

Fallowfield Campus Redevelopment Project

Ground Conditions Phase 1 Desk Study Report

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Executive Summary

Objectives	The purpose of this Desk Study is to establish the environmental, geological, hydrological and hydrogeological conditions present at the University of Manchester Fallowfield Campus that may result in potential contamination risks / ground related risks for existing and/or potential future uses. The overall aims of this report are (i) to inform the Client's understanding of potential ground-related risks associated with the proposed redevelopment and (ii) to provide evidence necessary to support the planning application.
Site Setting	The site covers 9.49 ha, and is located at Fallowfield Campus, 293 Wilmslow Road, Fallowfield, Manchester, M14 6HD, National Grid Reference (NGR) SJ 85733 94127. The existing site is currently student accommodation and university-related land use. Oak House and Woolton Hall are all still in use as student accommodation. Owens Park covering the northern half of the site is now closed as it does not meet current quality standards for use as student accommodation. The buildings on site are generally 4 storeys in height, with the exception of Owens Park tower in the north of the site which is 18 storeys.
Geological Setting	It is anticipated that the site is underlain by a sequence of Made Ground, underlain by Glacial Till, underlain by the Chester Formation.
History	The map records for the site indicate that it has been developed since pre-1890's and has had various uses. The site is presently occupied by the University of Manchester Fallowfield Campus, which was first recorded as Owens Park in 1972.
Geoenvironmental Considerations	A number of potential sources of contamination in near surface ground have been identified relating to the previous / historic uses (Made Ground). Low/moderate risk were assessed to people (demolition and construction workers, future site users and off site users) associated with this potential contamination. The potential risks associated with the possible presence of Unexploded Ordnance (UXO) were assessed as "Moderate". Mitigation options are available to reduce all of these risks to acceptable levels. It is recommended that prior to the commencement of development, data is obtained from a site-specific ground investigation which is presented in a factual report suitable for submission to the Local Planning Authority to address part of the standard planning condition associated with site investigation. Following on from this, an assessment of the data will need to be undertaken along with any subsequent recommendations on the need for any further investigation. Depending on the results of the ground investigation more detailed risk assessment and / or requirements for remediation may be required.

1 Introduction

1.1 General

This report presents the results of a Geoenvironmental Desk Study for the Fallowfield Campus Redevelopment Project prepared by Buro Happold on behalf of the Client, the University of Manchester (UoM). The purpose of this Study is to establish the environmental, geological, hydrological and hydrogeological conditions present at the site that may result in potential contamination risks for the proposed future use.

The site covers approximately 9.49 hectares (ha), and is located at Fallowfield Campus, 293 Wilmslow Road, Fallowfield, Manchester, M14 6HD, National Grid Reference (NGR) SJ 85733 94127.

The existing site is currently student accommodation and university-related land use. Oak House and Woolton Hall are all still in use as student accommodation. Owens Park covering the northern half of the site is now closed as it does not meet current quality standards for use as student accommodation.

The buildings are generally 4 storeys in height, with the exception of Owens Park tower in the north of the site which is 18 storeys. All of these buildings will be demolished to make way for the proposed development, including the Limes building which will be demolished and relocated elsewhere (under a future planning application). There are a number of high value and mature trees on the site and it is proposed to retain as many of these as possible.

The site location is shown below in Figure 1—1. An aerial photograph is available in Figure 1—2.



Figure 1—1 Site Location Plan extract



Figure 1—2 Recent aerial photograph of the site showing indicative site boundary.

Please note, the red line boundary shown on Figure 1—2 was the boundary at the time of obtaining the Groundsure report. The current red line boundary is shown in Figure 1—1 and this is the boundary that has been used within this assessment.

1.2 Study Aims and Objectives

The overall aim of this study is to carry out a geoenvironmental assessment of the site in order to inform the Client's understanding of potential ground-related risks associated with the phased erection of purpose built student accommodation (Sui Generis) up to 3,300 beds, to include all associated facilities and ancillary uses, demolition and other necessary works.

This report provides information relevant to redevelopment in accordance with the requirements of the National Planning Policy Framework (NPPF) [1]. The work was carried out in general accordance with the Model Procedures [2], the relevant British Standard [3], the Environment Agency (EA) Guiding Principles [4] and other current good practice guidance.

The particular objectives are:

- To determine the historical and current use of the site and its surroundings;
- To determine the nature of the ground conditions and the environmental sensitivity of the site;
- To assess the potential location, nature and extent of any ground and groundwater contamination;
- To assess the potential risks to people and the environment (natural and built) associated with ground contamination (solid, liquid or gas) both in the site's existing condition and for the proposed future use;
- To construct an initial Conceptual Site Model and carry out a preliminary contaminated land risk assessment, in general accordance with the EA/Department for Environment, Food and Rural Affairs (DEFRA) Model Procedures [2];
- To prepare a report based upon all of the above suitable to inform the Client about potential risks related to ground conditions and also suitable to support a planning application in accordance with NPPF [1] and to provide baseline information suitable for informing the Environmental Impact Assessment Scoping process; and
- To evaluate the potential need for and scope of any subsequent site investigations and/or remedial action or design.

1.3 Information Sources

The principal sources of information for this desk study report include:

- Historical and current topographic maps,
- British Geological Survey (BGS) geological maps [5],
- Historic Ground Investigation reports [6] [7] [8] [9] [10]; (0),
- Groundsure report (0 – exploratory holes only) [11],
- Zetica UXO Risk Map and Pre-Desk Study Assessment (PDSA) (0)
- Public register information,
- and
- Information available from the EA website and other online sources.

This report is therefore based upon information obtained from third party sources. The third party data has been accepted at face value and has not been independently verified. Buro Happold can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information. The current redline boundary is shown in Figure 1—1.

1.4 Competence

This work reported here was carried out by engineers from Buro Happold. Buro Happold is a consulting engineering company that manages its work under various Quality Management Systems that are certified to ISO 9001. The work itself was carried out by the staff with relevant qualifications, training and experience. The technical elements of this report have been reviewed by a Chartered Geologist.

2 Current land use and proposed development

2.1 Site Location

The site covers 9.49 hectares (ha), and is located at Fallowfield Campus, 293 Wilmslow Road, Fallowfield, Manchester, M14 6HD, National Grid Reference (NGR) SJ 85733 94127. The existing site is currently student accommodation and university-related land use. Oak House and Woolton Hall are all still in use as student accommodation. Owens Park covering the northern half of the site is now closed as it does not meet current quality standards for use as student accommodation. The buildings are generally four stories in height, with the exception of Owens Park tower in the north of the site which is 18 storeys. All of these buildings will be demolished to make way for the proposed development, including the Limes building which will be demolished and relocated elsewhere (under a future planning application). There are a number of high value and mature trees on the site and it is proposed to retain as many of these as possible.

2.2 Proposed development

The outline planning application (with access only) is for the for the phased demolition of existing buildings and phased development of up to 3,300 Purpose Built Student Accommodation bedrooms (Sui Generis use class) with associated facilities including waste storage, laundry and cycle storage; up to 4,500 sq m of floorspace to be used for ancillary purposes associated with the student residential use of the site within Use Class F1a, Class E(a), E(b), E(c), E(d), E(g), Sui Generis (drinking establishment and hot food takeaway); ancillary supporting staff accommodation (up to 55 bedrooms) (Sui Generis use class), and up to 1,200 sq m, of ancillary residential dwellings (Use Class C3), plus associated car parking, hard and soft landscaping, open space, utilities, footpaths and roads. The technical masterplan and parameter plans for the proposed development are presented in Figure 2—1.

The heights of the proposed buildings are set out from a datum point of +44.800m from a coordinate position of N:394293 E:385780 and range between 63.8 m AOD and 90.8 m AOD (including roof plant). 21 No. disabled car parking spaces and up to 825 No. bicycle spaces (25%) are proposed.

2.3 Current site conditions

2.3.1 Layout and topography

The site is an irregular rectangular in shape with a total area of approximately 9.49 ha. The site is on a very slight north-south downhill gradient ranging from 44m AOD along Old Hall Lane (to the north) to 39m AOD along Moseley Road (to the south).

2.4 Surrounding land use

The surrounding uses include residential houses to the west and south and student residential buildings to the south (Ladybarn House) and east (e.g. Richmond Park and Unsworth Park). Further UoM buildings are located to the north of the site (e.g. Sheavyn House and Ashburne Hall).

The surrounding area within and around the site provides significant green space including playing fields, rows of mature trees and parkland.

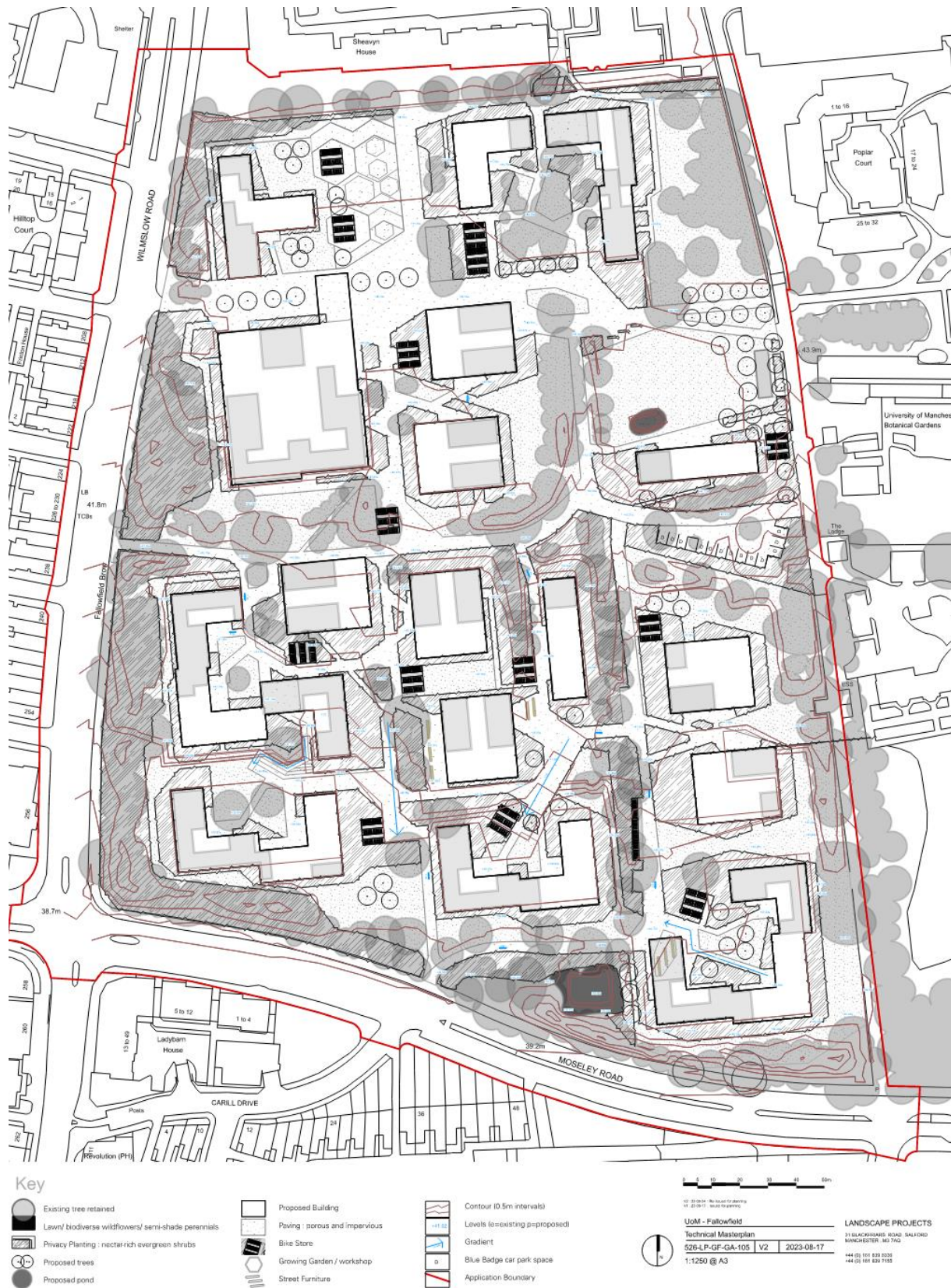


Figure 2—1 Technical Masterplan for the proposed development (extract)

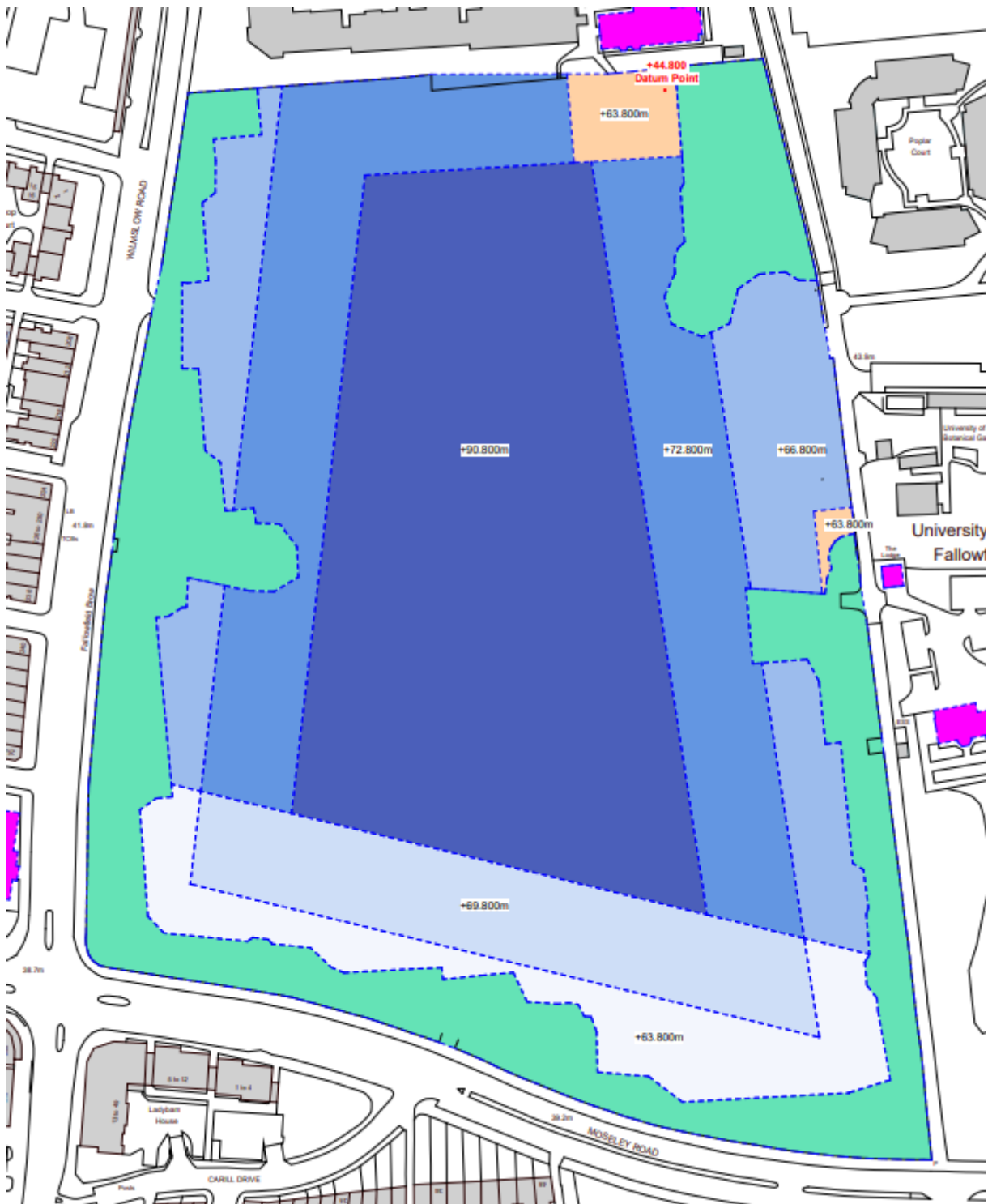


Figure 2—2 Parameter Plan (extract)

3 Environmental Setting

3.1 Published Geology

The anticipated site geology has been determined with reference to the relevant 1:10,000 scale / 1:50,000 scale BGS Map [5] [12] and Groundsure Report [11].

3.1.1 Superficial Geology

The BGS 1:10,000 scale geological map [12] records the site to be underlain by Boulder Clay.

The BGS 1:50,000 scale geological map [5] and Groundsure report [11] indicate that the site is underlain by Quaternary Glacial Till (TILLD-DMTN) across the majority of its area, with the exception of the southeast corner where there are no superficial deposits recorded. The total thickness of the superficial deposits is not recorded.

A thickness of Made Ground is anticipated due to the development history of the site.

3.1.2 Solid Geology

The BGS 1:10,000 / 1:50,000 scale geological maps [5] [12] and the Groundsure Report [11] indicate that the superficial deposits are underlain by the Triassic Chester Formation (formerly known as Bunter Pebble Beds / Chester Pebble Beds Formation). The Chester Formation comprises *"fine-to-coarse grained sandstone, commonly pebbly, with conglomerates and sporadic siltstones"*. The regional dip for the Chester Formation is recorded to be 8° to the southwest. An unnamed fault is recorded ~400m east of the site and is downthrown to the northwest by an unknown magnitude.

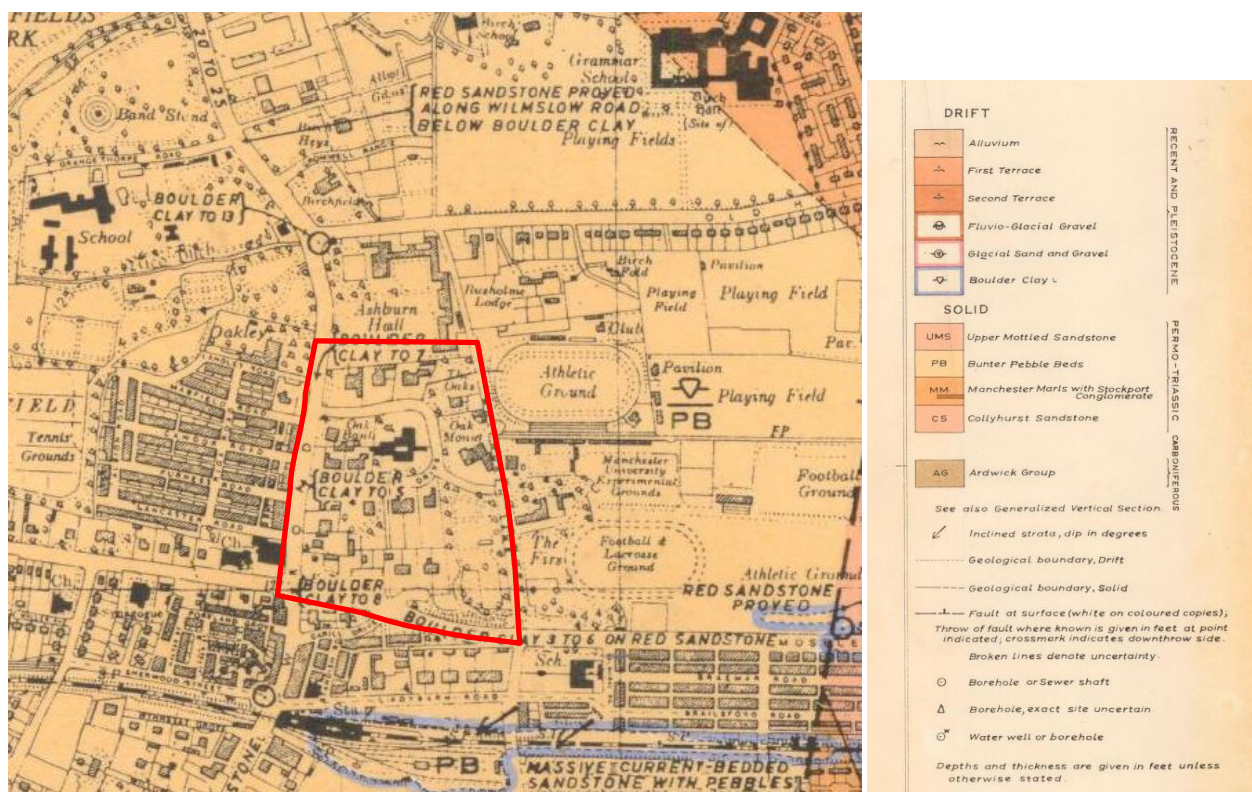


Figure 3—1 1:10,000 scale BGS map (extract)

3.2 Unpublished Geology

The anticipated ground conditions on site have been determined with reference to the Geotechnics Limited ground investigations on behalf of Coffey in 2015 [6] [7]. It should be noted that the ground conditions on-site may vary from the available records and are subject to review upon site specific information.

3.2.1 Geotechnics Factual Reports [6] [7]

In 2015, Coffey Geotechnics Limited commissioned Geotechnics Limited to complete two phases of site investigation (2a and 2b) at the UoM Owen Park Campus (of which the site is part of). The 2015 works relevant to the site comprised a total of:

- 36 No. boreholes (cable percussive to a maximum depth of 8.2m bgl and rotary to a maximum depth of 15.5m bgl);
- 14 No. window samples (maximum depth 3.9m bgl) ;
- 12 No. machine dug trial pits (maximum depth 4.5m bgl);
- In-situ SPT tests;
- In-situ Dynamic Cone Penetration (DCP) tests in trial pits;
- In-situ permeability tests (falling head tests);
- Installation of groundwater and ground gas monitoring wells and associated post-fieldwork monitoring visits; and
- Post-fieldwork geotechnical and geoenvironmental laboratory testing

An extract of the exploratory hole location plan is provided in Figure 3—2 C. The relevant exploratory holes are listed in Table 3—1.

Table 3—1 Geotechnics exploratory boreholes relevant to the site (2015).

Phase 2A				
BH01/1B	BH01/2	BH04/2	WS01/1B	WS01/2
BH02/1B	BH02/2	BH05/2	WS02/1B	
BH03/1B	BH03/2		WS03/1B	
Phase 2B				
BH04/1B	BH06/2	BH15/2	WS04/1B	TP01/1B
BH05/1B	BH07/2	BH16/2	WS05/1B	TP02/1B
BH05A/1B	BH08/2	BH17/2	WS06/1B	TP03/1B
BH06/1B	BH09/2	BH18/2	WS02/2	TP04/1B
BH07/1B	BH10/2	BH19/2	WS03/2	TP05/1B
BH08/1B	BH11/2	BH20/2	WS04/2	TP06/1B
BH09/1B	BH12/2	BH21/2	WS05/2	TP01/2
BH10/1B	BH13/2	BH22/2	WS06/2	TP02/2
BH11/1B	BH14/2		WS07/2	TP03/2
BH12/1B			WS08/2	TP04/2
BH13/1B				TP05/2
				TP06/2

*Boreholes in **blue** were continued with rotary follow-on.

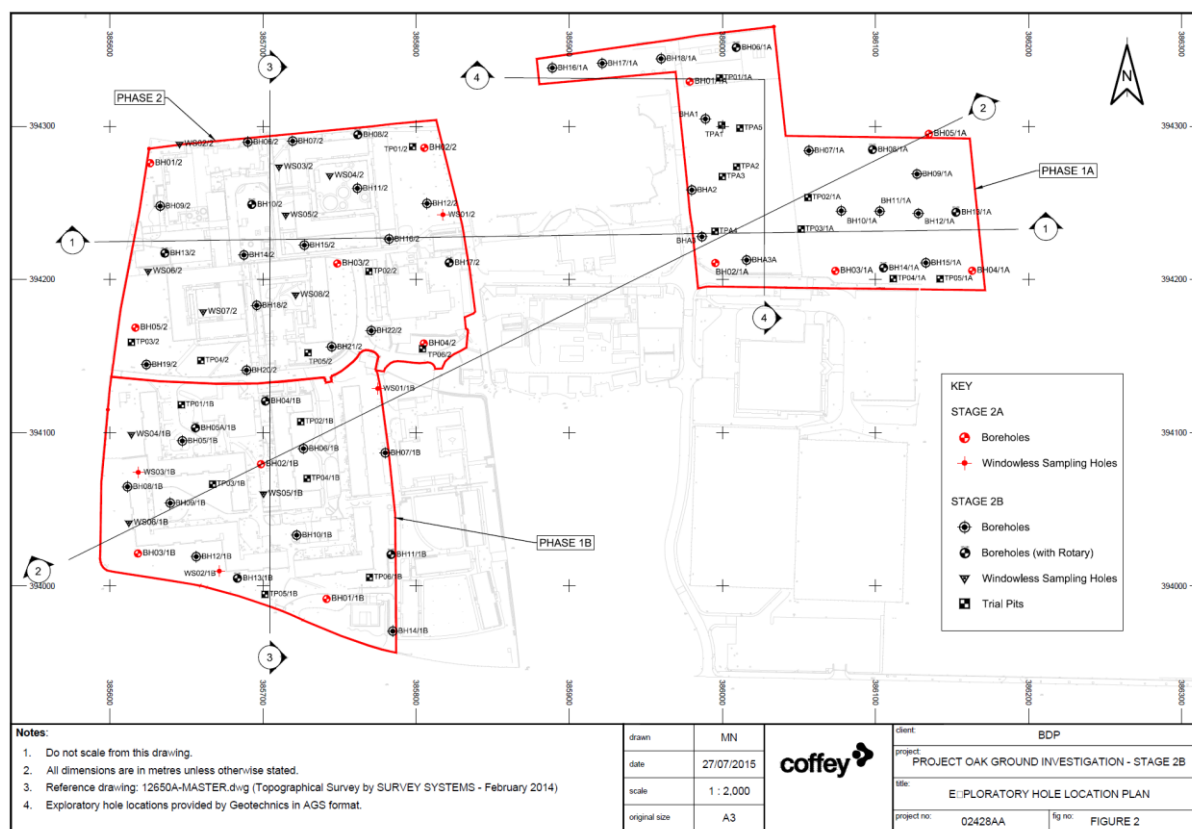


Figure 3—2 Coffey Exploratory Hole Location Plan (all phases)

Table 3—2 Summary of Ground Conditions

Depth to Top (m)	Thickness (m)	Description
0.00	0.20-2.60	Topsoil or Concrete/Macadam Over Sandy GRAVEL of brick, clinker and sandstone with low sandstone cobble content. Fragments of timber. And Gravelly sandy CLAY. Gravel of sandstone and limestone. [MADE GROUND] Note: Concrete obstruction at 0.80 m bgl in BH06/2
0.20-2.00	Absent – 3.10	Soft becoming firm then very stiff slightly sandy slightly gravelly CLAY. Gravel of subangular to rounded siltstone, sandstone and coal. And Very dense slightly clayey SAND [GLACIAL TILL]
1.40-4.10	Not proven	Very Dense clayey SAND with thinly laminated clay and extremely weak mudstone And Extremely weak red SANDSTONE And Extremely weak MUDSTONE [CHESTER FORMATION]

Based on the available site-specific data, the ground conditions comprise varying depths of Made Ground which is underlain by superficial deposits (clay and sand), underlain by completely weathered sandstone bedrock, in turn underlain by extremely weak sandstone and/or mudstone bedrock (Chester Formation).

3.2.2 Coffey Interpretive Reports [9] [10]

The Coffey reports confirmed the ground model as per Table 3—2. In addition:

- Groundwater is considered to be localised and perched within Made Ground across the site.
- Slightly elevated levels of heavy metals (lead & nickel), Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH's) above the residential without plant uptake chemical threshold were recorded within the Made Ground. The elevated results of TPH/PAH are primarily related to samples which contain tarmac fragments.
- The reports also advise that all results from the natural samples tested were below the residential threshold criteria.
- Slightly elevated PAH results were recorded within the groundwater samples which exceeded UK Drinking Water Standards.
- A ground gas classification of CS-1 was adopted for phases 1B and 2 which is considered to be relevant for the site.

3.3 Coal Mining

The Groundsure report [11] states that the site is not located in a coal mining reporting area as defined by the Coal Authority. The Coal Authority [13] interactive map was also consulted which recorded that the site is not in a Coal Mining Reporting area. No further assessment for coal mining is therefore considered to be required.

3.4 Hydrogeology & Hydrology

The hydraulic gradient for the site is likely to be influenced by general site topography and any local watercourses near to the site. As such, any shallow groundwater in the site area is likely to flow either south/southwest towards Fallowfield Brook located ~62m south of the site, or towards Cringle Brook located ~470m south of the site.

The hydrogeology of the site is likely to be characterised by a Principal Aquifer within the Chester Formation, overlain by unproductive strata of the Glacial Till.

The Glacial Till deposits are classified as a Secondary Undifferentiated Aquifer, defined as “Assigned where it is not possible to attribute either category A or B to a rock type. In general these layers have previously been designated as both Secondary A and B aquifer in different locations due to the variable characteristics of the rock type”.

The Chester Formation is classified as a Principal Aquifer, defined as “geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale”.

There is 1 No. historic groundwater abstraction recorded within 2km of the site as detailed in Table 3—3.

Table 3—3 Historical Groundwater Abstraction

Distance	Details	Date
1,407m south-east of site	Laundry Use OSC Group UK LTD Annual Volume (m3): 91,000	Start: 2004 Expiry: 2014

There are no active surface water abstractions recorded within 2km of the site.

There are 2 No. surface water bodies recorded with 250m of the site, namely:

- 62m south of the site, "Fallowfield Brook" which is classified as an "inland river not influenced by normal tidal action"; and
- 162m north of the site, "Platt Brook" which is classified as an "inland river not influenced by normal tidal action".

3.5 Flood Risk

The site is located within Flood Zone 1. The site is located in Flood Zone 1 and is therefore located outside of the 0.1% Annual Exceedance Probability (AEP) event, excluding Climate Change (CC) allowance.

The highest surface water flood risk due to areas likely to pond water during extreme rainfall events is located in the southeast of the site.

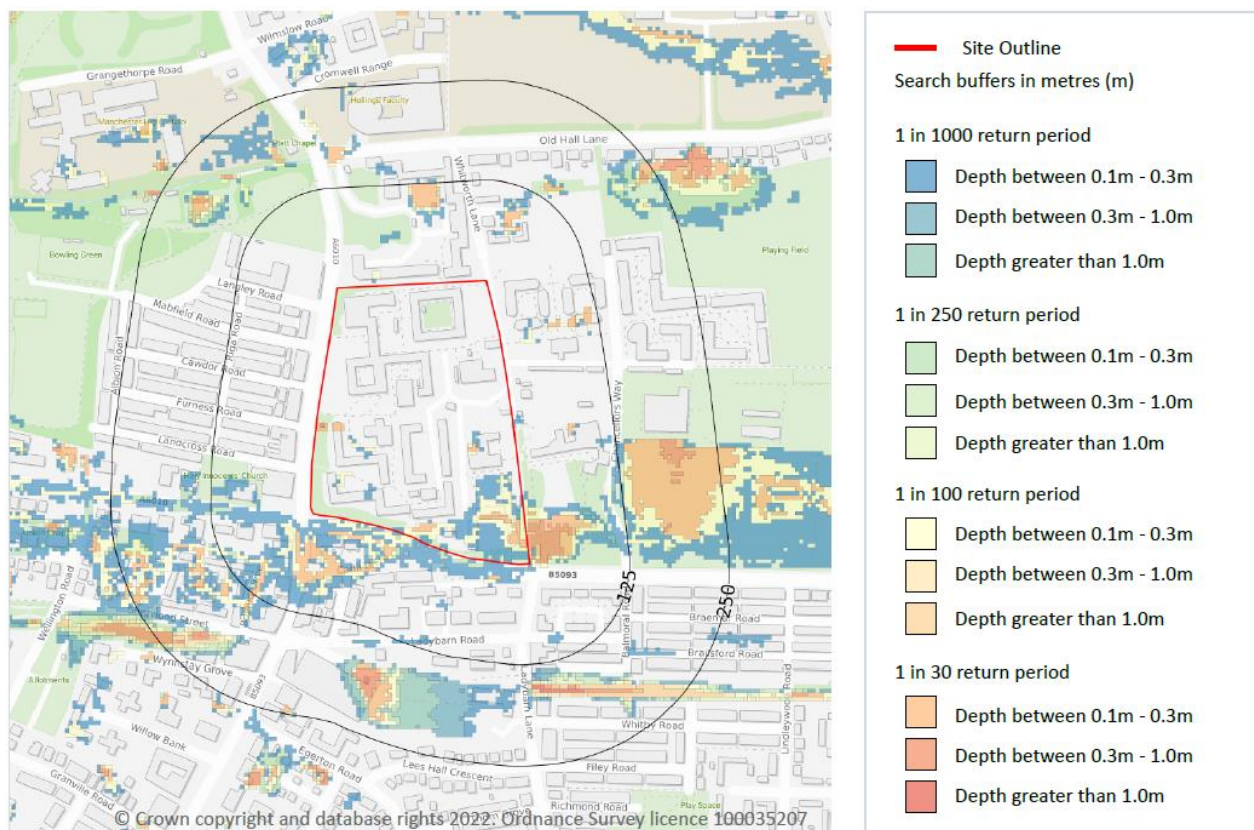


Figure 3—3 Surface Water Flood Map (extract— note old redline boundary from Groundsure)

3.6 Natural hazards

Regulatory data relating to ground stability for the site is summarised in Table 3-4 below.

Table 3-4 Potential natural hazards based on BGS Groundsure data

Potential Hazard	Hazard Rating
Shrink swell	Very Low. *Negligible in the south-east corner of the site, considered to be due to the anticipated lack of superficial deposits in this portion of the site.
Landslide	Very Low
Soluble Rocks	Negligible
Compressible Ground	Negligible
Collapsible Deposits	Very Low
Running Sand	Low to Very Low

3.7 Radon

The Indicative Atlas of Radon for England and Wales [14] and the Groundsure report [11] indicate that the site is not a Radon Affected Area, as less than 1% of properties are above the Action Level. Therefore, no radon protective measures are necessary.

3.8 Unexploded ordnance (UXO)

The Zetica Risk Map and PDSA (included as 0) classifies the site as “moderate” risk. A detailed UXO desk study is recommended to be commissioned and obtained by the Client prior to any intrusive investigation and construction works.

4 Site Setting

4.1 Site History

The site history and that for the immediate surrounding area has been assessed using historical maps from 1851 to 2010. This history is summarised in Table 4-1 below. The maps are presented in Appendix B (Groundsure Report).

Table 4-1 Summary of site history and history of the surrounding area

Historical Land Use		
OS Map Edition	Site	Surrounding Area (within 100m)
1849-1859 (1:10,000)	The site is recorded to be open fields	Fallowfield Brook is recorded to the south of the site, flowing from east to west.
1890 (1:10,560)		Residential buildings, a church and some schools are recorded in the surrounding area. Manchester Central Station railway line is recorded 100m south of the site.
1893 (1:2,500)	A number of unnamed buildings are recorded across the site, serviced by roads (Oak Drive and Carill Drive). A tramway is recorded from north to south in the western portion of the site.	
1905 (1:10,560)		Manchester Athletic Ground, Owen's College Athletic Ground and a nursery are recorded to the east of the site. Expansion of the residential buildings to the west of the site.
1932 (1:10,560)		Grangethorpe Hospital recorded ~100 m northwest of the site.
1934 (1:2,500)		Nursery no longer recorded - site was redeveloped and recorded as Manchester University Experimental Grounds
1955 (1:10,560)		School recorded where Grangethorpe Hospital was located previously.
1957-1958 (1:2,500)	The tramway is no longer recorded.	
1972-1976 (1:10,000)	The site has been redeveloped and is now recorded as Owen Park.	
1980-1983 (1:10,000)	Expansion of the buildings in Owen Park	
2001 (1:10,000)		Railway line to the south, and stadium to the northeast are no longer recorded (present in 1985-1989 maps).

4.2 Regulatory Data

Regulatory data relating to potentially contaminative uses is summarised in Table 4-2 below. This information was obtained from the Groundsure report [11].

Table 4-2 Summary of Regulatory Data

Item	Location [on/off site]	Information	Potential to Impact
Environmental Permits, Incidents and Registers			
Licensed pollutant release (Part A(2)/B)	41m W 350m S 388m S	Dry Cleaning Waste oil burner Waste oil burner	Low Low Low
Pollution Incidents (EA/NRM)	465m N	Water impact: Cat. 2 (significant) Land Impact: Cat. 4 (No impact) Air Impact: Cat. 4 (No impact)	Low
None of the following were recorded within 500m of the site: Radioactive substance authorisations, Licensed discharges to controlled waters, Pollutant release to surface waters, Pollutant release to public sewer, List 1 dangerous substances, pollution inventory substances, pollution inventory waste transfers, pollution inventory radioactive waste			
Landfill and Other Waste Sites			
Waste exemptions	On site - Owens Park 91m W 103m S 116m E 288m SW 289m SW	Treating and storing waste exemption Disposing of waste exemption Treating waste exemption Use of waste in construction Storing of waste exemption Disposing of waste exemption	Moderate Low Low Low Low Low
The following industrial activities were recorded within 500m: Active or recent landfill, historic landfill (BGS), historic landfill (LA/mapping records), historic landfill (EA/NRW records), historical waste sites, licensed waste sites			
Current and Past Industrial Land Use			
Electrical Sub Station	On site	Electrical Features	Moderate
Unspecified Heap	On site (1905-1938)	-	Low/Moderate
The following activities were recorded within 100m of the site: Nursery later known as Manchester University Experimental Grounds (1916-present), Builders Yard (pre-1956- present), Electrical Sub Station.			
Points of Interest (Environmentally Sensitive Sites, visual, cultural, agricultural, habitat designations)			
None of the following were recorded within 2000 m of the site: Site of Special Scientific Interest, conserved wetland sites (Ramsar), Special Areas of Conservation (SAC), Special Protected Areas (SPA), National Nature Reserves, Local nature reserves, Designated ancient woodland, Biosphere reserves, forest parks, marine conservation zones, green belt, nitrate sensitive areas, nitrate vulnerable zones.			

5 Preliminary Geoenvironmental Risk Assessment

5.1 General Approach

In the UK, the assessment of risk from contamination is based on consideration of the conceptual site model and follows the “source-pathway-receptor” approach. If one of these three elements (source, pathway or receptor) is absent, it is considered that there is no risk of harm. If, however, there is considered to be a linkage between any given source and any given receptor, a risk-based approach is used to assess the significance or impact of the linkage. Risks are defined as the probability of an event occurring combined with the severity of the consequence of that event. Particularly, to assess the risks to site end users posed by any given source, the sensitivity of each receptor is considered. For example, the concentration of contamination acceptable at a site to be developed as a residential property with a garden used to grow vegetables and accessible to young children is set lower than that for a commercial site where soil is exposed only in minor areas of landscaping and the only long-term users of the site are adults. Similarly, a site overlying a Principal Aquifer supplying potable water will be considered more stringently than a site overlying an impermeable geology with only minor seepages of groundwater.

5.2 Climate Change

It is accepted that the climate is changing and that this will affect future weather patterns. The EA [15] requires factoring climate change into risk assessments and remedial solutions. The British Standard, ‘*Adaptation to Climate Change – Principles, Requirements and Guidelines*’ [16] states that ‘*climate change impacts shall be assessed comprehensively...including...contamination*’ and should focus ‘*upon understanding the implications of future climate change trends and climate events over the full lifespan of a decision*’. The NPPF [17] requires new development to contribute to ‘*mitigating and adapting to climate change*’ and to ‘*minimise vulnerability and increase resilience*’ to the range of impacts arising from climate change.

The changes to weather patterns in the UK may include: an increase in warmer weather; an increase in the frequency and intensity of rainfall events; and an increase in the duration or frequency of dry spells in the summer. Such events are also likely to become more extreme. There is the potential for these scenarios to impact upon potential contaminant migration pathways in particular with respect to both hazardous ground gas and contaminated groundwater via permeable strata, during both demolition/construction and operation of the proposed development. As ground conditions at the proposed development may be vulnerable to extreme weather events due to climate change during the demolition, construction and operation phases, these potential impacts have been considered in the risk assessment.

5.3 Conceptual site model

The potential risks posed to human health and the environment by ground contamination at this site have been evaluated by a generic quantitative risk assessment which incorporates the ‘source-pathway-receptor’ identification and assessment methodology in accordance with LCRM [18]. The risk assessment process therefore involves the identification of each source based on the information in this report, including any available existing ground investigation results together with the identification of relevant exposure pathway(s) and receptors. The potential risks to the receptors have been assessed by considering the potential effect of the source on the receptor as well as the likelihood of a pathway linking the two, i.e. a contaminant linkage as discussed above.

5.4 Sources

The potential contamination sources at the site have been identified from a review of regulatory data, historical maps and previous site investigations and are summarised in Table 5-1. The 'Contaminants of Concern' in this risk assessment are based primarily on information from this review of historical information and by reference to relevant Industry Profile reports and Research & Development 66 [19].

Table 5-1 Summary of potential sources of contamination

Potential Source	Location	Likely Age	Potential Contaminants of Concern
The site area current uses: Made Ground	On-site	1893 to present	Asbestos, heavy metals, organic and inorganic compounds, PAHs, TPHs, fuels/oils and ground gases.
Fuel and oil spills from car parking	On-site	1970's to present	Petroleum hydrocarbon, fuel, oils.
Surrounding area previous uses: nursery, builders yard, electrical sub-station	Off-site	1916 to 1950 Electrical substation - unknown to present	Asbestos, heavy metals, organic and inorganic compounds, acids /alkalis, PCBs, PAHs, TPHs, fuels and oils, organic solvents, and ground gases.

5.5 Pathways and receptors

The proposed development consists of the phased erection of purpose-built student accommodation (Sui Generis) up to 3,300 beds, to include all associated facilities and ancillary uses, demolition and other necessary works (see Section 2.2). The presence of contamination (in soils, liquids or gases) has the potential to impact upon human and environmental receptors both in the short term (during demolition and construction) and in the long term (during use and occupation). Those receptors and the pathways that could link them to the sources identified are summarised in Table 5-2.

Table 5-2 Summary table of receptors and potential pathways

Receptor		Pathway
Human Health	Investigation and demolition/construction workers	Direct/ dermal contact. Ingestion/ inhalation of soils. Inhalation of gas / vapour.
	Future site users / visitors (residents, guests, workers)	Direct/dermal contact. Inhalation of contaminated dusts, gas & vapour.
	Off-site occupiers / visitors of neighbouring land	Inhalation of contaminated dusts.
Controlled Waters	Fallowfield Brook / Platt Brook	Migration via permeable strata and preferential pathways (e.g. piling)
	Chester Formation: Principal Aquifer	Migration via permeable strata and preferential pathways (e.g. piling)
Building/Services	Buried concrete foundations. Potable water supply pipework	Direct contact / aggressive attack

5.6 Assessment of risk

The assessment of the level of risk for each of the potential contaminant linkages identified above is summarised in Table 5-3. The table lists the potential sources identified above. For each source, an assessment is made, receptor by receptor, as to the magnitude of the potential consequence (reflecting the potential severity of the hazard associated with that source and the sensitivity of the receptor).

Consideration has also been given to the level of uncertainty associated with each of these potential sources. For example, some of the information is based on historical records. Where site specific information has been used the uncertainty is reduced, however it is also noted that no investigation can examine 100% of the ground and therefore some degree of uncertainty will remain. Because of this uncertainty, the identification of the sources is based upon a conservative assessment of the potential location, nature and extent of the source. The probability or likelihood of the hazard being realised is then assessed by consideration of the directness / integrity of the exposure pathway that could link the receptor to the source. The assigned level of risk is determined by the terms of consequence and probability in accordance with C552 [20]. The final column describes all the factors considered in the assessment and presents the justification for the assessed level of risk.

Table 5-3 Preliminary Risk Assessment

Source		Receptor/ Pathway	Risk assessment (following CIRIA C552)			Comment on hazard realisation
Origin	Contaminants of concern		Consequence	Probability	Risk	
On-site: Made Ground	Asbestos, heavy metals, organic and inorganic compounds, acids /alkalis, PCBs, PAHs, TPHs, fuels and oils, organic solvents, resins/adhesives, catalysts, sizing agents, binders and ground gases.	Description of the Source: The site was first recorded to be developed in the 1890s and has undergone a series of redevelopments.				
		Future site users / visitors (employees, guests and maintenance) Direct / dermal contact. Inhalation of soils / dusts. Ingestion of contaminated water supplies. Migration and accumulation of hazardous gases.	Severe	Unlikely	Moderate / Low	Proposed future use is for residential and commercial use with soft and hard landscaping. Potential for dust generation, direct contact and ingestion. Exposure time is relatively limited. Mitigation of potential risks can be achieved by appropriate investigation / design and implementation of remediation / mitigation measures including encapsulation.
		Investigation, demolition and construction workers Direct / dermal contact. Ingestion / inhalation of contaminated soils, gases and vapours.	Medium	Unlikely	Low	Potential for exposure during investigations, demolition and earthworks. Period of exposure dependent on construction timescales. Standard Health and Safety precautions likely to be used by workers. Mitigation of potential risks can be achieved by appropriate investigation and adoption of standard good construction practice.
		Off site occupiers / visitors of neighbouring land Inhalation of contaminated dusts.	Medium	Unlikely	Low	Large scale development, potential to impact surrounding visitors by dust generation. Increased potential during any earthworks. Mitigation of potential risks can be achieved by appropriate investigation and adoption of standard good construction practice.
		Degradation of Water quality [Superficial Secondary Undifferentiated aquifer – Glacial Till]	Medium	Unlikely	Low	Potential for increased infiltration and promotion of leaching during development earthworks. Mitigation of potential risks could be achieved by appropriate investigation, risk assessment and design.
		Degradation of Water quality [Bedrock Principal aquifer – Chester Formation]	Severe	Unlikely	Moderate / Low	Potential for increased infiltration and promotion of leaching during development earthworks. Mitigation of potential risks could be achieved by appropriate investigation, risk assessment and design.
		Buildings/services - permeation of water supply pipework, degradation of concrete Direct contact/, aggressive attack/ below ground structures	Medium	Unlikely	Low	Potential for direct contact on site. Mitigation of potential risks can be achieved by appropriate investigation / design and implementation of appropriate design.

6 Conclusions and Recommendations

6.1 Summary of geoenvironmental risks

6.1.1 Assessed risks

An Initial Conceptual Site Model has been determined and a Preliminary Risk Assessment with respect to ground contamination has been carried out for the site based on available data. The main sources of potential contamination have been identified and the potential risks have been qualitatively assessed. The assessment is based upon the site in its current condition, but it also includes consideration of the potential risks associated with any below ground works (e.g. site investigation or future foundation works) and the potential future use. A summary of the potentially significant risks (i.e. greater than Low) is presented below.

Table 6-1 Summary of potential risks

Receptor	Source	Potential Risk
Investigation and demolition/construction workers	Made Ground/ Demolition debris	Moderate/Low
Degradation of water quality (bedrock Principal Aquifer)	Made Ground/ Demolition debris	Moderate/Low

The Phase 1 Environmental Risk Assessment has defined the risks in relation to the redevelopment of the site on human health and the environment, including controlled waters.

The Coffey / Geotechnics investigation provided clarification of the ground model carried out in 2015 with respect to areas of Made Ground and has further established baseline conditions with respect to ground contamination, groundwater contamination and potential for ground gas from on-site and off-site sources.

Based on the results of the Geotechnics ground investigation, there is a low to moderate risk to human health during demolition and construction in respect of the slightly elevated levels of heavy metals (lead & nickel), Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH's) above the residential without plant uptake chemical threshold within the Made Ground. The elevated results of TPH/PAH are primarily related to samples which contain tarmac fragments. The reports also advise that all results from the natural samples tested were below the residential threshold criteria.

Slightly elevated PAH results were recorded within the groundwater samples which exceeded UK Drinking Water Standards. These thresholds are considered onerous for the site and in relation to the proposed development, therefore the risk to controlled water is low.

Information from the ground investigation undertaken at the site to date has not identified any significant ground constraints that might render the site unsuitable for the proposed development. The presence of Made Ground presents minor potential impacts on the demolition and construction phase but an overall improvement for the operational phase of the proposed development due to clean cover (hardstanding and soft landscaping build ups).

The risks during demolition and construction can, however, be adequately managed (through industry recognised standards and best practice measures), and so the redevelopment of the site is unlikely to generate any significant ground conditions (including groundwater) related environmental effects. The risks can be adequately managed so as not to cause unacceptable harm to human health, the built environment, ecology or controlled waters.

6.1.2 Recommendations

There are risks associated with the limited site-specific information, site history, and land use in the surrounding area. Therefore, it is recommended that an intrusive site investigation is completed.

Prior to the GI being undertaken, it is recommended that a detailed UXO desk study is commissioned and obtained by the Client. This will provide a thorough assessment of UXO risk on site and advise on any mitigation measures that may need to be included during intrusive works.

The aims and objectives of the investigation should combine geotechnical and geoenvironmental objectives to gain an understanding of:

- The presence, extent, and nature of any Made Ground/ fill materials;
- The geotechnical and geoenvironmental properties of site won materials for re-use on-site, and/or waste classification;
- The ground gas regime; and
- The shallow and deep groundwater regime.

The investigation would identify the potential pathways and allow assessment of risk to sensitive receptors. This data will also inform any remediation/ mitigation requirements associated with the proposed development. To meet both the geotechnical and geoenvironmental aims and objectives above, the scope of the site investigation should include the following:

- Boreholes (of suitable frequency and depth) to determine the shallow and deep ground conditions. Boreholes should include monitoring installations to intercept ground gas and shallow groundwater;
- Window samples to determine the shallow conditions. Window samples should include monitoring installations to intercept ground gas and shallow groundwater;
- Trial pitting across the site with sampling of near surface soils;
- In-situ testing (SPTs, U100 samples);
- Geotechnical & chemical testing of representative soil and groundwater samples; and
- A ground gas and groundwater monitoring programme.

The factual data obtained from this investigation would be collated, assessed and presented in a report suitable for submission in support of a reserved matters planning application.

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Appendix A: Geotechnics GI

Appendix B: Groundsure Report

Appendix C: UXO Risk Map and PDSA

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