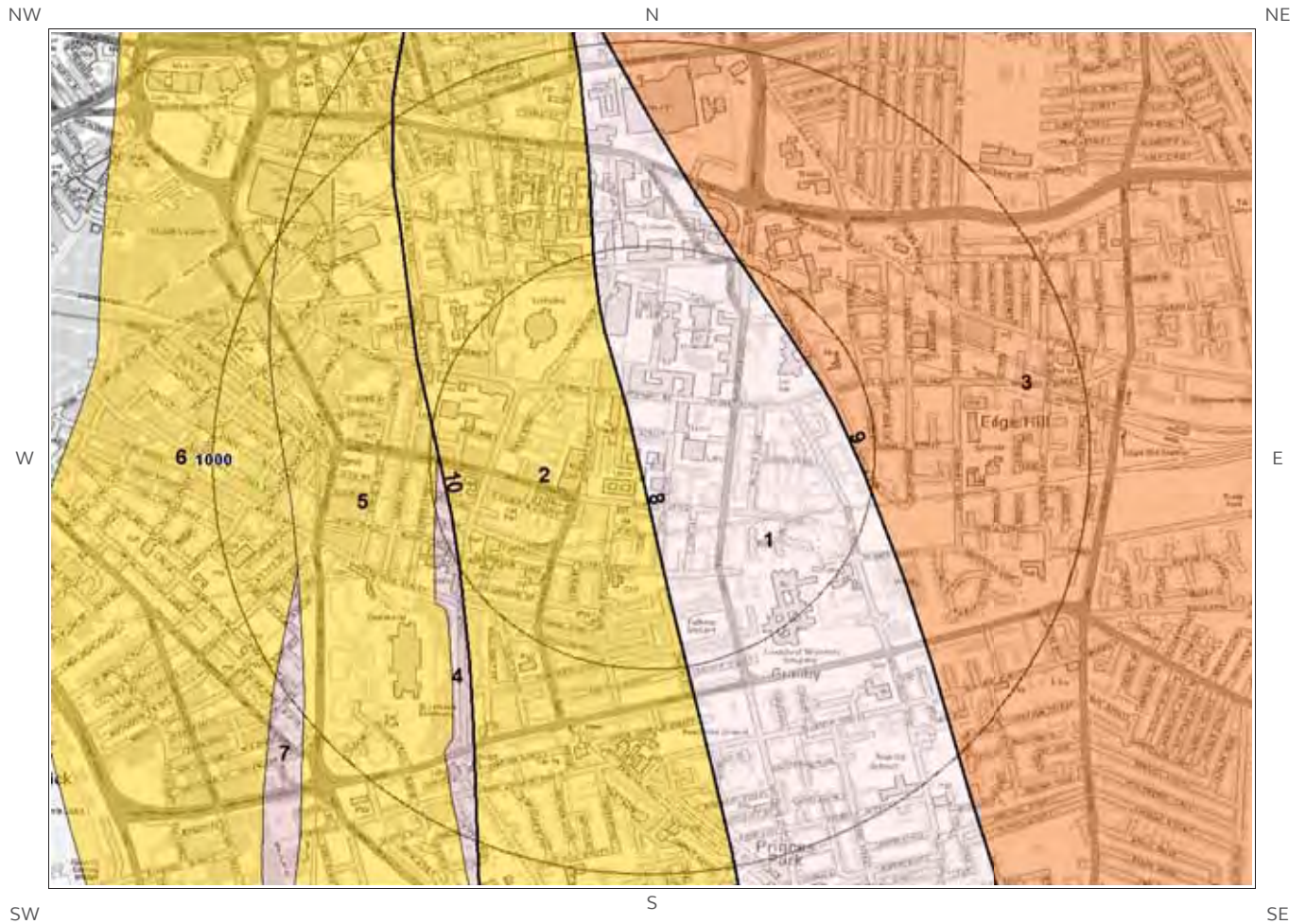
This Geology shows the main components as discrete layers, there are: Artificial/ Made Ground, Superficial/ Drift Geology and Landslips. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

2.2.4 Landslip Permeability

Are there any records relating to permeability of landslips within the study site boundary? No

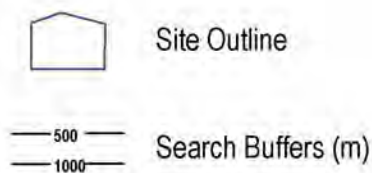
Database searched and no data found.

2.3 Bedrock and Faults Map (1:50,000 scale)



Ground Workings Legend

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2.3 Bedrock, Solid Geology & Faults

The following geological information represented on the mapping is derived from 1:50,000 scale BGS Geological mapping, Sheet No: 096

2.3.1 Bedrock/Solid Geology

Records of Bedrock/Solid Geology within 500m of the study site boundary:

ID	Distance	Direction	LEX Code	Rock Description	Rock Age
1	0.0	On Site	WLSF-SDST	WILMSLOW SANDSTONE FORMATION - SANDSTONE	-
2	17.0	W	HEY-SDST	HELSEBY SANDSTONE FORMATION - SANDSTONE	ANISIAN
3	408.0	NE	CHES-PESST	CHESTER FORMATION - SANDSTONE, PEBBLY (GRAVELLY)	OLENEKIAN
4	466.0	W	TPSF-SIMS	TARPORLEY SILTSTONE FORMATION - SILTSTONE, MUDSTONE AND SANDSTONE	OLENEKIAN
5	483.0	W	HEY-SDST	HELSEBY SANDSTONE FORMATION - SANDSTONE	ANISIAN

2.3.2 Permeability of Bedrock Ground

Are there any records relating to permeability of bedrock ground within the study site boundary? Yes

Distance	Direction	Flow Type	Maximum Permeability	Minimum Permeability
0.0	On Site	Intergranular	High	High
17.0	W	Mixed	High	Moderate

2.3.3 Faults

Are there any records of Faults within 500m of the study site boundary? Yes

ID	Distance	Direction	Category Description	Feature Description
8	17.0	W	FAULT	Fault, inferred
9	408.0	NE	FAULT	Fault, inferred
10	466.0	W	FAULT	Fault, inferred

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of Great Britain at 1:50,000 scale.

This Geology shows the main components as discrete layers, these are: Bedrock/Solid Geology and linear features such as Faults. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nation wide coverage.

3 Radon Data

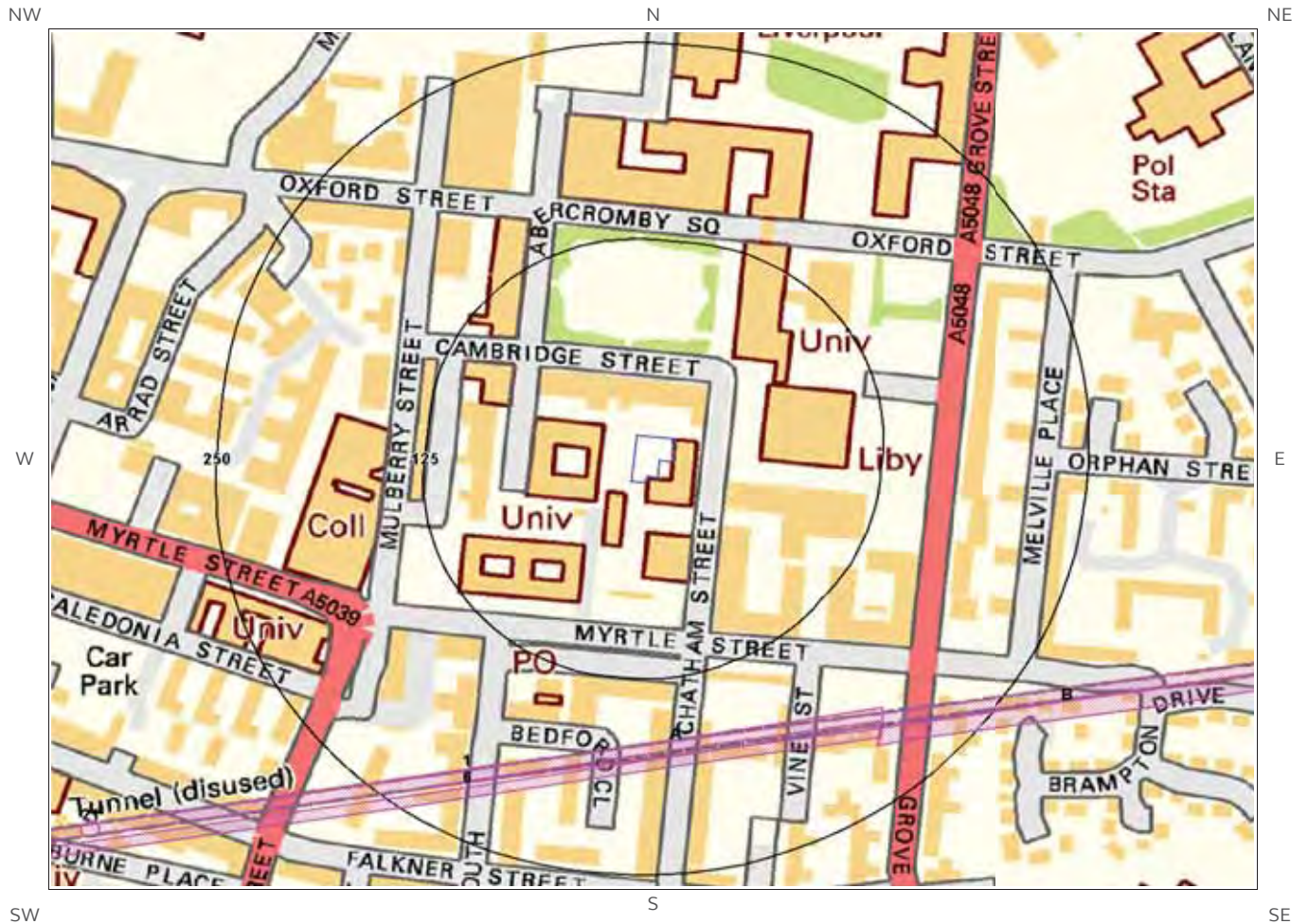
3.1 Radon Affected Areas

Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level? The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

3.2 Radon Protection

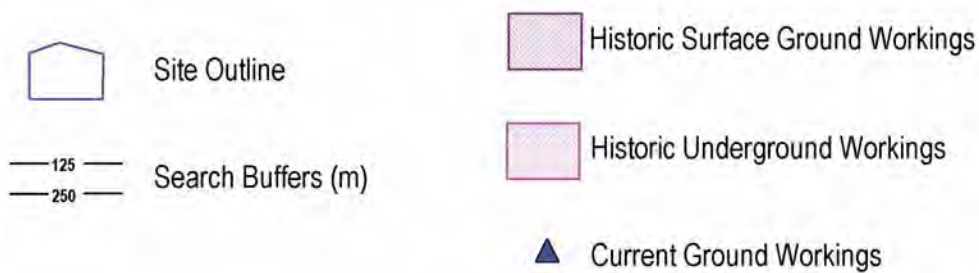
Is the property in an area where Radon Protection are required for new properties or extensions to existing ones as described in publication BR211 by the Building Research Establishment? No radon protective measures are necessary.

4 Ground Workings Map



Ground Workings Legend

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4 Ground Workings

4.1 Historical Surface Ground Working Features derived from Historical Mapping

This dataset is based on Groundsure's unique Historical Land Use Database derived from 1:10,560 and 1:10,000 scale historical mapping

Are there any Historical Surface Ground Working Features within 250m of the study site boundary? No

Database searched and no data found.

4.2 Historical Underground Working Features derived from Historical Mapping

This data is derived from the Groundsure unique Historical Land Use Database. It contains data derived from 1:10,000 and 1:10,560 historical Ordnance Survey Mapping and includes some natural topographical features (Shake Holes for example) as well as manmade features that may have implications for ground stability. Underground and mining features have been identified from surface features such as shafts. The distance that these extend underground is not shown.

Are there any Historical Underground Working Features within 1000m of the study site boundary? Yes

The following Historical Underground Working Features are provided by Groundsure:

ID	Distance (m)	Direction	NGR	Use	Date
1	164.0	S	335267 389597	Tunnel	1938
2A	165.0	S	335878 389685	Tunnel	1956
3A	165.0	S	335878 389685	Disused Tunnel	1975
4A	165.0	S	335878 389685	Disused Tunnel	1988
5A	165.0	S	335878 389685	Tunnel	1965
6	175.0	S	335266 389586	Tunnel	1906
7B	207.0	SE	336418 389754	Tunnel	1925
8B	207.0	SE	336418 389754	Tunnel	1906
9B	207.0	SE	336418 389754	Tunnel	1938
Not shown	366.0	NE	336147 390231	Tunnel	1906
Not shown	366.0	NE	336147 390231	Tunnel	1925
Not shown	366.0	NE	336147 390231	Tunnel	1891
Not shown	366.0	NE	336147 390231	Tunnel	1938

ID	Distance (m)	Direction	NGR	Use	Date
Not shown	377.0	N	336086 390263	Tunnel	1968
Not shown	377.0	N	335931 390313	Tunnel	1975
Not shown	377.0	N	335931 390313	Tunnel	1989
Not shown	385.0	NE	336241 390203	Tunnel	1891
Not shown	385.0	NE	336241 390203	Tunnel	1925
Not shown	385.0	NE	336241 390203	Tunnel	1906
Not shown	385.0	NE	336241 390203	Tunnel	1938
21	388.0	SW	335616 389646	Unspecified Shaft	1965
Not shown	396.0	NE	336247 390215	Tunnel	1989
Not shown	396.0	NE	336247 390215	Tunnel	1975
Not shown	396.0	NE	336247 390215	Tunnel	1968
Not shown	407.0	N	335800 390353	Tunnel	1968
Not shown	475.0	E	336434 389767	Air Shaft	1975
Not shown	475.0	E	336434 389767	Air Shaft	1965
Not shown	475.0	E	336434 389767	Air Shaft	1988
Not shown	518.0	NE	336565 390209	Tunnel	1925
Not shown	518.0	NE	336565 390209	Tunnel	1938
Not shown	518.0	NE	336565 390209	Tunnel	1906
Not shown	530.0	N	335047 390885	Tunnel	1906
Not shown	533.0	NE	336017 390460	Tunnel	1968
Not shown	533.0	NE	336017 390460	Tunnel	1975
Not shown	533.0	NE	336017 390460	Tunnel	1957
Not shown	538.0	N	335048 390893	Tunnel	1938
Not shown	570.0	NE	336360 390315	Air Shaft	1975
Not shown	684.0	NE	336575 390221	Air Shaft	1989
Not shown	684.0	NE	336575 390221	Air Shaft	1975
Not shown	687.0	E	336701 389793	Tunnel	1988
Not shown	687.0	E	336701 389793	Tunnel	1965
Not shown	687.0	E	336701 389793	Tunnel	1956

ID	Distance (m)	Direction	NGR	Use	Date
Not shown	687.0	E	336701 389793	Tunnel	1975
Not shown	700.0	E	336706 390074	Tunnel	1989
Not shown	700.0	E	336706 390074	Tunnel	1968
Not shown	700.0	E	336706 390074	Tunnel	1975
Not shown	724.0	NW	335425 390478	Tunnel	1975
Not shown	724.0	NW	335425 390478	Tunnel	1989
Not shown	755.0	W	335183 389505	Tunnel	1956
Not shown	756.0	W	335183 389505	Tunnel	1988
Not shown	756.0	W	335183 389505	Tunnel	1965
Not shown	756.0	W	335183 389505	Tunnel	1975
Not shown	759.0	W	333435 389680	Tunnel	1938
Not shown	765.0	W	333429 389679	Tunnel	1906
Not shown	769.0	W	335220 389587	Unspecified Shaft	1965
Not shown	769.0	W	335220 389587	Unspecified Shaft	1975
Not shown	769.0	W	335220 389587	Unspecified Shaft	1988
Not shown	796.0	W	335077 390077	Tunnel	1989
Not shown	812.0	W	335071 390085	Tunnel	1975
Not shown	842.0	NW	335210 390415	Tunnel	1989
Not shown	847.0	E	336789 390124	Air Shaft	1975
Not shown	847.0	E	336789 390124	Air Shaft	1989
Not shown	971.0	W	334053 390146	Railway Tunnel	1973
Not shown	988.0	W	334921 389549	Tunnel	1956
Not shown	988.0	W	334921 389549	Tunnel	1949
Not shown	990.0	W	334845 389525	Tunnel	1966

4.3 Current Ground Workings

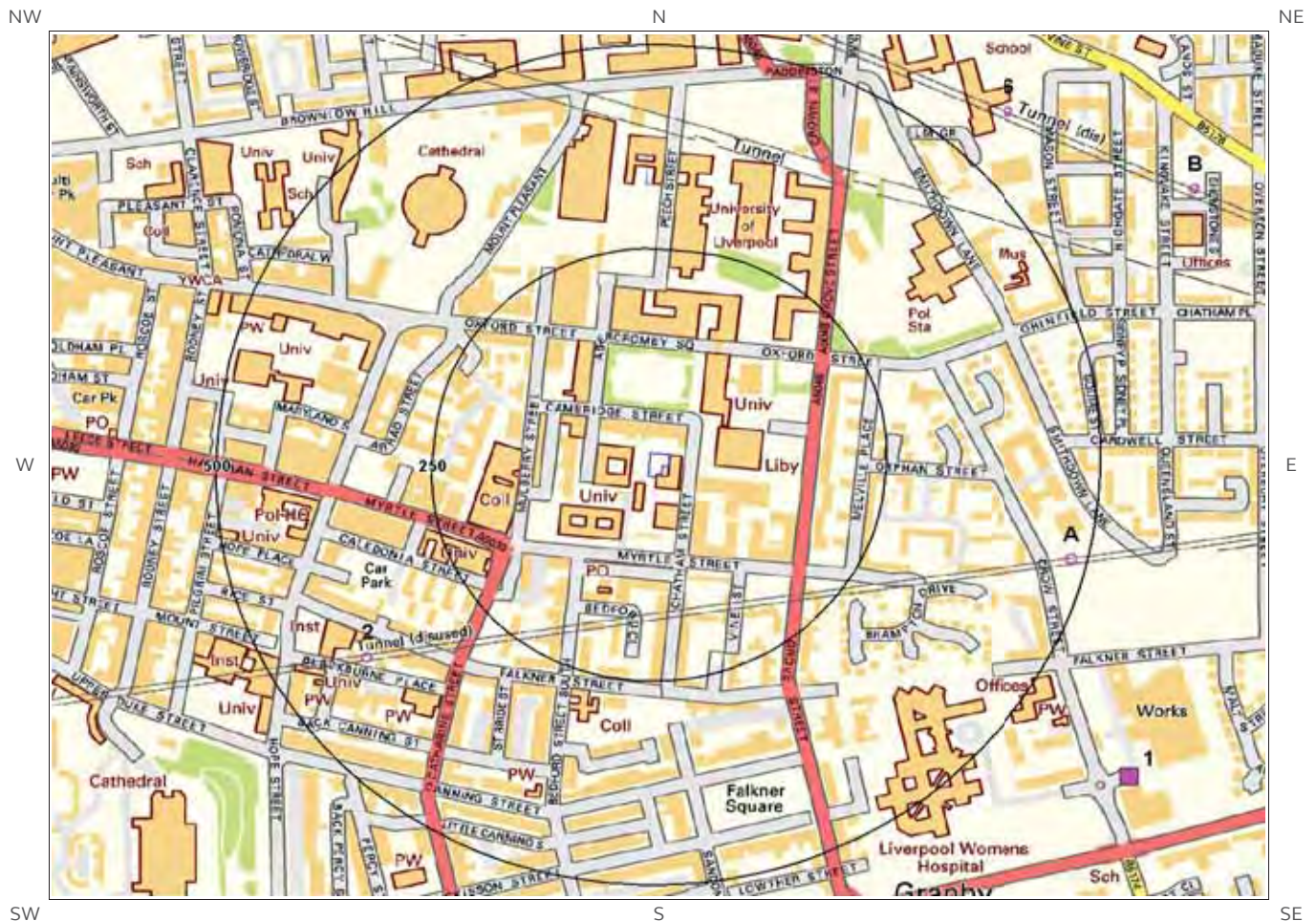
This dataset is derived from the BGS BRITPITS database covering active; inactive mines; quarries; oil wells; gas wells and mineral wharves; and rail deposits throughout the British Isles.

Are there any BGS Current Ground Workings within 1000m of the study site boundary? Yes

The following Current Ground Workings information is provided by British Geological Survey:

ID	Distance (m)	Direction	NGR	Commodity Produced	Pit Name	Type of working	Status
Not shown	428.0	E	336395 389875	Clay & Shale	Smithdown Road Brick Pits	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased
Not shown	431.0	N	335820 390310	Sandstone	Brownlow Hill Quarries	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased
Not shown	461.0	NE	336375 390110	Sandstone	Williamson's Quarries	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased
Not shown	685.0	SW	335465 389375	Sandstone	Old Park	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased
Not shown	894.0	NE	336660 390460	Sandstone	Duke Street	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased

5 Mining, Extraction & Natural Cavities Map



Mining, Extraction and
Natural Cavities Legend

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5 Mining, Extraction & Natural Cavities

5.1 Historical Mining

This dataset is derived from Groundsure unique Historical Land-use Database that are indicative of mining or extraction activities.

Are there any Historical Mining areas within 1000m of the study site boundary? Yes

The following Historical Mining information is provided by Groundsure:

ID	Distance (m)	Direction	NGR	Details	Date
2	388.0	SW	335616 389646	Unspecified Shaft	1965
3A	475.0	E	336434 389767	Air Shaft	1975
4A	475.0	E	336434 389767	Air Shaft	1965
5A	475.0	E	336434 389767	Air Shaft	1988
6	570.0	NE	336360 390315	Air Shaft	1975
7B	684.0	NE	336575 390221	Air Shaft	1975
8B	684.0	NE	336575 390221	Air Shaft	1989
Not shown	769.0	W	335220 389587	Unspecified Shaft	1965
Not shown	769.0	W	335220 389587	Unspecified Shaft	1988
Not shown	769.0	W	335220 389587	Unspecified Shaft	1975
Not shown	847.0	E	336789 390124	Air Shaft	1975
Not shown	847.0	E	336789 390124	Air Shaft	1989

5.2 Coal Mining

This dataset provides information as to whether the study site lies within a known coal mining affected area as defined by the coal authority.

Are there any Coal Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.3 Johnson Poole and Bloomer

This dataset provides information as to whether the study site lies within an area where JPB hold information relating to mining.

Are there any JPB Mining areas within 1000m of the study site boundary? No

The following information provided by JPB is not represented on mapping: Database searched and no data found.

5.4 Non-Coal Mining

This dataset provides information as to whether the study site lies within an area which may have been subject to non-coal historic mining.

Are there any Non-Coal Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.5 Non-Coal Mining Cavities

This dataset provides information from the Peter Brett Associates (PBA) mining cavities database (compiled for the national study entitled "Review of mining instability in Great Britain, 1990" PBA has also continued adding to this database) on mineral extraction by mining.

Are there any Non-Coal Mining cavities within 1000m of the study site boundary? Yes

The following Non-Coal Mining Cavities information provided by Peter Brett Associates:

ID	Distance (m)	Direction	NGR	Address	Superficial Deposits	Bedrock Deposits	Extracted Mineral
1	656.0	SE	336500 389500	Edge hill, Merseyside	-	-	Unknown

5.6 Natural Cavities

This dataset provides information based on Peter Brett Associates natural cavities database.

Are there any Natural Cavities within 1000m of the study site boundary? No

Database searched and no data found.

5.7 Brine Extraction

This data provides information from the Coal Authority issued on behalf of the Cheshire Brine Subsidence Compensation Board.

Are there any Brine Extraction areas within 1000m of the study site boundary? No

Database searched and no data found.

5.8 Gypsum Extraction

This dataset provides information on Gypsum extraction from British Gypsum records.

Are there any Gypsum Extraction areas within 1000m of the study site boundary? No

Database searched and no data found.

5.9 Tin Mining

This dataset provides information on tin mining areas and is derived from tin mining records. This search is based upon postcode information to a sector level..

Are there any Tin Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.10 Clay Mining

This dataset provides information on Kaolin and Ball Clay mining from relevant mining records.

Are there any Clay Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

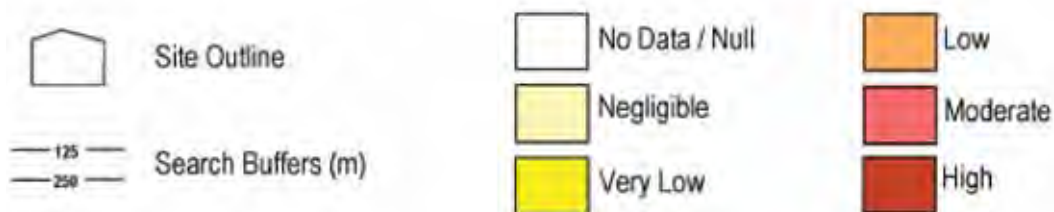
6 Natural Ground Subsidence

6.1 Shrink-Swell Clay Map

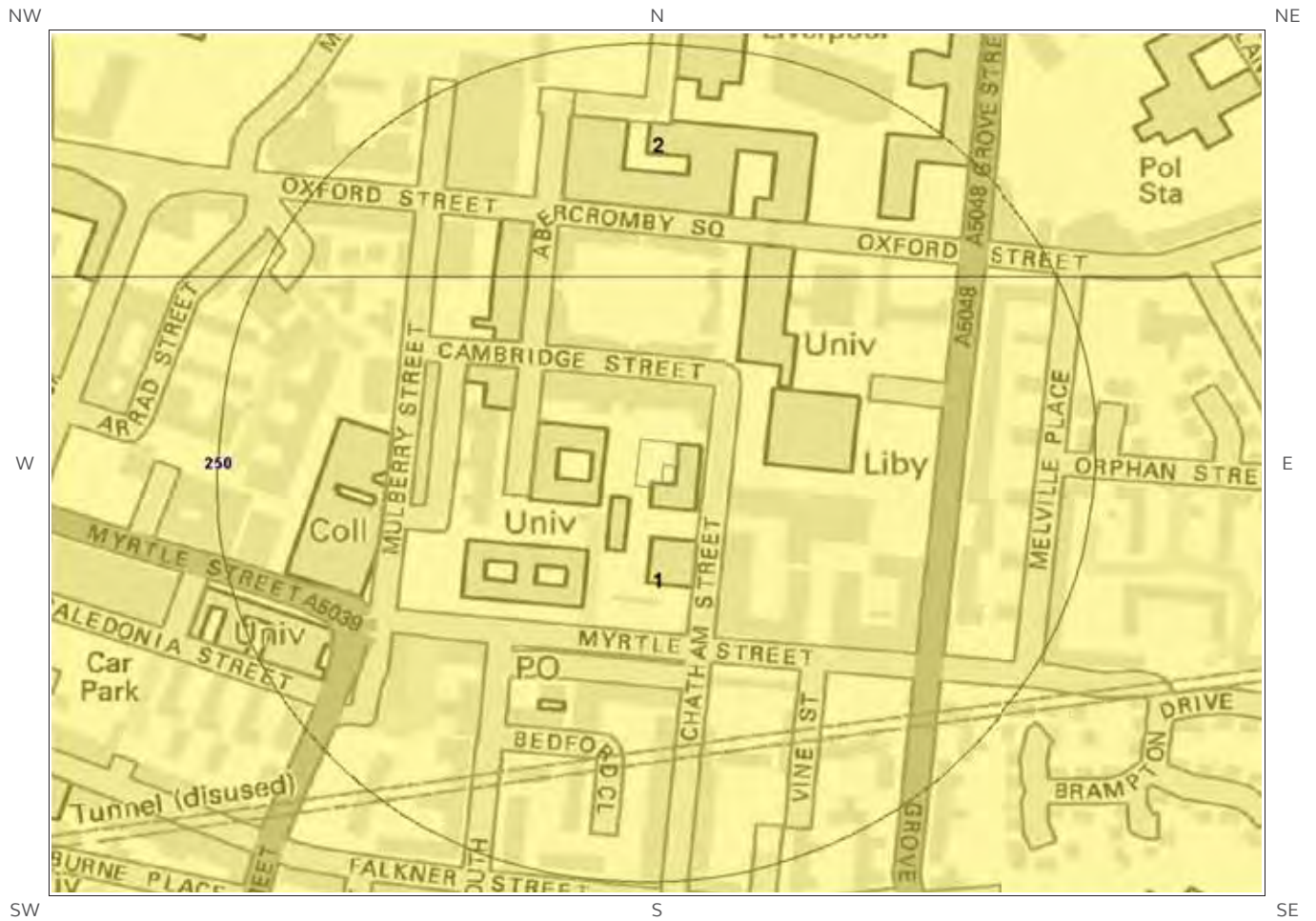


Shrink Swell Clay Legend

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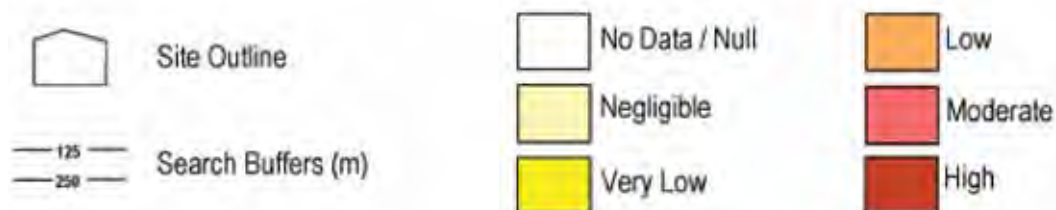


6.2 Landslides Map

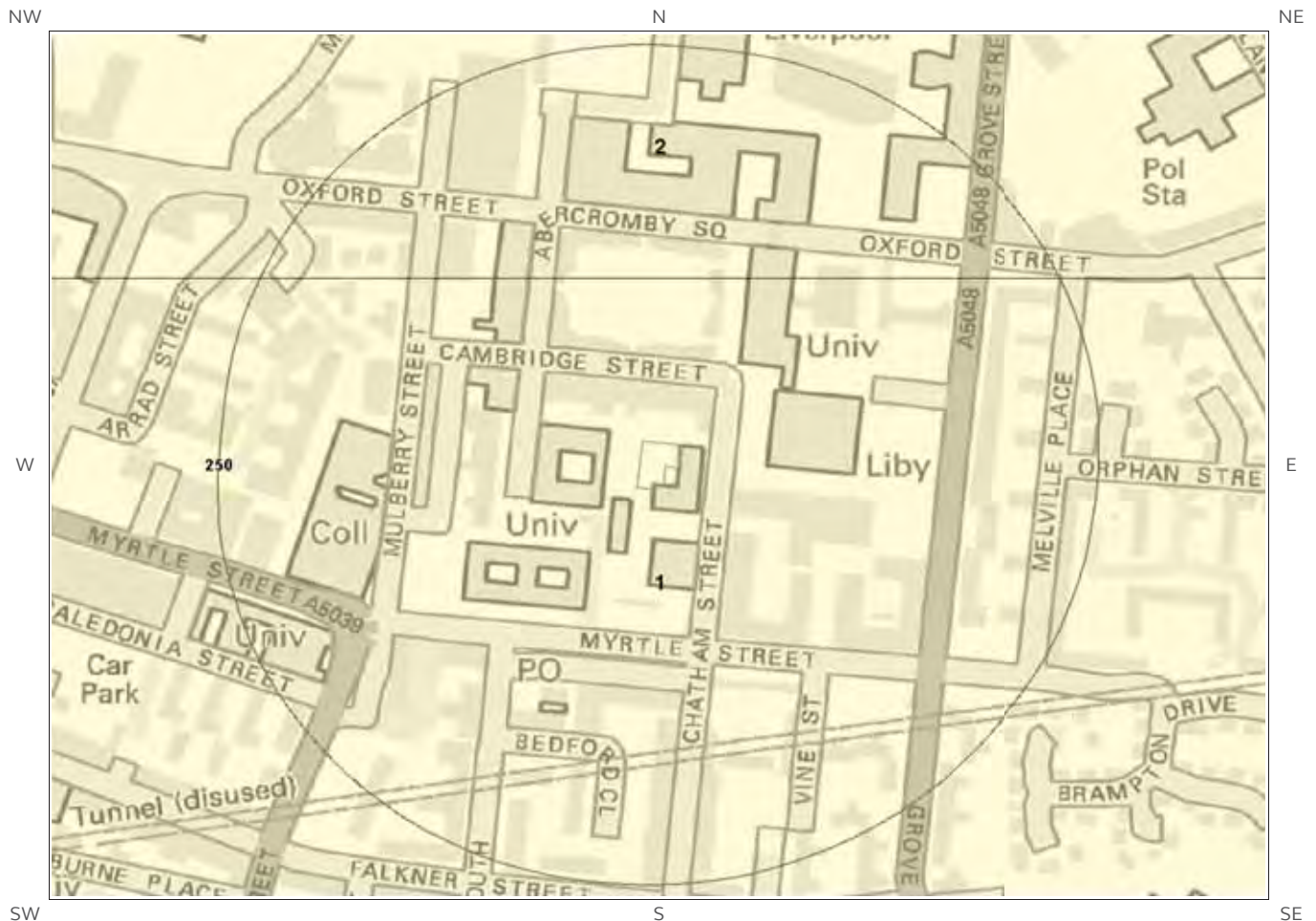


Landslides Legend

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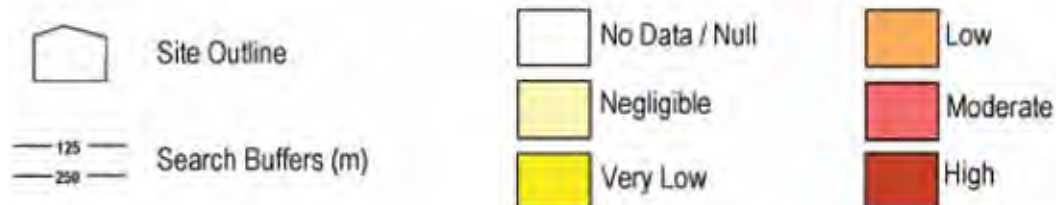


6.3 Ground Dissolution of Soluble Rocks Map

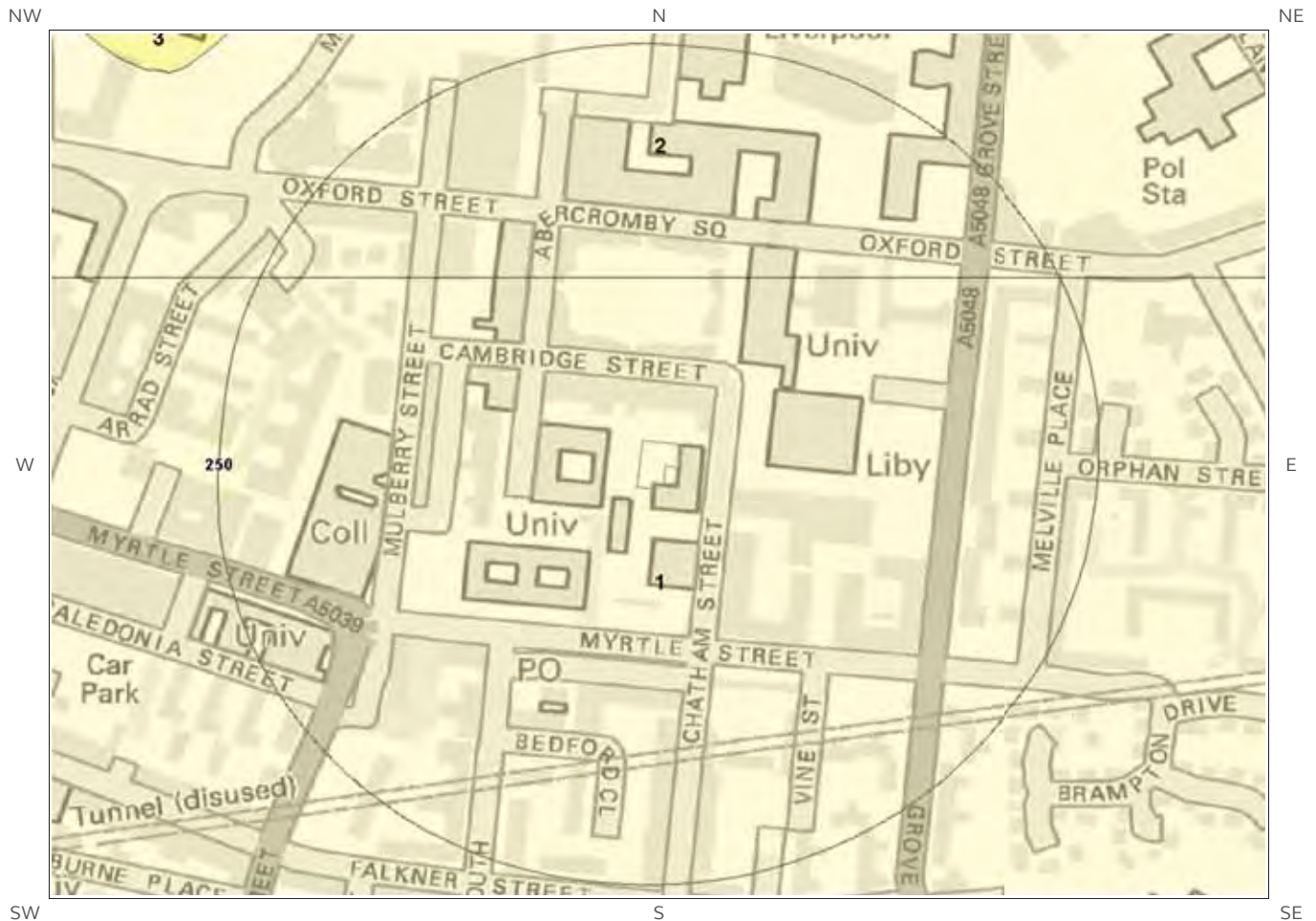


Ground Dissolution
Soluble Rocks Legend

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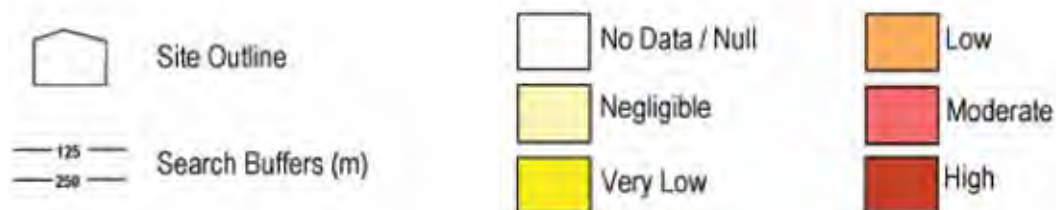


6.4 Compressible Deposits Map



Compressible Deposits Legend

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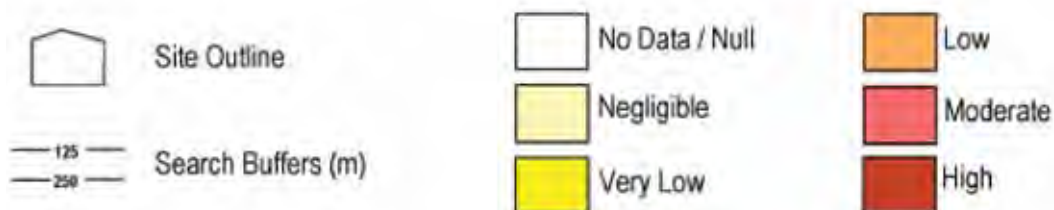


6.5 Collapsible Deposits Map



Collapsible Deposits Legend

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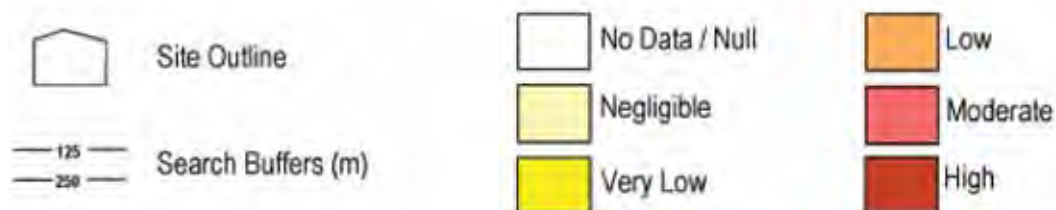


6.6 Running Sand Map



Running Sand Legend

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6 Natural Ground Subsidence

The National Ground Subsidence rating is obtained through the 6 natural ground stability hazard datasets, which are supplied by the British Geological Survey (BGS).

The following GeoSure data represented on the mapping is derived from the BGS Digital Geological map of Great Britain at 1:50,000 scale.

What is the maximum hazard rating of natural subsidence within the study site* boundary? Very Low

6.1 Shrink-Swell Clays

The following Shrink Swell information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	Ground conditions predominantly non-plastic. No special actions required to avoid problems due to shrink-swell clays. No special ground investigation required, and increased construction costs or increased financial risks are unlikely likely due to potential problems with shrink-swell clays.
2	2.0	SE	Very Low	Ground conditions predominantly low plasticity. No special actions required to avoid problems due to shrink-swell clays. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with shrink-swell clays.

6.2 Landslides

The following Landslides information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Very Low	Slope instability problems are unlikely to be present. No special actions required to avoid problems due to landslides. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with landslides.

* This includes an automatically generated 50m buffer zone around the site

6.3 Ground Dissolution of Soluble Rocks

The following Ground Dissolution information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with soluble rocks.

6.4 Compressible Deposits

The following Compressible Deposits information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	No indicators for compressible deposits identified. No special actions required to avoid problems due to compressible deposits. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with compressible deposits.

6.5 Collapsible Deposits

The following Collapsible Rocks information provided by the British Geological Survey:

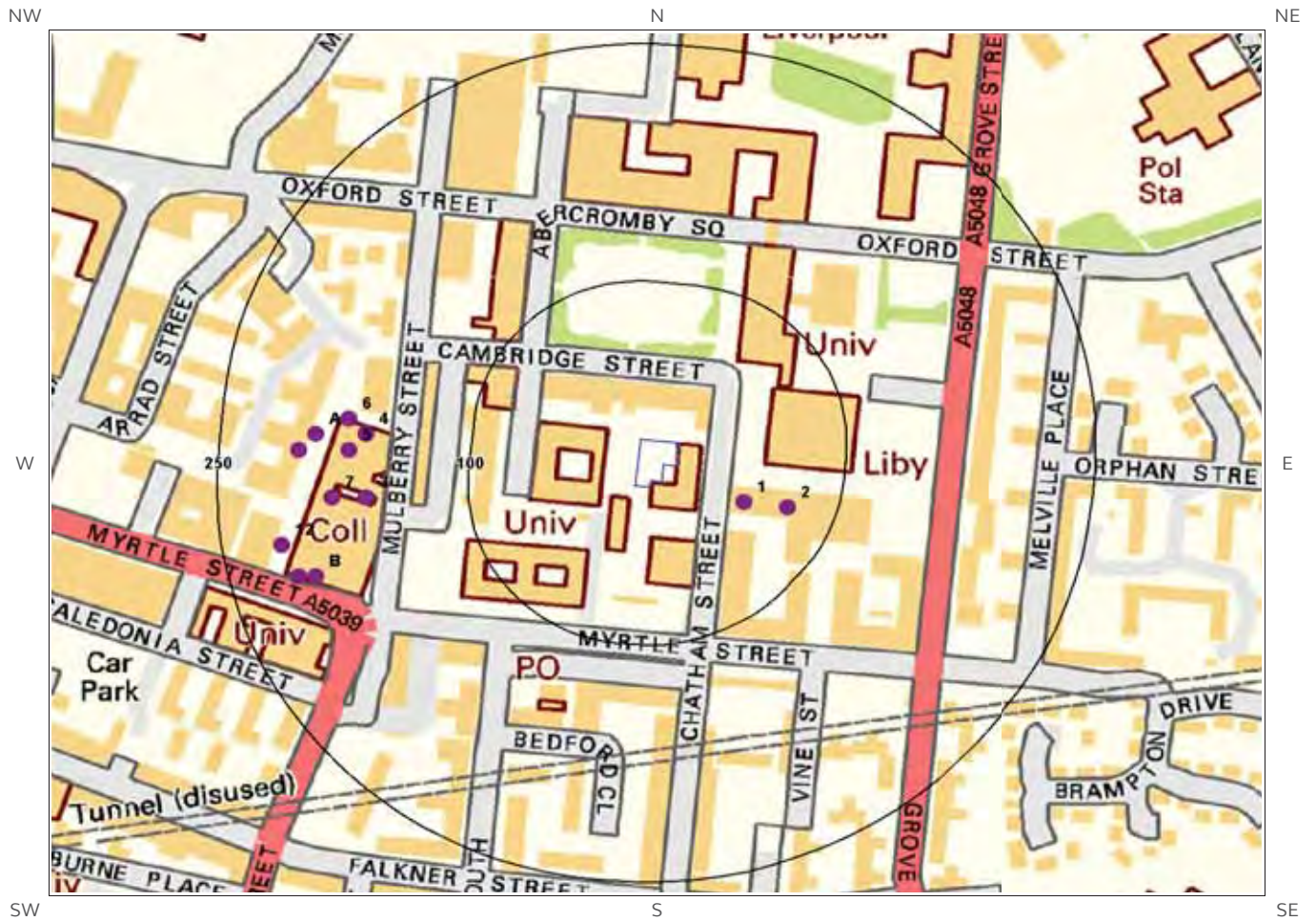
ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Very Low	Deposits with potential to collapse when loaded and saturated are unlikely to be present. No special ground investigation required or increased construction costs or increased financial risk due to potential problems with collapsible deposits.

6.6 Running Sands

The following Running Sands information provided by the British Geological Survey:

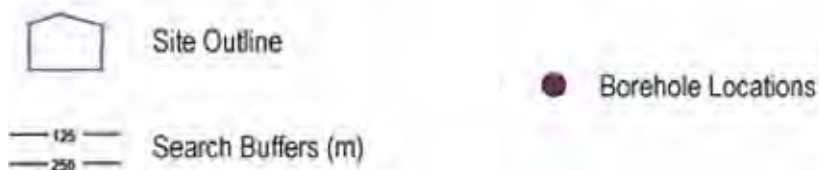
ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	No indicators for running sand identified. No special actions required to avoid problems due to running sand. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with running sand.
2	2.0	SE	Very Low	Very low potential for running sand problems if water table rises or if sandy strata are exposed to water. No special actions required, to avoid problems due to running sand. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with running sand.

7 Borehole Records Map



Borehole Records Legend

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7 Borehole Records

The systematic analysis of data extracted from the BGS Borehole Records database provides the following information.

Records of boreholes within 250m of the study site boundary:

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ID	Distance (m)	Direction	NGR	BGS Reference	Drilled Length	Borehole Name
1	46.0	SE	336006 389857	SJ38NE286	7.1	LIVERPOOL UNIVERSITY 2
2	71.0	E	336032 389854	SJ38NE285	8.1	LIVERPOOL UNIVERSITY 1
3	161.0	W	335780 389860	SJ38NE266	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET TP 4
4	164.0	W	335780 389900	SJ38NE259	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET 1
5	173.0	W	335770 389890	SJ38NE265	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET TP 3
6	175.0	W	335770 389910	SJ38NE263	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET TP 1
7	181.0	W	335760 389860	SJ38NE261	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET 3
8A	194.0	W	335750 389900	SJ38NE264	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET TP 2
9B	200.0	W	335750 389810	SJ38NE267	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET TP 5
10A	202.0	W	335740 389890	SJ38NE260	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET 2
11B	209.0	W	335740 389810	SJ38NE262	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET 4
12	215.0	W	335730 389830	SJ38NE268	-1.0	CITY COLLEGE DEVELOPMENT MULBERRY STREET TP 6

The borehole records are available using the hyperlinks below: Please note that if the donor of the borehole record has requested the information be held as commercial-in-confidence, the additional data will be held separately by the BGS and a formal request must be made for its release.

#1: scans.bgs.ac.uk/sobi_scans/boreholes/157988

#2: scans.bgs.ac.uk/sobi_scans/boreholes/157987

8 Estimated Background Soil Chemistry

Records of background estimated soil chemistry within 250m of the study site boundary:

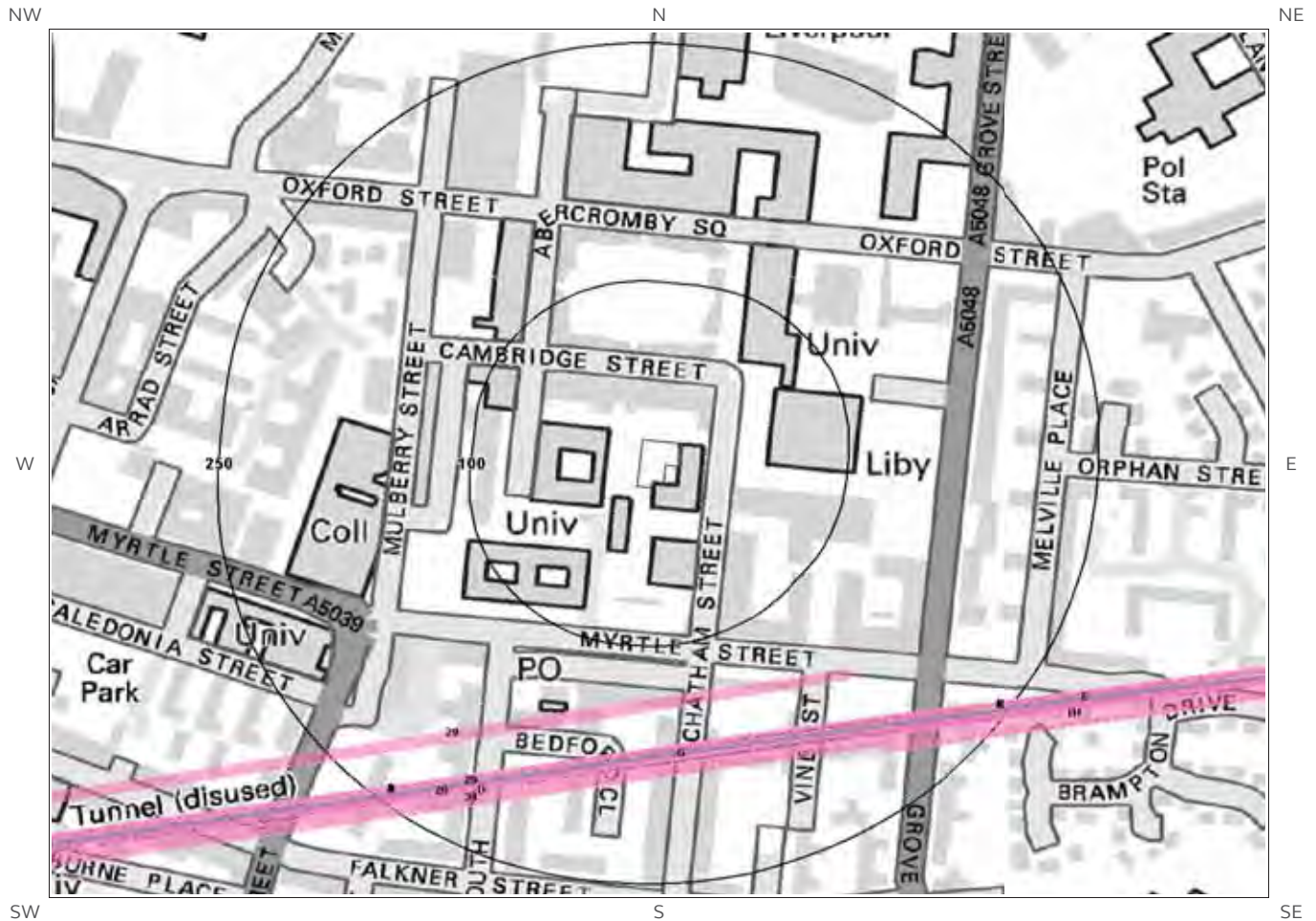
7

For further information on how this data is calculated and limitations upon its use, please see the Groundsure Geo Insight User Guide, available on request.

Distance (m)	Direction	Sample Type	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Nickel (Ni)	Lead (Pb)
0.0	On Site	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	<15 mg/kg	100 - 200 mg/kg
0.0	On Site	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	15 - 30 mg/kg	100 - 200 mg/kg
32.0	E	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	15 - 30 mg/kg	100 - 200 mg/kg
32.0	E	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	15 - 30 mg/kg	100 - 200 mg/kg
39.0	NE	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	<15 mg/kg	100 - 200 mg/kg
39.0	NE	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	<15 mg/kg	100 - 200 mg/kg
50.0	W	RuralSoil	<15 mg/kg	<1.8 mg/kg	60 - 90 mg/kg	<15 mg/kg	100 - 200 mg/kg

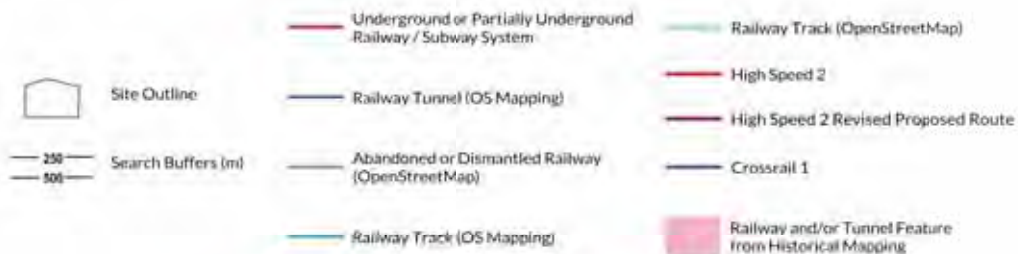
*As this data is based upon underlying 1:50,000 scale geological information, a 50m buffer has been added to the search radius.

9 Railways and Tunnels Map



Railways and Tunnels Legend

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9 Railways and Tunnels

9.1 Tunnels

This data is derived from OpenStreetMap and provides information on the possible locations of underground railway systems in the UK - the London Underground, the Tyne & Wear Metro and the Glasgow Subway.

Have any underground railway lines been identified within the study site boundary? No

Have any underground railway lines been identified within 250m of the study site boundary? No

Database searched and no data found.

Any records that have been identified are represented on the Railways and Tunnels Map.

This data is derived from Ordnance Survey mapping and provides information on the possible locations of railway tunnels forming part of the UK overground railway network.

Have any other railway tunnels been identified within the site boundary? No

Have any other railway tunnels been identified within 250m of the site boundary? No

Database searched and no data found.

Any records that have been identified are represented on the Railways and Tunnels Map.

9.2 Historical Railway and Tunnel Features

This data is derived from Groundsure's unique Historical Land-use Database and contains features relating to tunnels, railway tracks or associated works that have been identified from historical Ordnance Survey mapping.

Have any historical railway or tunnel features been identified within the study site boundary? No

Have any historical railway or tunnel features been identified within 250m of the study site boundary? Yes

ID	Distance (m)	Direction	NGR	Details	Date
28	131	S	335440 389650	Tunnel	1928
1A	162	S	335750 389669	Tunnel	1980
2A	162	S	335750 389669	Tunnel	1989
3	163	S	335424 389617	Tunnel	1953
4	163	S	335424 389617	Tunnel	1967
5A	163	S	335750 389668	Tunnel	1953

ID	Distance (m)	Direction	NGR	Details	Date
6A	163	S	335750 389668	Tunnel	1977
7A	163	S	335750 389668	Tunnel	1953
8A	163	S	335750 389668	Tunnel	1968
9B	164	S	336250 389741	Disused Tunnel	1996
10B	164	S	336250 389741	Disused Tunnel	1994
11B	164	S	336250 389741	Disused Tunnel	1994
12A	164	S	335750 389668	Disused Tunnel	1993
13A	164	S	335750 389668	Disused Tunnel	1999
29	164	S	335267 389597	Tunnel	1938
14C	165	S	336379 389759	Tunnel	1953
15C	165	S	336379 389759	Tunnel	1965
16B	165	S	336250 389740	Disused Tunnel	1987
17B	165	S	336250 389740	Disused Tunnel	1989
18B	165	S	336250 389740	Disused Tunnel	1975
19B	165	S	336250 389740	Tunnel	1953
30G	165	S	335878 389685	Tunnel	1967
31G	165	S	335878 389685	Tunnel	1956
32G	165	S	335878 389685	Disused Tunnel	1989
33G	165	S	335878 389685	Disused Tunnel	1987
20	169	S	n/a	Tunnel	1908
21D	171	S	335291 389594	Tunnel	1927
22D	171	S	335291 389594	Tunnel	1927
23D	171	S	335291 389594	Tunnel	1908
34	175	S	335266 389586	Tunnel	1906
24E	204	SE	n/a	Tunnel	1905
25E	204	SE	n/a	Tunnel	1889
26F	207	SE	336414 389754	Tunnel	1927
27F	207	SE	336414 389754	Tunnel	1908
35H	207	SE	336418 389754	Tunnel	1938
36H	207	SE	336418 389754	Tunnel	1906

ID	Distance (m)	Direction	NGR	Details	Date
37H	207	SE	336418 389754	Tunnel	1925
38F	208	SE	336422 389755	Tunnel	1925

Any records that have been identified are represented on the Railways and Tunnels Map.

9.3 Historical Railways

This data is derived from OpenStreetMap and provides information on the possible alignments of abandoned or dismantled railway lines in proximity to the study site.

Have any historical railway lines been identified within the study site boundary? No

Have any historical railway lines been identified within 250m of the study site boundary? Yes

Distance (m)	Direction	Status
168	S	Abandoned

Multiple sections of the same track may be listed in the detail above

Any records that have been identified are represented on the Railways and Tunnels Map.

9.4 Active Railways

These datasets are derived from Ordnance Survey mapping and OpenStreetMap and provide information on the possible locations of active railway lines in proximity to the study site.

Have any active railway lines been identified within the study site boundary? No

Have any active railway lines been identified within 250m of the study site boundary? No

Database searched and no data found.

Multiple sections of the same track may be listed in the detail above

Any records that have been identified are represented on the Railways and Tunnels Map.

9.5 Railway Projects

These datasets provide information on the location of large scale railway projects High Speed 2 and Crossrail 1 .

Is the study site within 5km of the route of the High Speed 2 rail project? No

Is the study site within 500m of the route of the Crossrail 1 rail project? No

Further information on proximity to these routes, the project construction status and associated works can be obtained through the purchase of a Groundsure HS2 and Crossrail 1 Report.

The route data has been digitised from publicly available maps by Groundsure. The route as provided relates to the Crossrail 1 project only, and does not include any details of the Crossrail 2 project, as final details of the route for Crossrail 2 are still under consultation.

Please note that this assessment takes account of both the original Phase 2b proposed route and the amended route proposed in 2016. As the Phase 2b route is still under consultation, Groundsure are providing information on both options until the final route is formally confirmed. Practitioners should take account of this uncertainty when advising clients.

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BGS Geological Hazards Reports and general geological enquiries



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Standard Terms and Conditions

Groundsure's Terms and Conditions can be viewed online at this link:
[**https://www.groundsure.com/terms-and-conditions-sept-2016/**](https://www.groundsure.com/terms-and-conditions-sept-2016/)



Terra Consult

Bold Business Centre, Bold Lane,
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Groundsure
Reference:

HMD-147-4340083

Your Reference: 3571-PO-001978

Report Date 11 Oct 2017

Report Delivery Method: Email - pdf

Enviro Insight

Address: Cypress Building, LIVERPOOL, L7 7EL

Dear Sir/ Madam,

Thank you for placing your order with Groundsure. Please find enclosed the **Groundsure Enviro Insight** as requested.

If you need any further assistance, please do not hesitate to contact our helpline on 08444 159000 quoting the above Groundsure reference number.

Yours faithfully,

A handwritten signature in black ink, appearing to be 'J. O.', followed by a comma.

Managing Director
Groundsure Limited

Enc.
Groundsure Enviroinsight



Enviro Insight

Address: Cypress Building, LIVERPOOL, L7 7EL

Date: 11 Oct 2017

Reference: HMD-147-4340083

Client: Terra Consult

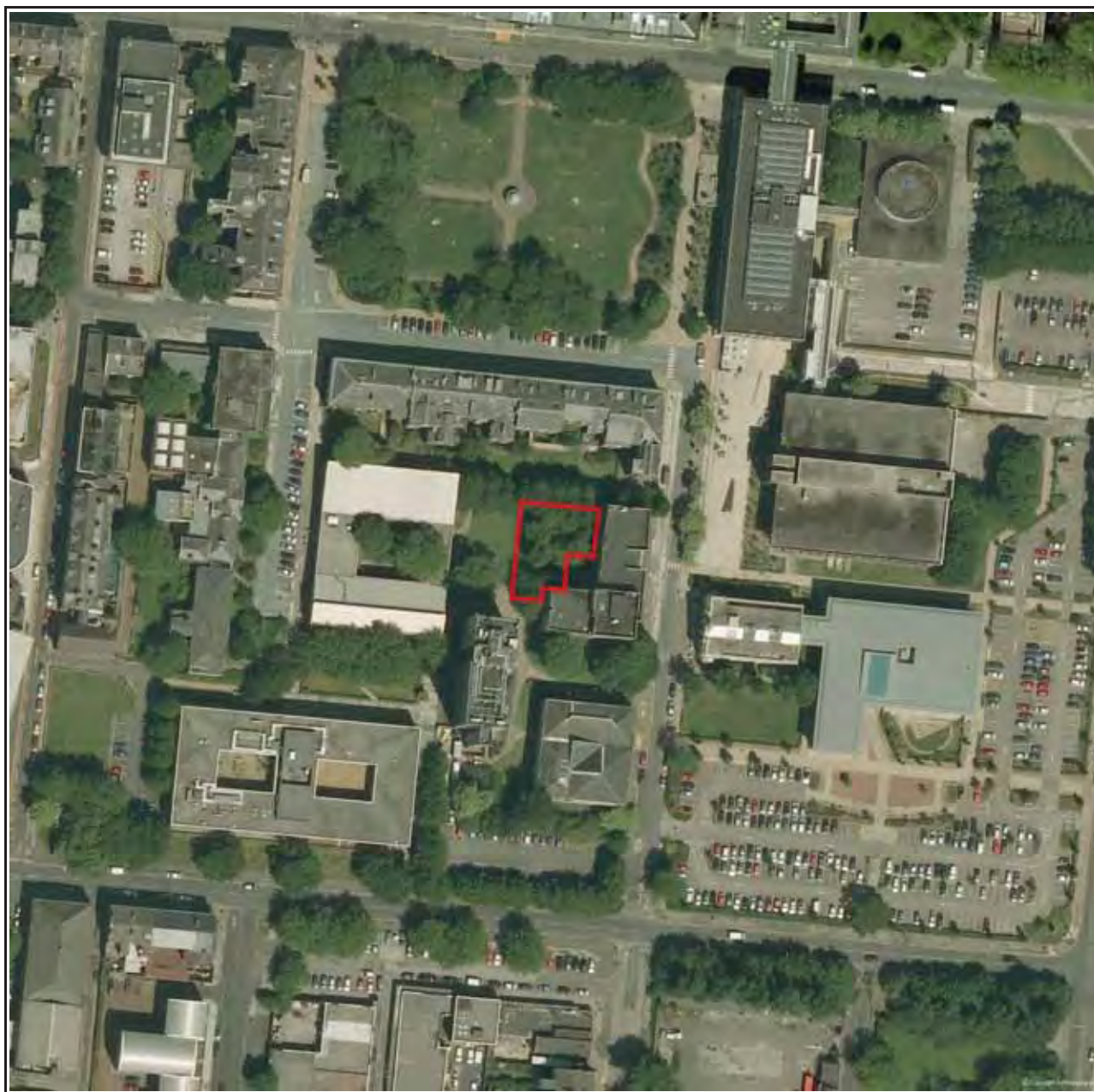
NW

N

NE

W

E



SW

S

SE

Aerial Photograph Capture date: 24-Jun-2009

Grid Reference: 335954,389892

Site Size: 0.05ha

Report Reference: HMD-147-4340083

Client Reference: 3571-PO-001978

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Overview of Findings

For further details on each dataset, please refer to each individual section in the main report as listed. Where the database has been searched a numerical result will be recorded. Where the database has not been searched '-' will be recorded.

Section 1: Historical Industrial Sites	On-site	0-50	51-250	251-500
1.1 Potentially Contaminative Uses identified from 1:10,000 scale mapping	0	0	26	65
1.2 Additional Information – Historical Tank Database	0	0	1	19
1.3 Additional Information – Historical Energy Features Database	0	7	31	73
1.4 Additional Information – Historical Petrol and Fuel Site Database	0	0	0	0
1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database	0	0	22	42
1.6 Potentially Infilled Land	0	0	12	24
Section 2: Environmental Permits, Incidents and Registers	On-site	0-50m	51-250	251-500
2.1 Industrial Sites Holding Environmental Permits and/or Authorisations				
2.1.1 Records of historic IPC Authorisations	0	0	0	0
2.1.2 Records of Part A(1) and IPPC Authorised Activities	0	0	0	0
2.1.3 Records of Red List Discharge Consents	0	0	0	0
2.1.4 Records of List 1 Dangerous Substances Inventory sites	0	0	0	0
2.1.5 Records of List 2 Dangerous Substances Inventory sites	0	0	0	0
2.1.6 Records of Part A(2) and Part B Activities and Enforcements	0	0	0	0
2.1.7 Records of Category 3 or 4 Radioactive Substances Authorisations	0	0	6	0
2.1.8 Records of Licensed Discharge Consents	0	0	0	0
2.1.9 Records of Water Industry Referrals	0	0	0	0
2.1.10 Records of Planning Hazardous Substance Consents and Enforcements within 500m of the study site	0	0	0	0
2.2 Records of COMAH and NIHHS sites	0	0	0	0
2.3 Environment Agency/Natural Resources Wales Recorded Pollution Incidents				
2.3.1 National Incidents Recording System, List 2	0	0	1	0
2.3.2 National Incidents Recording System, List 1	0	0	0	0
2.4 Sites Determined as Contaminated Land under Part 2A EPA 1990	0	0	0	0

Section 3: Landfill and Other Waste Sites	On-site	0-50m	51-250	251-500	501-1000	1000-1500
---	---------	-------	--------	---------	----------	-----------

3.1 Landfill Sites						
3.1.1 Environment Agency/Natural Resources Wales Registered Landfill Sites	0	0	0	0	0	Not searched
3.1.2 Environment Agency/Natural Resources Wales Historic Landfill Sites	0	0	0	0	1	0
3.1.3 BGS/DoE Landfill Site Survey	0	0	0	0	0	0
3.1.4 Records of Landfills in Local Authority and Historical Mapping Records	0	0	0	0	0	0
3.2 Landfill and Other Waste Sites Findings						
3.2.1 Operational and Non-Operational Waste Treatment, Transfer and Disposal Sites	0	0	0	14	Not searched	Not searched
3.2.2 Environment Agency/Natural Resources Wales Licensed Waste Sites	0	0	0	0	2	5

Section 4: Current Land Use	On-site	0-50m	51-250	251-500
4.1 Current Industrial Sites Data	0	1	6	Not searched
4.2 Records of Petrol and Fuel Sites	0	0	0	0
4.3 National Grid Underground Electricity Cables	0	0	0	0
4.4 National Grid Gas Transmission Pipelines	0	0	0	0

Section 5: Geology	
5.1 Are there any records of Artificial Ground and Made Ground present beneath the study site?	No
5.2 Are there any records of Superficial Ground and Drift Geology present beneath the study site?	Yes
5.3 For records of Bedrock and Solid Geology beneath the study site see the detailed findings section.	

Section 6: Hydrogeology and Hydrology	0-500m
6.1 Are there any records of Strata Classification in the Superficial Geology within 500m of the study site?	Yes
6.2 Are there any records of Strata Classification in the Bedrock Geology within 500m of the study site?	Yes
	On-site 0-50m 51-250 251-500 501-1000 1000-2000
6.3 Groundwater Abstraction Licences (within 2000m of the study site)	0 0 0 0 3 10
6.4 Surface Water Abstraction Licences (within 2000m of the study site)	0 0 0 0 0 0
6.5 Potable Water Abstraction Licences (within 2000m of the study site)	0 0 0 0 0 3
6.6 Source Protection Zones (within 500m of the study site)	0 0 0 0 Not searched Not searched
6.7 Source Protection Zones within Confined Aquifer	0 0 0 0 Not searched Not searched
6.8 Groundwater Vulnerability and Soil Leaching Potential (within 500m of the study site)	1 0 1 0 Not searched Not searched

Section 6: Hydrogeology and Hydrology

0-500m

	On-site	0-50m	51-250	251-500	501-1000	1000-1500
6.9 Is there any Environment Agency/Natural Resources Wales information on river quality within 1500m of the study site?	No	No	No	No	No	No
6.10 Detailed River Network entries within 500m of the site	0	0	0	0	Not searched	Not searched
6.11 Surface water features within 250m of the study site	No	No	No	Not searched	Not searched	Not searched

Section 7: Flooding

7.1 Are there any Environment Agency Zone 2 floodplains within 250m of the study site?	No					
7.2 Are there any Environment Agency/Natural Resources Wales Zone 3 floodplains within 250m of the study site	No					
7.3 What is the Risk of flooding from Rivers and the Sea (RoFRaS) rating for the study site?	Very Low					
7.4 Are there any Flood Defences within 250m of the study site?	No					
7.5 Are there any areas benefiting from Flood Defences within 250m of the study site?	No					
7.6 Are there any areas used for Flood Storage within 250m of the study site?	No					
7.7 What is the maximum BGS Groundwater Flooding susceptibility within 50m of the study site?	Limited potential					
7.8 What is the BGS confidence rating for the Groundwater Flooding susceptibility areas?	Low					

Section 8: Designated Environmentally Sensitive Sites

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
8.1 Records of Sites of Special Scientific Interest (SSSI)	0	0	0	0	0	0
8.2 Records of National Nature Reserves (NNR)	0	0	0	0	0	0
8.3 Records of Special Areas of Conservation (SAC)	0	0	0	0	0	0
8.4 Records of Special Protection Areas (SPA)	0	0	0	0	0	0
8.5 Records of Ramsar sites	0	0	0	0	0	0
8.6 Records of Ancient Woodlands	0	0	0	0	0	0
8.7 Records of Local Nature Reserves (LNR)	0	0	0	0	0	0
8.8 Records of World Heritage Sites	0	0	0	1	1	0
8.9 Records of Environmentally Sensitive Areas	0	0	0	0	0	0

Section 8: Designated Environmentally Sensitive Sites

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
8.10 Records of Areas of Outstanding Natural Beauty (AONB)	0	0	0	0	0	0
8.11 Records of National Parks	0	0	0	0	0	0
8.12 Records of Nitrate Sensitive Areas	0	0	0	0	0	0
8.13 Records of Nitrate Vulnerable Zones	0	0	0	0	0	1
8.14 Records of Green Belt land	0	0	0	0	0	0

Section 9: Natural Hazards

9.1 What is the maximum risk of natural ground subsidence?

Very Low

9.1.1 What is the maximum Shrink-Swell hazard rating identified on the study site?

Very Low

9.1.2 What is the maximum Landslides hazard rating identified on the study site?

Very Low

9.1.3 What is the maximum Soluble Rocks hazard rating identified on the study site?

Negligible

9.1.4 What is the maximum Compressible Ground hazard rating identified on the study site?

Negligible

9.1.5 What is the maximum Collapsible Rocks hazard rating identified on the study site?

Very Low

9.1.6 What is the maximum Running Sand hazard rating identified on the study site?

Very Low

9.2 Radon

9.2.1 Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level?

The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

9.2.2 Is the property in an area where Radon Protection are required for new properties or extensions to existing ones as described in publication BR211 by the Building Research Establishment?

No radon protective measures are necessary.

Section 10: Mining

10.1 Are there any coal mining areas within 75m of the study site?

No

10.2 Are there any Non-Coal Mining areas within 50m of the study site boundary?

No

10.3 Are there any brine affected areas within 75m of the study site?

No

Using this report

The following report is designed by Environmental Consultants for Environmental Professionals bringing together the most up-to-date market leading environmental data. This report is provided under and subject to the Terms & Conditions agreed between Groundsure and the Client. The document contains the following sections:

1. Historical Industrial Sites

Provides information on past land uses that may pose a risk to the study site in terms of potential contamination from activities or processes. Potentially Infilled Land features are also included. This search is conducted using radii of up to 500m.

2. Environmental Permits, Incidents and Registers

Provides information on Regulated Industrial Activities and Pollution Incidents as recorded by Regulatory Authorities, and sites determined as Contaminated Land. This search is conducted using radii up to 500m.

3. Landfills and Other Waste Sites

Provides information on landfills and other waste sites that may pose a risk to the study site. This search is conducted using radii up to 1500m.

4. Current Land Uses

Provides information on current land uses that may pose a risk to the study site in terms of potential contamination from activities or processes. These searches are conducted using radii of up to 500m. This includes information on potentially contaminative industrial sites, petrol stations and fuel sites as well as high pressure gas pipelines and underground electricity transmission lines.

5. Geology

Provides information on artificial and superficial deposits and bedrock beneath the study site.

6. Hydrogeology and Hydrology

Provides information on productive strata within the bedrock and superficial geological layers, abstraction licenses, Source Protection Zones (SPZs) and river quality. These searches are conducted using radii of up to 2000m.

7. Flooding

Provides information on river and coastal flooding, flood defences, flood storage areas and groundwater flood areas. This search is conducted using radii of up to 250m.

8. Designated Environmentally Sensitive Sites

Provides information on the Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar sites, Local Nature Reserves (LNR), Areas of Outstanding Natural Beauty (AONB), National Parks (NP), Environmentally Sensitive Areas, Nitrate Sensitive Areas, Nitrate Vulnerable Zones and World Heritage Sites and Scheduled Ancient Woodland. These searches are conducted using radii of up to 2000m.

9. Natural Hazards

Provides information on a range of natural hazards that may pose a risk to the study site. These factors include natural ground subsidence and radon..

10. Mining

Provides information on areas of coal and non-coal mining and brine affected areas.

11. Contacts

This section of the report provides contact points for statutory bodies and data providers that may be able to provide further information on issues raised within this report. Alternatively, Groundsure provide a free Technical Helpline (08444 159000) for further information and guidance.

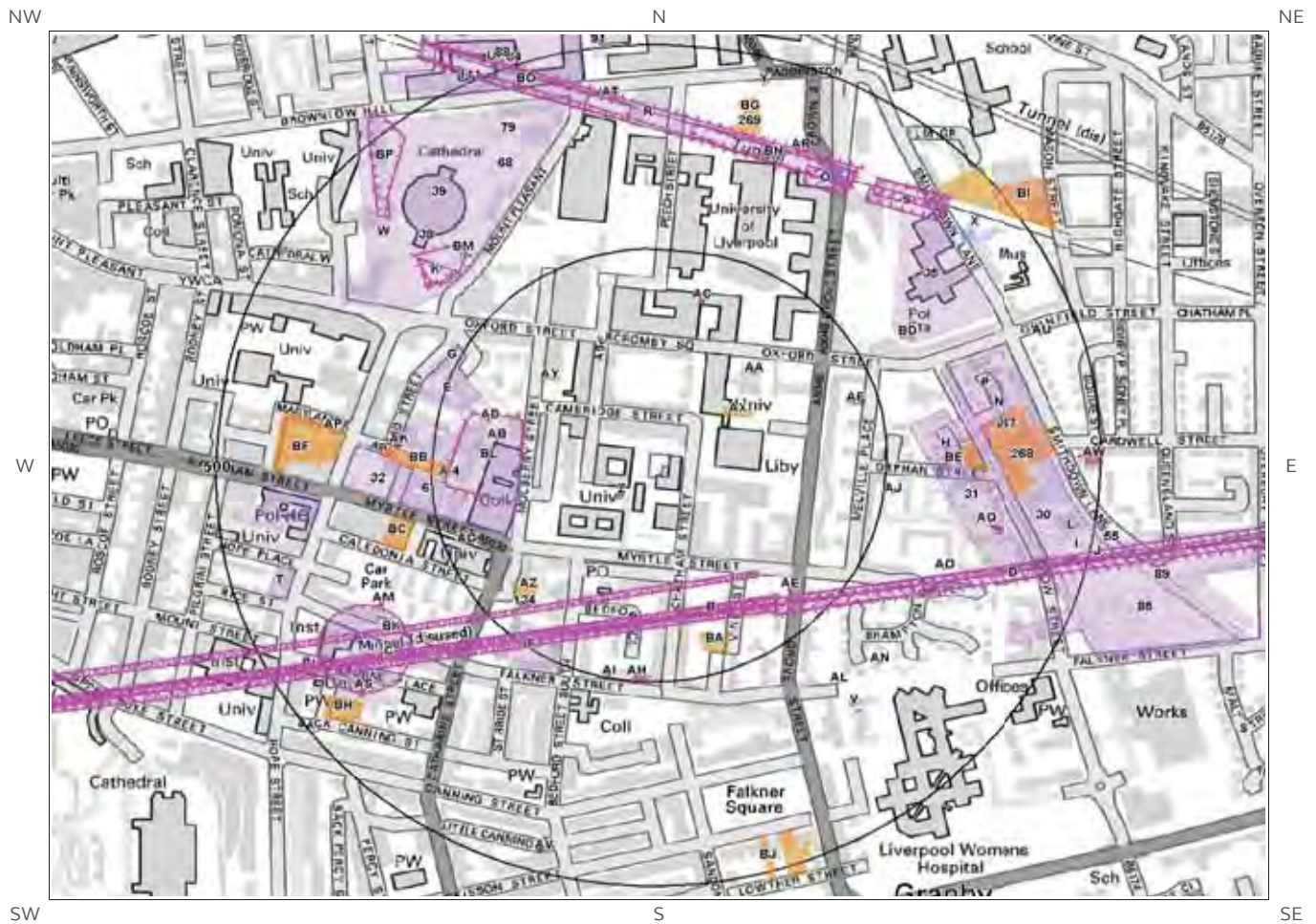
Note: Maps

Only certain features are placed on the maps within the report. All features represented on maps found within this search are given an identification number. This number identifies the feature on the mapping and correlates it to the additional information provided below. This identification number precedes all other information and takes the following format -Id: 1, Id: 2, etc. Where numerous features on the same map are in such close proximity that the numbers would obscure each other a letter identifier is used instead to represent the features. (e.g. Three features which overlap may be given the identifier "A" on the map and would be identified separately as features 1A, 3A, 10A on the data tables provided).

Where a feature is reported in the data tables to a distance greater than the map area, it is noted in the data table as "Not Shown".

All distances given in this report are in Metres (m). Directions are given as compass headings such as N: North, E: East, NE: North East from the nearest point of the study site boundary.

1. Historical Land Use



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1. Historical Industrial Sites

1.1 Potentially Contaminative Uses identified from 1:10,000 scale Mapping

The systematic analysis of data extracted from standard 1:10,560 and 1:10,000 scale historical maps provides the following information:

Records of sites with a potentially contaminative past land use within 500m of the search boundary: 91

ID	Distance [m]	Direction	Use	Date
1BK	131	S	Tunnel	1928
2A	147	W	Hospitals	1987
3A	147	W	Hospitals	1989
4	148	W	Hospitals	1967
5BL	150	W	Cemetery	1851
6	157	W	Hospitals	1956
7C	164	S	Tunnel	1938
8B	165	S	Tunnel	1967
9B	165	S	Tunnel	1956
10C	175	S	Tunnel	1906
11D	207	SE	Tunnel	1925
12D	207	SE	Tunnel	1906
13D	207	SE	Tunnel	1938
14E	207	W	Hospital	1967
15E	207	W	Hospital	1956
16E	207	W	Hospital	1987
17E	207	W	Hospital	1989
18D	208	SE	Tunnel	1925
19F	210	SW	Hospital	1989
20F	210	SW	Hospital	1987
21F	210	SW	Hospital	1956
22F	210	SW	Hospital	1967
23F	215	SW	Hospital	1938
24G	242	NW	Hospital	1989
25G	242	NW	Hospital	1968
26G	242	NW	Hospital	1975
27H	278	E	Unspecified Commercial/Industrial	1925
28H	278	E	Unspecified Commercial/Industrial	1938
29I	278	E	Railway Sidings	1891
30	278	E	Coal Yards	1891
31	280	E	Unspecified Commercial/Industrial	1925
32	286	W	Police Station	1967

33I	297	E	Railway Sidings	1906
34J	297	E	Railway Sidings	1938
35	299	NE	Police Station	1989
36I	299	E	Railway Sidings	1925
37J	300	E	Railway Sidings	1925
38	306	NW	Workhouse	1851
39	308	NW	Unspecified Workhouse	1906
40BE	309	E	Police Station	1967
41AQ	309	E	Unspecified Commercial/Industrial	1925
42K	314	NW	Unspecified Heap	1975
43K	314	NW	Unspecified Heap	1957
44L	330	E	Unspecified Commercial/Industrial	1938
45L	330	E	Unspecified Commercial/Industrial	1925
46L	330	E	Unspecified Commercial/Industrial	1906
47L	330	E	Unspecified Commercial/Industrial	1925
48P	335	E	Unspecified Commercial/Industrial	1851
49M	336	SW	Unspecified Shaft	1987
50M	336	SW	Unspecified Shaft	1989
51L	341	E	Railway Sidings	1956
52I	341	E	Unspecified Commercial/Industrial	1956
53N	347	E	Unspecified Works	1989
54N	347	E	Unspecified Works	1987
55	360	E	Railway Sidings	1967
56J	360	E	Coal Depot	1967
57	365	E	Railway Sidings	1851
58O	366	NE	Tunnel	1925
59O	366	NE	Tunnel	1906
60O	366	NE	Tunnel	1891
61O	366	NE	Tunnel	1938
62P	374	E	Railway Sidings	1925
63BN	377	N	Tunnel	1968
64Q	377	W	Police Station	1989
65Q	377	W	Police Station	1987
66R	377	N	Tunnel	1975
67R	377	N	Tunnel	1989
68	378	NW	Fever Hospital	1851
69S	385	NE	Tunnel	1938
70S	385	NE	Tunnel	1925
71S	385	NE	Tunnel	1906
72S	385	NE	Tunnel	1891
73M	388	SW	Unspecified Shaft	1967

74S	396	NE	Tunnel	1968
75S	396	NE	Tunnel	1975
76S	396	NE	Tunnel	1989
77BO	407	N	Tunnel	1968
78BP	417	NW	Unspecified Heap	1975
79	424	NW	Sheds	1851
80T	426	W	Hospital	1967
81T	426	W	Hospital	1989
82T	426	W	Hospital	1987
83X	443	NE	Unspecified Tank	1975
84	460	N	Lunatic Hospital	1851
85	468	E	Unspecified Commercial/Industrial	1851
86U	469	N	Unspecified Commercial/Industrial	1975
87U	469	N	Unspecified Commercial/Industrial	1989
88	472	N	Infirmary	1938
89	485	E	Railway Sidings	1851
90BI	486	NE	Unspecified Works	1968
91	488	N	Hospital	1851

1.2 Additional Information – Historical Tank Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical tanks within 500m of the search boundary:

20

ID	Distance (m)	Direction	Use	Date
92AB	178	W	Unspecified Tank	1989
93BM	322	NW	Tanks	1927
94V	351	SE	Tanks	1996
95V	351	SE	Tanks	1994
96V	357	SE	Tanks	1996
97V	357	SE	Tanks	1994
98V	363	SE	Tanks	1996
99V	363	SE	Tanks	1994
100W	407	NW	Unspecified Tank	1927
101W	407	NW	Unspecified Tank	1893
102W	407	NW	Unspecified Tank	1908
103W	407	NW	Unspecified Tank	1927
104X	428	NE	Unspecified Tank	1927
105X	428	NE	Unspecified Tank	1908
106X	428	NE	Unspecified Tank	1893

107Y	465	N	Unspecified Tank	1968
108Y	466	N	Unspecified Tank	1968
109Y	466	N	Unspecified Tank	1987
110Y	466	N	Unspecified Tank	1979
111	499	NW	Unspecified Tank	1959

1.3 Additional Information – Historical Energy Features Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical energy features within 500m of the search boundary:

111

ID	Distance (m)	Direction	Use	Date
112Z	32	SW	Electricity Substation	1989
113Z	32	SW	Electricity Substation	1980
114Z	32	SW	Electricity Substation	1967
115Z	32	SW	Electricity Substation	1968
116Z	32	SW	Electricity Substation	1977
117Z	34	SW	Electricity Substation	1999
118Z	34	SW	Electricity Substation	1993
119AA	136	NE	Electricity Substation	1953
120AA	137	NE	Electricity Substation	1953
121AB	177	W	Electricity Substation	1993
122AC	188	N	Generator House	1979
123AC	188	N	Generator House	1987
124AD	189	W	Electricity Substation	1989
125AD	189	W	Electricity Substation	1980
126AD	190	W	Electricity Substation	1993
127AD	190	W	Electricity Substation	1977
128AE	198	SE	Electricity Substation	1994
129AE	198	SE	Electricity Substation	1996
130AE	198	SE	Electricity Substation	1994
131AE	199	SE	Electricity Substation	1987
132AE	199	SE	Electricity Substation	1984
133AE	199	SE	Electricity Substation	1989
134	205	SW	Electricity Substation	1999
135AF	212	E	Electricity Substation	1994
136AF	212	E	Electricity Substation	1996
137AF	212	E	Electricity Substation	1994
138AG	221	W	Electricity Substation	1989
139AG	221	W	Electricity Substation	1980
140AG	223	W	Electricity Substation	1977
141AG	223	W	Electricity Substation	1999

142AG	223	W	Electricity Substation	1993
143AH	240	S	Electricity Substation	1989
144AH	240	S	Electricity Substation	1980
145AH	241	S	Electricity Substation	1977
146AH	241	S	Electricity Substation	1993
147AH	241	S	Electricity Substation	1999
148AI	243	S	Electricity Substation	1967
149AI	244	S	Electricity Substation	1968
150AJ	258	E	Electricity Substation	1987
151AJ	258	E	Electricity Substation	1984
152AJ	260	E	Electricity Substation	1996
153AJ	260	E	Electricity Substation	1994
154AJ	260	E	Electricity Substation	1994
155AJ	260	E	Electricity Substation	1989
156AJ	260	E	Electricity Substation	1975
157AK	287	W	Electricity Substation	1980
158AK	287	W	Electricity Substation	1989
159AK	288	W	Electricity Substation	1953
160AK	288	W	Electricity Substation	1968
161AK	288	W	Electricity Substation	1977
162AK	288	W	Electricity Substation	1953
163AK	288	W	Electricity Substation	1999
164AK	288	W	Electricity Substation	1993
165AK	288	W	Electricity Substation	1967
166AK	288	W	Electricity Substation	1953
167AL	321	SE	Electricity Substation	1994
168AL	321	SE	Electricity Substation	1996
169AM	336	SW	Electricity Substation	1989
170AM	336	SW	Electricity Substation	1980
171AN	337	SE	Electricity Substation	1984
172AN	337	SE	Electricity Substation	1987
173AM	338	SW	Electricity Substation	1977
174AM	338	SW	Electricity Substation	1999
175AM	338	SW	Electricity Substation	1993
176AN	338	SE	Electricity Substation	1989
177AN	338	SE	Electricity Substation	1975
178AN	339	SE	Electricity Substation	1994
179AO	339	E	Electricity Substation	1987
180AO	339	E	Electricity Substation	1984
181AO	340	E	Electricity Substation	1996
182AO	340	E	Electricity Substation	1994
183AO	340	E	Electricity Substation	1994
184AO	340	E	Electricity Substation	1989
185AP	367	W	Electricity Substation	1989
186AP	367	W	Electricity Substation	1980
187AP	367	W	Electricity Substation	1999

188AP	367	W	Electricity Substation	1993
189AP	368	W	Electricity Substation	1977
190AQ	379	E	Electricity Substation	1984
191AQ	379	E	Electricity Substation	1987
192AQ	380	E	Electricity Substation	1994
193AQ	380	E	Electricity Substation	1994
194AQ	380	E	Electricity Substation	1996
195AQ	384	E	Electricity Substation	1989
196AR	399	N	Electricity Substation	1968
197AR	399	N	Electricity Substation	1968
198AR	399	N	Electricity Substation	1979
199AR	399	N	Electricity Substation	1987
200AS	407	SW	Electricity Substation	1999
201AS	407	SW	Electricity Substation	1993
202AT	432	N	Electricity Substation	1953
203AT	433	N	Electricity Substation	1953
204AT	436	N	Electricity Substation	1953
205AU	454	E	Electricity Substation	1968
206AU	454	E	Electricity Substation	1987
207AU	454	E	Electricity Substation	1979
208AU	454	E	Electricity Substation	1968
209AV	462	S	Electricity Substation	1967
210AV	470	S	Electricity Substation	1990
211AV	470	S	Electricity Substation	1968
212AV	470	S	Electricity Substation	1984
213AV	470	S	Electricity Substation	1987
214AV	472	S	Electricity Substation	1996
215AV	472	S	Electricity Substation	1994
216AW	473	E	Electricity Substation	1984
217AW	494	E	Electricity Substation	1987
218AW	495	E	Electricity Substation	1996
219AW	495	E	Electricity Substation	1994
220AW	495	E	Electricity Substation	1994
221AW	496	E	Electricity Substation	1989
222AW	496	E	Electricity Substation	1975

1.4 Additional Information – Historical Petrol and Fuel Site Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical petrol stations and fuel sites within 500m of the search boundary:

0

Database searched and no data found.

1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical garage and motor vehicle repair sites within 500m of the search boundary: 64

ID	Distance (m)	Direction	Use	Date
223AX	78	NE	Garage	1953
224AX	79	NE	Garage	1953
225AY	139	NW	Garage	1953
226AY	139	NW	Garage	1953
227AY	139	NW	Garage	1953
228AZ	179	SW	Garage	1980
229AZ	180	SW	Garage	1967
230AZ	180	SW	Garage	1977
231AZ	180	SW	Garage	1968
232BA	195	S	Garage	1965
233BA	195	S	Garage	1953
234BA	195	S	Garage	1953
235BB	229	W	Garage	1980
236BB	229	W	Garage	1989
237BB	229	W	Garage	1967
238BB	229	W	Garage	1953
239BB	230	W	Garage	1993
240BB	230	W	Garage	1999
241BB	230	W	Garage	1953
242BB	230	W	Garage	1953
243BB	230	W	Garage	1977
244BB	230	W	Garage	1968
245BC	277	W	Garage	1967
246BC	277	W	Garage	1953
247BC	277	W	Garage	1953
248BC	277	W	Garage	1968
249BC	277	W	Garage	1953
250BD	302	NE	Garage	1953
251BD	302	NE	Garage	1968
252BD	302	NE	Garage	1953
253BD	302	NE	Garage	1953
254BD	302	NE	Garage	1968
255BE	334	E	Garage	1953
256BE	335	E	Garage	1965
257BE	335	E	Garage	1953
258BE	337	E	Garage	1984
259BE	339	E	Garage	1975

260AP	352	W	Garage	1980
261BF	359	W	Garage	1953
262BF	359	W	Garage	1967
263BF	359	W	Garage	1977
264BF	359	W	Garage	1953
265BF	359	W	Garage	1968
266BF	359	W	Garage	1953
267	361	E	Container Repair Depot	1975
268	372	E	Vehicle Repair Centre	1984
269	400	N	Motor Engineering Works	1953
270BG	412	N	Motor Engineering Works	1953
271BG	412	N	Motor Engineering Works	1953
272BH	430	SW	Garage	1980
273BH	430	SW	Garage	1953
274BH	430	SW	Garage	1967
275BH	431	SW	Garage	1968
276BH	431	SW	Garage	1953
277BH	431	SW	Garage	1953
278BH	431	SW	Garage	1977
279BI	443	NE	Motor Body Building and Motor Engineering Works	1953
280BJ	455	S	Garage	1989
281BJ	457	S	Garage	1989
282BI	483	NE	Motor Body Building and Motor Engineering Works	1968
283BI	483	NE	Motor Body Building and Motor Engineering Works	1979
284BI	493	NE	Motor Body Building and Motor Engineering Works	1953
285BI	493	NE	Motor Body Building and Motor Engineering Works	1968
286BI	493	NE	Motor Body Building and Motor Engineering Works	1953

1.6 Potentially Infilled Land

Records of Potentially Infilled Features from 1:10,000 scale mapping within 500m of the study site: 36

The following Historical Potentially Infilled Features derived from the Historical Mapping information is provided by Groundsure:

ID	Distance(m)	Direction	Use	Date
287BK	131	S	Tunnel	1928
288BL	150	W	Cemetery	1851
289C	164	S	Tunnel	1938
290B	165	S	Tunnel	1956
291B	165	S	Disused Tunnel	1989
292B	165	S	Tunnel	1967
293B	165	S	Disused Tunnel	1987

294C	175	S	Tunnel	1906
295D	207	SE	Tunnel	1925
296D	207	SE	Tunnel	1906
297D	207	SE	Tunnel	1938
298D	208	SE	Tunnel	1925
299K	314	NW	Unspecified Heap	1975
300BM	314	NW	Unspecified Heap	1957
301M	336	SW	Unspecified Shaft	1987
302M	336	SW	Unspecified Shaft	1989
303O	366	NE	Tunnel	1925
304O	366	NE	Tunnel	1891
305O	366	NE	Tunnel	1938
306O	366	NE	Tunnel	1906
307BN	377	N	Tunnel	1968
308R	377	N	Tunnel	1975
309R	377	N	Tunnel	1989
310S	385	NE	Tunnel	1891
311S	385	NE	Tunnel	1906
312S	385	NE	Tunnel	1925
313S	385	NE	Tunnel	1938
314M	388	SW	Unspecified Shaft	1967
315S	396	NE	Tunnel	1989
316S	396	NE	Tunnel	1968
317S	396	NE	Tunnel	1975
318BO	407	N	Tunnel	1968
319BP	417	NW	Unspecified Heap	1975
320I	475	E	Air Shaft	1987
321I	475	E	Air Shaft	1967
322I	475	E	Air Shaft	1989