



EARTH ENVIRONMENTAL
& GEOTECHNICAL

Phase I Desk Study and
GeoEnvironmental
Investigation Report

23 Ringley Road

Whitefield

Manchester

April 2023

On behalf of

Mr. & Mrs Baig

Earth Environmental & Geotechnical Ltd
Houldsworth Mill Business & Arts Centre
Houldsworth Street
Stockport
SK5 6DA

Tel : 0161 975 6088

Email info@earthenvironmental.co.uk
www.earthenvironmental.co.uk

**PHASE I DESK STUDY AND SITE
INVESTIGATION REPORT**

23 RINGLEY ROAD

WHITEFIELD

MANCHESTER

Report Ref: A5255/SI/V1

APRIL 2023

Prepared on Behalf of:

MR & MRS BAIG

By:

Earth Environmental & Geotechnical Ltd
Houldsworth Mill Business & Arts Centre
Houldsworth Street
Stockport
SK5 6DA

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BDI Structural Solutions Ltd

PHASE I DESK STUDY AND SITE INVESTIGATION REPORT

23 RINGLEY ROAD, WHITEFIELD, MANCHESTER

Report Reference: A5255/23/SI/V1

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Prepared for: BDI Structural Solutions Ltd

Prepared by: Earth Environmental & Geotechnical Ltd
Houldsworth Mill Business & Arts Centre
Houldsworth Street
Stockport
SK5 6DA

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Written by:



Daniel Shanks
Senior GeoEnvironmental Consultant



Approved by:

Adam Czarnecki
Director

TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY	VI
2.0	INTRODUCTION	1
2.1	BACKGROUND	1
2.2	EXISTING PLANNING APPLICATIONS	1
2.3	TERMS OF REFERENCE.....	1
2.4	REPORT SCOPE	1
2.5	LIMITATIONS OF THE STUDY	1
3.0	SITE LOCATION & DESCRIPTION	3
3.1	PROPOSED DEVELOPMENT.....	6
4.0	REVIEW OF DESK STUDY INFORMATION	7
4.1	GENERAL.....	7
4.2	GEOLOGY	7
4.3	GROUND WORKINGS	7
4.4	MINING AND OTHER UNDERGROUND WORKINGS	8
4.5	RADON	8
4.6	HYDROGEOLOGY AND HYDROLOGY	8
4.7	LANDFILL AND WASTE MANAGEMENT ACTIVITY.....	9
4.8	INDUSTRIAL LAND USE INFORMATION	9
4.9	ENVIRONMENTAL PERMITS, INCIDENTS AND REGISTERS	10
4.10	ENVIRONMENTALLY SENSITIVE SITES	11
4.11	ECOLOGY	11
4.12	ARCHAEOLOGY	11
4.13	POTENTIAL FLOOD RISKS	11
4.14	SITE HISTORY	12
5.0	PRELIMINARY CONTAMINATION RISK ASSESSMENT	17
5.1	INTRODUCTION	17
5.2	POTENTIAL SOURCES	18
5.3	POTENTIAL RECEPTORS	18
5.4	POTENTIAL PATHWAYS	18
5.5	PRELIMINARY CONCEPTUAL MODEL	19
6.0	GEOTECHNICAL HAZARDS ASSOCIATED WITH THE DEVELOPMENT	22
7.0	SITE INVESTIGATION	24
7.1	EXPLORATORY FIELDWORK	24
7.2	LABORATORY TESTING	26
7.2.1	<i>Geotechnical Testing</i>	26
7.2.2	<i>Environmental Testing</i>	26
8.0	GROUND CONDITIONS ENCOUNTERED	28
8.1	SOIL PROFILE ENCOUNTERED.....	28
8.2	OBSERVABLE INDICATIONS OF CONTAMINATION.....	28
8.3	OBSTRUCTIONS.....	29
8.4	GROUNDWATER	29
9.0	ENGINEERING PROPERTIES OF SOILS ENCOUNTERED	30
9.1	GENERAL.....	30
9.2	GRANULAR	30
10.0	GEOTECHNICAL ASSESSMENT.....	32
10.1	PROPOSED DEVELOPMENT.....	32
10.2	GROUND CONDITIONS ENCOUNTERED	32
10.3	FOUNDATION CONSIDERATIONS	32

10.3.1	Conventional Shallow Depth Strip/Pad Foundations	32
10.4	PAVEMENT DESIGN.....	34
10.5	SOIL PERMEABILITY TESTING	34
10.6	CHEMICAL ATTACK ON BURIED CONCRETE	35
10.7	SUITABILITY OF EXCAVATED MATERIALS	35
10.8	TEMPORARY WORKS	35
11.0	SOIL CONTAMINATION RISK ASSESSMENT	37
11.1	TIER I HUMAN HEALTH SOIL RISK ASSESSMENT – GROUNDWORKERS DURING DEVELOPMENT.....	37
11.2	TIER I HUMAN HEALTH SOIL RISK ASSESSMENT – FUTURE SITE USERS.....	37
11.3	SOIL WASTE ASSESSMENT	39
12.0	CONCLUSIONS & RECOMMENDATIONS	40
12.1	SOIL CONTAMINATION.....	40
12.2	ASBESTOS.....	40
12.3	FOUNDATIONS.....	40
12.4	SOIL DISPOSAL	40
12.5	SOAKAWAYS/SOIL PERMEABILITY	40
12.6	RISK TO BURIED (WATER) SERVICES.....	41
12.7	SITE PERSONNEL.....	41
12.8	OTHER MATTERS.....	41

LIST OF FIGURES

Figure 1	Site Location Plan
Figure 2	General Site Photographs
Figure 3	Proposed Development Plan
Figure 4	Ordnance Survey Map Extract 1893
Figure 5	Ordnance Survey Map Extract 1929 - 1932
Figure 6	Ordnance Survey Map Extract 1970
Figure 7	Aerial Photograph 2018
Figure 8	Exploratory Hole Location Plan
Figure 9	SPT N1(60) v Depth Plot

TABLES

Table 1	Environmental Permits, Incidents and Registers within 500m of the Site
Table 2	Site History
Table 3	Consequence, Probability and Risk
Table 4	Estimation of Level of Risk by Comparison of Consequence and Probability
Table 5	Preliminary Conceptual Model and Risk Assessment
Table 6	Summary of Geotechnical Hazards
Table 7	Sampling Location Justification
Table 8	Shear Strength Definitions
Table 9	Summary of Exploratory Holes Undertaken
Table 10	Summary of Laboratory Geotechnical Tests Undertaken
Table 11	Summary of Ground Conditions Encountered
Table 12	Summary of Laboratory Geotechnical Test Results
Table 13	Summary of Design Parameters (Granular)
Table 14	Summary of Allowable Bearing Pressures
Table 15	Summary of Anticipated Settlement (Granular)
Table 16	Comparison of Capping Thickness with and without Geotextile
Table 17	Results of Falling Head Testing
Table 18	Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land

Table 19	Soil Results Comparison with C4SL/S4UL Values
Table 20	Waste Classification of Soils

APPENDICES

Appendix 1	Groundsure Report
Appendix 2	Exploratory Hole Logs
Appendix 3	Geotechnical Testing Results
Appendix 4	Chemical Testing Results
Appendix 5	Soil Waste Assessment
Appendix 6	Falling Head Testing Results
Appendix 7	Report Limitations

1.0 EXECUTIVE SUMMARY

Appointment	A site investigation has been commissioned by BDI Structural Solutions Ltd, on behalf of Mr Khurram Baig (the Client), to examine ground conditions for a proposed development at 23 Ringley Road, Whitefield.
The Investigation	The investigation comprised four window sampling boreholes and one hand dug trial pit with associated sampling and in situ testing, laboratory contamination testing.
The Site	The site is located at 23 Ringley Road, Whitefield, Manchester, approximately 660m southwest of Whitefield town centre. The approximate National Grid Reference for the centre of the site is SD 79949 05747 (X: 379949, Y: 405747) with the closest postcode being M45 7LD. BGS digital mapping shows the site is underlain by superficial deposits of Glaciofluvial sand & gravel with solid geology beneath the site of the Nob End Rock, part of the Pennine Middle Coal Measures Formation, comprising sandstone.
Site History	In summary, the site was part of a larger agricultural field until the late 1930s, where a structure was constructed on site. The structure is not recorded as a residential property and was recorded to be present between 1938 - 1956. The existing building on site is recorded on site from 1967, along with a detached garage/ outbuilding. The site remained largely the same until the late 1980s, where a rear extension was added to the property. Aerial images between 2000 - 2022 show the ground surrounding the property to be largely soft standing with an area of hardstanding to the north of the building. Off-site, the surrounding area was occupied by agricultural fields since the start of historical mapping, with sporadic residential properties to the southwest and southeast of the site. A sand pit was located approximately 200m south of the site and was partially infilled in the late 1920s. A golf course was first mapped in the early 1900s to the north of the site and has been present since. Extensive residential development took place surrounding the site between the 1960s - 1990s.
Ground Conditions Encountered	The exploratory holes generally encountered topsoil, overlying variable, medium dense SAND, to a maximum depth of 6.00m bgl. Made ground was recorded between ground level and to a maximum depth of 1.00m bgl in WS1 and WS3, in place of the topsoil. Groundwater was not encountered during the site investigation or during the subsequent groundwater monitoring visit.
Geotechnical Assessment	Shallow strip/pad foundation placed in the natural sand at a minimum depth of approximately 1.00m bgl are considered appropriate for the current proposed development, dependent on allowable bearing pressures and tolerance of structures to settlement. Pavement Design - preliminary design value = 1% in Made Ground, 3 - 6%, 20-40% in sand/ granular. Design Sulphate Class = DS-1 ACEC Site Classification = AC-1s Soakaways are not considered feasible for the proposed development.
Contamination Assessment	Risk from contamination to groundworkers during development - Low. Exceedances of arsenic detected in WS1, exceedances of benzo(b)fluoranthene and dibenz(a,h)anthracene in WS3. Proposed development shows hardstanding in both areas, removing the contamination pathway. Risk from contamination to future site users - Low. Soil Waste Assessment: 5 samples tested; 5 classified as Non-Hazardous.
<i>This sheet is intended to provide a summary only of the report. It does not provide a definitive engineering analysis for the purposes of costing or construction and is subject to the limitation of the agreed brief.</i>	

2.0 INTRODUCTION

2.1 Background

A site investigation has been commissioned by BDI Structural Solutions Ltd, on behalf of Mr. Khurram Baig (the Client), to examine ground conditions for a proposed development at 23 Ringley Road, Whitefield, Manchester.

2.2 Existing Planning Applications

2.2.1 Planning Application to Bury Council, 68424, dated May 2022.

A planning application has been submitted for the site to Bury Council (Reference: 68424) for the demolition of the existing bungalow and the development of a new three-storey dwelling. The application was approved in July 2022 pending the compliance of conditions.

2.3 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) have been commissioned by the Client, to undertake a site investigation of the site in accordance with proposal A5255/23 dated 14th February 2023. The objectives of this investigation are as follows:

- *Provide factual information on the work undertaken including sampling location plan, borehole logs, chemical and geotechnical testing.*
- *Integrated Phase 1 Environmental Desk Study.*
- *Tier 1 (semi-quantitative) risk assessment will be undertaken. This will compare the concentrations of soil contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g., existing/ future end users and site neighbours.*
- *Classification of soils for offsite disposal.*
- *Assessment of ground conditions for foundation design.*

2.4 Report Scope

This report presents a review of the Phase I desk study information, full factual records of the site work carried out, the ground conditions encountered in the exploratory holes, and the in situ and laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on geotechnical design and potential ground contamination risks for the proposed development.

2.5 Limitations of the Study

The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information, improved practices or changes in legislation may require a reinterpretation of the report in whole or in part. EEG reserve the right to amend either conclusions or recommendations considering any further information that may become available. The report is provided for the sole use by the client and is confidential to them.

Recommendations within this report are also based on exploratory records and examination of samples and, where applicable, laboratory tests. No liability can be accepted for conditions not revealed by the boreholes particularly at intervening locations. Whilst every effort is made to ensure accuracy of data supplied, all opinions expressed as to the spatial distribution of strata between sampling locations is for guidance only and no responsibility is accepted as to its accuracy.

3.0 SITE LOCATION & DESCRIPTION

The site is located at 23 Ringley Road, Whitefield, Manchester, approximately 660m southwest of Whitefield town centre. The approximate National Grid Reference for the centre of the site is SD 79949 05747 (X: 379949, Y: 405747) with the closest postcode being M45 7LD.

The site is a rectangular shaped parcel of land occupied by 23 Ringley Road with current access via Ringley Road to the north of the site. The maximum dimensions of the proposed site are approximately 60m northwest to southeast and 60m north to south. The site occupies an area of approximately 0.11 hectares.

The site currently comprises an occupied bungalow, with associated private gardens and vehicular parking.

The site is generally surrounded by residential properties on all sides, with Stand Golf Course located approximately 170m north of the site and Philips High School located approximately 300m southeast.

The site location is shown below in Figure 1.

Figure 1 Site Location Plan

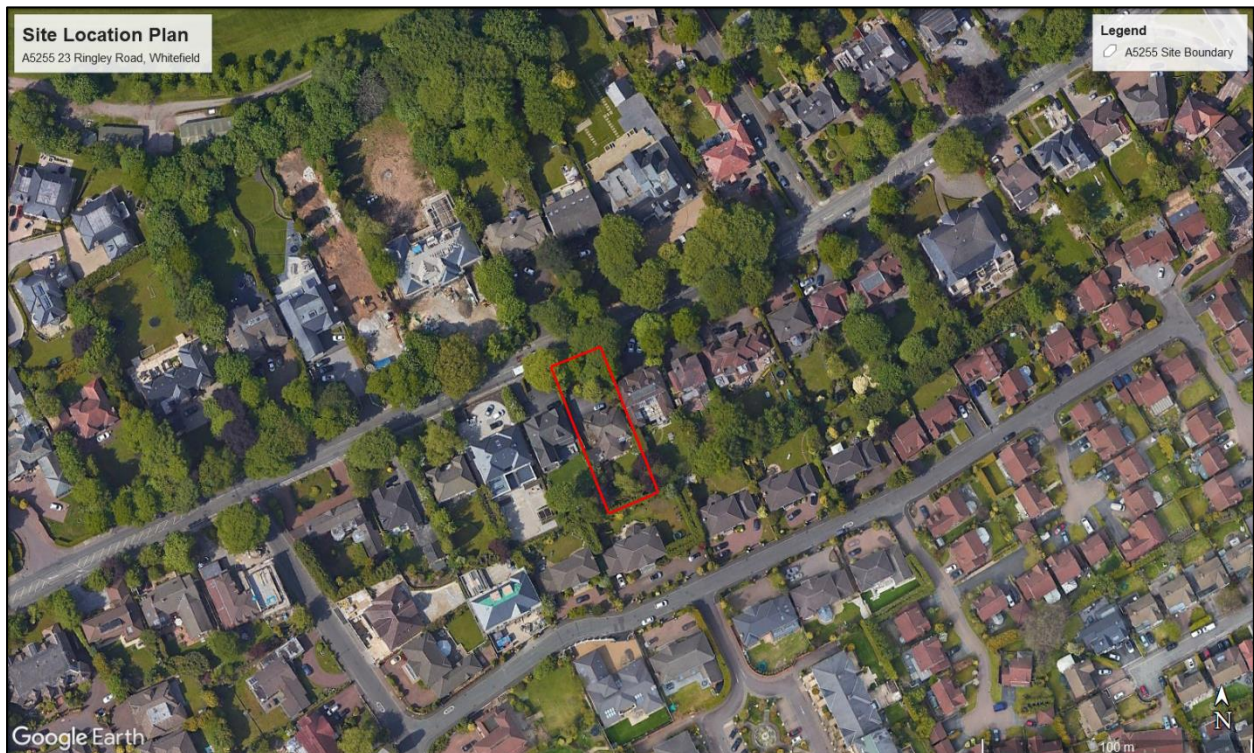


Figure 2 General Site Photographs

Photograph showing the front of the existing property, facing southeast



Photograph showing the rear of the existing property, facing northwest



Photograph showing potential historical greenhouse, to the rear of the property, facing west



Photograph showing representative soils (TP1)

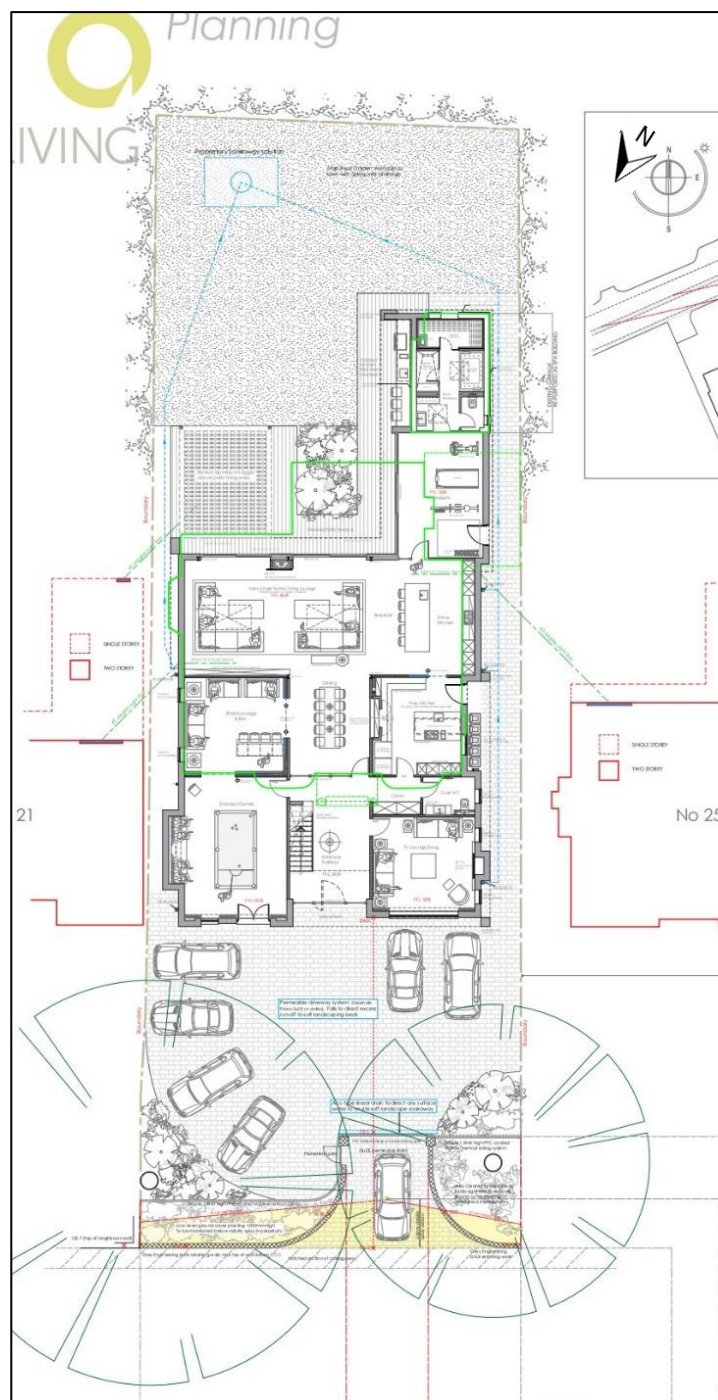


3.1 Proposed Development

It is understood that the Client intends to demolish the existing bungalow and detached outbuilding, and construct a new three-storey, residential dwelling. The development will include substantial vehicular parking to the front of the property, with a proposed soakaway in the rear garden.

A proposed development plan is shown in Figure 3 below:

Figure 3: Proposed Development Plan



4.0 REVIEW OF DESK STUDY INFORMATION

4.1 General

The geology of the site is covered by British Geological Survey (BGS) online data and the site specific GroundSure Enviro+Geo Insight report (Appendix 1).

Environmental conditions are covered by Environment Agency (EA) and British Geological Survey (BGS) online data, and the site specific GroundSure Enviro+Geo Insight report.

4.2 Geology

According to the British Geological Survey (BGS), the site is not underlain by artificial deposits.

The BGS states the site is underlain by superficial deposits of Devensian Glaciofluvial sand and gravel.

The site is underlain by bedrock of the Nob End Rock, part of the Pennine Middle Coal Measures Formation, comprising sandstone.

There are 10 records of linear features within 500m of the site boundary. The closest record refers to an inferred, normal fault, located 57m north of the site. Other records in the vicinity refer to further inferred normal faults, inferred coal seams and fossil horizons.

There are no records of landslips within 500m of the site boundary.

There are 4 borehole records identified within 250m of the site. The closest borehole record is located 84m southwest of the site (BGS ID: 17761781), with recorded lithologies as follows:

- Topsoil/ Made Ground, 0.00 - 0.90m.
- Firm, very sandy CLAY with some stones, 0.90 - 2.00m.
- Dense, loamy SAND & GRAVEL, 2.00 - 2.45m.
- Dense, clayey GRAVEL & COBBLES, 2.45 - 2.95m.
- Medium dense SAND, 2.95 - 5.50m.

The site is in an area where the hazard rating is negligible regarding shrink swell clays, compressible deposits, and dissolution of soluble rocks, and very low regarding running sands, collapsible deposits, and landslides.

4.3 Ground Workings

There is 1 record of BritPits identified within 500m of the site boundary. The record refers to Sand Hole Sand Pit, located 203m southeast of the site, which extracted sand. The site has recorded to have ceased production.

There are 12 records of historical surface ground working features identified within 250m of the site boundary. The closest record refers to a refuse heap located 108m southeast of the site, mapped in 1965.

4.4 Mining and Other Underground Workings

The site is located within an identified Coal Mining Reporting Area, however, is not within a Coal Authority Development High Risk Area.

There are no records for non-coal mining areas located within 1km of the site.

There are no areas of brine extraction, gypsum extraction, tin mining, or clay mining within 1km of the site.

There are no records for non-coal cavities identified within 1km of the site.

There are no records of natural cavities identified within 1km of the site.

There are 10 records for historical underground working features identified within 1km of the site. All records refer to tunnels located between 601m and 606m northeast of the site, mapped between 1891 and 1981.

4.5 Radon

The site is in an area where between 1 - 3% of properties are above the Action Level. Radon protection measures are therefore not required.

4.6 Hydrogeology and Hydrology

Both the superficial and bedrock geology is classified by the Environment Agency as a "Secondary A Aquifer." 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. The Glaciofluvial Deposits are recorded to have an intergranular flow type with a very high to high permeability, whereas the sandstone bedrock is recorded to have a fracture flow type with a high to moderate permeability.

The groundwater vulnerability of the site has been classified as high to low vulnerability and the soil leaching potential of the site has been classified as high. The BGS describes high vulnerability areas as "Areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits," and low vulnerability areas as "Areas that provide the greatest protection from pollution. They are likely to be characterised by low leaching soils and/or the presence of superficial deposits characterised by a low permeability."

There are 14 groundwater abstraction licence records within 2km of the site. The closest record refers to a historical permit for spray irrigation - direct at Stand Golf Club, Whitefield, located 224m north of the site.

There are 2 surface water abstraction licence records within 2km of the site. The closest record refers to a historical licence for process water, located 1.6km east of the site.

There are 3 potable abstraction license records within 2km of the site. The closest record refers to a historical licence for Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial/Public Services, located 789m northeast of the site.

The site is not located within a Source Protection Zone or within a Source Protection Zone with confined aquifer.

There are no water network entries within 250m of the site.

There are no surface water features within 250m of the site.

There is 1 record of a Water Framework Directive (WDF) surface water body catchment located on site. The record refers to the River Irwell (Croal to Irk) catchment.

There is 1 record of a Water Framework Directive (WDF) surface water body located 2.3km south of the site. The record refers to the River Irwell (Croal to Irk). The water body was given a failed chemical rating and moderate ecological rating in 2019.

There is 1 record of a Water Framework Directive (WDF) groundwater body located on-site. The record refers to the Northern Manchester Carboniferous Aquifers, which was given a poor chemical rating in 2019.

4.7 Landfill and Waste Management Activity

There are no records for current Environment Agency/Natural Resource Wales landfill records within 500m of the site.

There are no records of historic Environment Agency/Natural Resource Wales landfill site within 500m of the site.

There are no records of BGS/DoE non-operational landfill sites within 500m of the site.

There are no records of historical waste sites from the Local Authority and Historical Mapping Records within 500m of the site.

There are no records of waste treatment, transfer, or disposal sites within 500m of the site.

There are no records of current Environment Agency/Natural Resources Wales licensed waste sites within 500m of the site.

4.8 Industrial Land Use Information

There are 24 records of potentially contaminative historical land uses identified within 500m of the site. The closest record refers to a refuse heap, located 108m southeast of the site, dated 1965. Other records in the area refer to further refuse heaps, unspecified pits, old sand pits, gravel pits, unspecified heaps, sand pits, unspecified ground workings, unspecified tanks, and unspecified works, dated between 1851 and 1991.

There are 5 records of current potentially contaminative land uses identified within 250m of the site. The closest record refers to a generic tank, located 185m northwest of the site. Other records in the vicinity refer to electricity sub-stations and a gas governor station.

There are 3 records of historical tanks identified within 500m of the site. The closest record refers to an unspecified tank located 181m northwest of the site, dated 1987 - 1992.

There are 15 records of historical energy features identified within 500m of the site. 14 records refer to electrical substations, with the closest record located 189m south of the site, dated between 1989 - 1992. The other record refers to a gas governor.

There are no records for current petrol or fuel sites within 500m of the site.

There are no records of historical petrol or fuel sites within 500m of the site.

There are no historical garage and motor vehicle repair site records identified within 500m of the site.

There are no National Grid high voltage underground electricity transmission cables within 500m of the site.

There are no National Grid high-pressure gas transmission pipelines within 500m of the site.

There are no historical railway and tunnel features identified within 250m of the site.

There are no historical railway lines identified within 250m of the site.

There are no current active railway line records identified within 250m of the site.

There are no underground railway lines or tunnels identified within 250m of the site.

The site is not within 500m of the route of the High Speed 2 rail project.

The site is not within 500m of the route of the Crossrail 1 rail project.

4.9 Environmental Permits, Incidents and Registers

The Groundsure Report includes records of environmental permits, incidents, and registers within 500m of the site, which are summarised in Table 1 below.

Table 1: Environmental Permits, Incidents and Registers within 500m of the Site

Permit/Incident/Register	Number
Historical Licensed Industrial Activities (IPC)	0
Part A (1) and IPPC Authorised Activities	1
Pollutant Release to Surface Waters (Red List)	0
List 1 Dangerous Substances Inventory Sites	0
List 2 Dangerous Substances Inventory Sites	0
Part A (2) and Part B Activities and Enforcements	0
Category 3 or 4 Radioactive Substance Authorisations	0
Licensed Discharge to controlled waters	0
Planning Hazardous Substance Consents and Enforcements	0
Dangerous or Hazardous (COMAH and NIHHS) Sites	0
Sites Determined as Contaminated Land under Part 2A EPA 1990	0
Regulated Explosive Sites	0
Pollutant Release to Public Sewer	0
Substantiated Pollution Incidents (Category 1 and 2)	0
Pollution Inventory Substances, Wastes and Radioactive Wastes	0

There is 1 record of a Licensed Industrial Activity (PartA(1)) within 500m of the site. The record refers a new medium combustion plant, located 170m north of the site.

4.10 Environmentally Sensitive Sites

There are no records of Sites of Specific Interest (SSSI) within 2km of the site.

There are no records of Special Areas of Conservation (SAC) within 2km of the site.

There are 5 records of Local Nature Reserves (LNR) within 2km of the site. The closest record refers to Chapelfield reserve, located 888m northwest of the site.

There are 5 records of Designated Ancient Woodland within 2km of the site. The closest record refers to Carters Hill Wood, an ancient & semi-natural woodland, located 998m southwest of the site.

There are 3 records of Green Belts located within 2km of the site. All records refer to the Merseyside & Greater Manchester Green Belt, with the closest located 116m northwest of the site.

There is 1 record of a Nitrate Vulnerable Zone within 2km of the site. The closest record also refers to the Irwell/ Man. Ship Canal (Kearsley to Irlam Locks) surface water NVZ, located 233m southeast of the site.

There are no other records of environmentally sensitive sites within 2km of the site.

4.11 Ecology

An ecological assessment of the site falls outside the brief of this report. Where considered necessary, advice should be sought from an ecological specialist in this respect.

However, the site is classified as urban land. See Appendix 1 for full details, including habitat designations.

4.12 Archaeology

An archaeological assessment falls outside the brief of this report. Where considered necessary, advice should be sought from an archaeological specialist in this respect.

However, there is 1 record of a Conservation Area within 250m of the site. This refers to All Saints, Whitefield, located 91m northeast of the site.

There are no records of World Heritage Sites, Listed Buildings or Scheduled Ancient Monuments within 250m of the site.

4.13 Potential Flood Risks

Detailed assessment of flood risk is outside the scope of this report. However, reference to Environment Agency records indicates that the site does not lie within a Zone 2 or Zone 3 Flood Zone.

There is no risk of flooding from rivers and sea (RoFRaS) on site or within 50m of the site.

There are no records of historical flood events within 250m of the site.

There are no records of flood defences located within 250m of the site.

There are no records of areas benefitting from flood defences within 250m of the site.

There are no records of areas used for flood storage within 250m of the site.

The highest risk of surface water flooding occurring on-site is negligible.

The highest risk of groundwater flooding occurring on-site is moderate.

4.14 Site History

The historical development of the site has been determined by reference historical plans and Google Earth imagery. The reviewed historical plans comprise only readily available records and may be limited; however, the information available to date indicates that additional searches are unlikely to add to our understanding of the site. The earliest available historical mapping covering the site dates to 1848 - 1850.

The history of the site is detailed overleaf in Table 2:

Table 2: Site History

Date	On-Site History	Surrounding Land Use History
18348 - 1850 1:10,560	The site is part of a larger field (Wall Field).	The site is generally surrounded by agricultural land. A road named Bury & Prestwich Trust is located directly north of the site. Stand Hall/ Wallfield, and its surrounding grounds, is located directly west of the site. A small sand pit is located approximately 200m south of the site. All Saints Church and All Saints Sunday School is located approximately 450m northeast of the site. Residential properties are located approximately 250m southwest and southeast of the site.
1893 1:2,500 1891 1:10,560	No significant change on site.	A residential property named The Woodlands is now located directly north of the site. A school is located directly east of the sand pit, approximately 200m southeast of the site.
1909 1:2,500 1907 - 1908 1:10,560	No significant change on site.	The large open space to the north of The Woodlands, >100m north of the site, is now recorded to be a golf course. Bury & Prestwich Trust now named Ringley Road.
1922 1:2,500 1915, 1923 1:10,560	No significant change on site.	Slight residential development to the northeast of the site, along Ringley Road.

Date	On-Site History	Surrounding Land Use History
1929 - 1932 1:2,500 1927 - 1932 1:10,560	No significant change on site.	Significant residential development to the northeast of the site. The sand pit to the south of the site has been partially infilled, with residential properties constructed.
1938, 1955 - 1956 1:10,560	A structure is present crossing the north of the site. The structure is not anticipated to be a building.	A larger school is present approximately 300m southeast of the site.
1955, 1956 1:1,250 1965 - 1968 1:10,560	The structure previously crossing the north of the site is no longer present.	The property labelled Wallfield is no longer present to the west of the site. The residential property at The Woodlands to the north of the site has been redesigned, with the plot now split into three. The smaller school to the southeast of the site is now a light engineering works.
1967 - 1969 1:1,250 1970 1:2,500 1973 - 1977, 1981 - 1988 1:10,000	The existing property of 23 Ringley Road is now present on site along with the detached out-building to the south.	Further residential development along Ringley Road. The light engineering works to the southeast of the site has been demolished, with Whitefield Hebrew Congregation Synagogue.
1987 - 1992, 1992 1:1,250	A rear extension to the property has been constructed. A glasshouse (greenhouse) is now marked to the south of the outbuilding.	Significant residential development to the south of the site.
2003 1:1,250 2001, 2010, 2022 1:10,000	No significant change on site.	Slight residential development surrounding the site.
2000-2022 Aerial Image	The site comprises a plot of land occupied by 23 Ringley Road, with soft standing to the rear of the property and an area of hardstanding to the front. Large trees present in the north and south of the site.	The site is generally surrounded by residential properties, many of which have been redeveloped, particularly in recent years.

To summarise, the site was part of a larger agricultural field until the late 1930s, where a structure was constructed on site. The structure is not recorded as a residential property and was recorded to be present between 1938 - 1956. The existing building on site is recorded on site from 1967, along with a detached garage/ outbuilding. The site remained largely the same until the late 1980s, where a rear extension was added to the property. Aerial images between 2000 - 2022 show the ground surrounding the property to be largely soft standing with an area of hardstanding to the north of the building.

Off the site, the surrounding area was occupied by agricultural fields since the start of historical mapping, with sporadic residential properties to the southwest and southeast of the site. A sand pit was located approximately 200m south of the site and was partially infilled in the late 1920s. A golf course was first mapped in the early 1900s to the north of the site and has been present since. Extensive residential development took place surrounding the site between the 1960s - 1990s.

Figure 4 Ordnance Survey Map Extract 1893

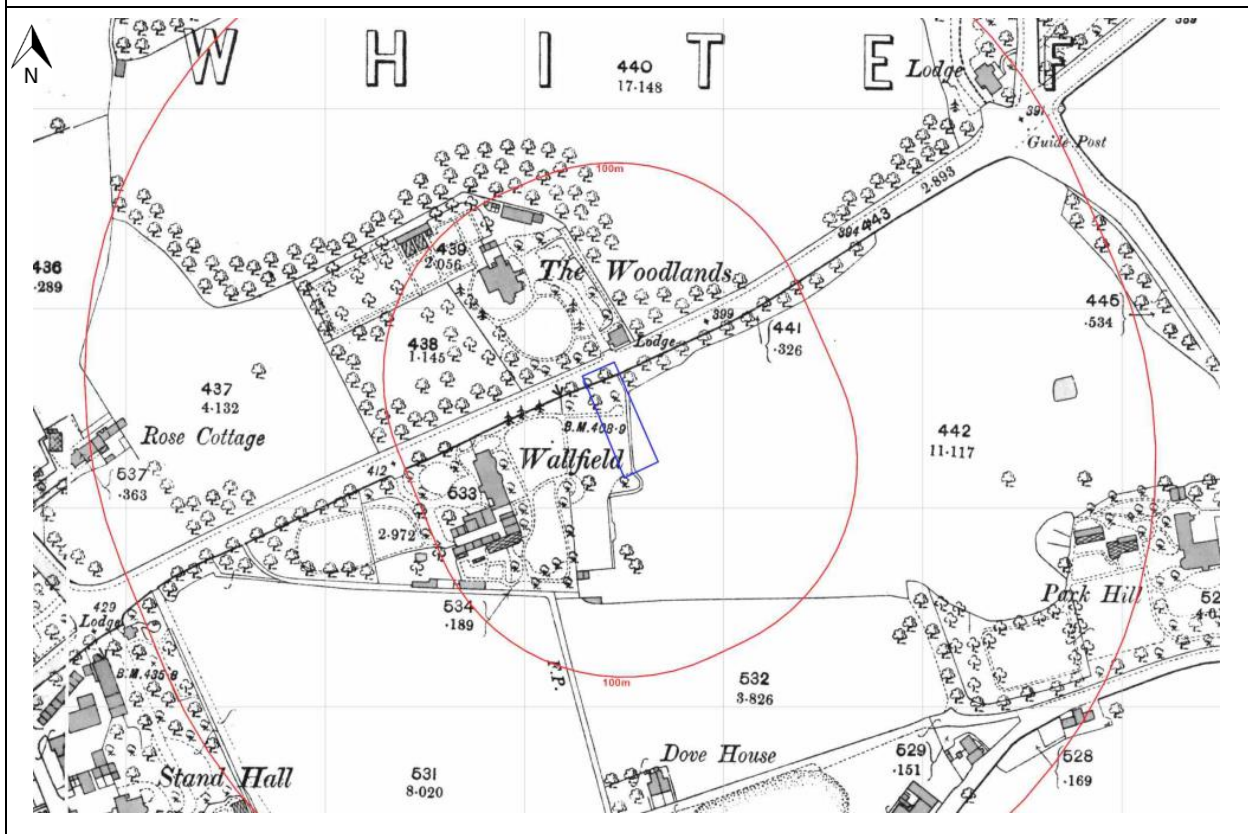


Figure 5 Ordnance Survey Map Extract 1929 - 1932

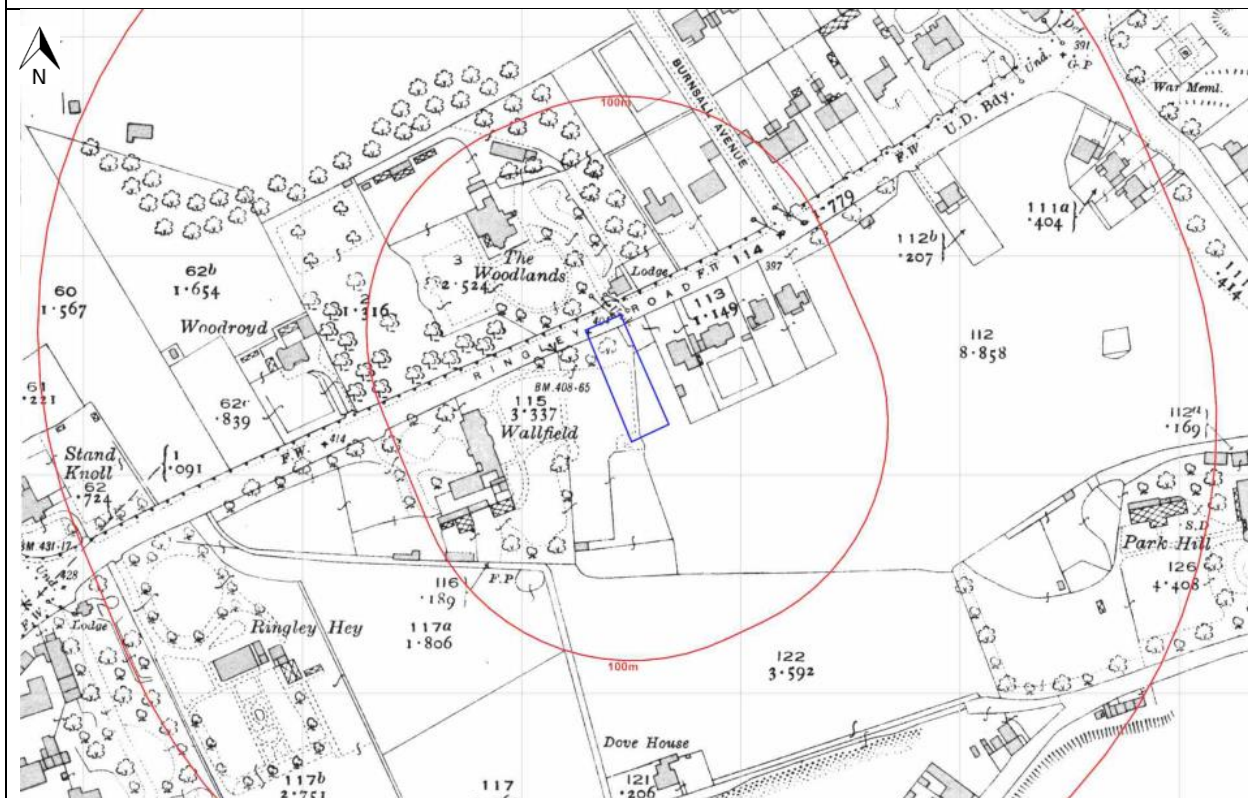


Figure 6 Ordnance Survey Map Extract 1970



Figure 7 Aerial Photograph 2018



5.0 PRELIMINARY CONTAMINATION RISK ASSESSMENT

5.1 Introduction

The following paragraphs outline a Preliminary Risk Assessment (PRA) for the site as defined by DEFRA and the EA Model Procedures for the Management of Land Contamination, CLR11⁽²⁰⁰⁴⁾.

Table 5 provides a Preliminary Conceptual Model (PCM) which defines the site in terms of a potential pollution linkage, that is, whether a pathway exists between a contamination source and a sensitive environmental receptor (Source-Pathway-Receptor relationship). The likelihood, severity and risk level are as defined within Table 3 and Table 4 below. The assessment of probability, a modified risk table, and certain consequence definitions are based on CIRIA C552 and CLR11.

Table 5 considers whether a pollution linkage is potentially present or not and provides a preliminary qualitative assessment of risk based on the information currently available. Where a possible linkage is identified, it does not necessarily mean that a significant risk exists but indicates that further information is required through appropriate site investigation to substantiate the conceptual model.

Table 3: Consequence, Probability and Risk

Probability	Consequence,	Risk
High Likelihood- There is a pollution linkage and an event either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution	Very High – acute risk to the human health likely to result in significant harm. Risk of severe or irreversible effect on ground/surface water quality. Catastrophic damage to buildings / property.	Very High – there is a high potential that the source-pathway-receptor scenarios may give rise to harm to human health, or the environment and remedial action is likely to be required.
Likely – there is a pollution linkage, and all the elements are present, which means that it is probable an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.	High – Severe or irreversible effect on human health. Temporary severe or irreversible effect on ground/surface water quality. Reduction of water quality rendering groundwater or surface water unfit to drink and/or substantial adverse impact on groundwater dependant environmental receptors.	High – it is likely that the source-pathway-receptor scenarios may give rise to an impact on human health or the environment, which may require remediation and/or control measures to mitigate risks
Low likelihood– there is a pollutant linkage and circumstances are possible for an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term	Moderate – Long term or short-term moderate effect on human health. Moderate effect on ground/surface water quality, reversible with time. Reduced reliability of a supply at a groundwater or surface water abstraction source	Moderate – it is possible that the source-pathway-receptor scenarios may give rise to an impact on human health or the environment, however it is either relatively unlikely that such would be severe, or if any harm were to occur it is more likely that harm would be mild.
Unlikely – there is a pollution linkage, but circumstances are such that it is doubtful that an event would occur even in the very long term.	Low – Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.) Slight effect on ground/surface water quality, reversible with time. Marginal reduced reliability of a supply at a groundwater or surface water abstraction source.	Low – it is possible that harm could arise at the source, however it is likely that this would at worst be mild.
		Very Low – it is unlikely that the source-pathway-receptor scenarios will give rise to an impact on human health or the environment.

Table 4: Estimation of Level of Risk by Comparison of Consequence and Probability

		Consequence			
		High	Moderate	Low	Very low
Probability	High Likelihood	Very High	High risk	Moderate risk	Moderate to low risk
	Likely	High risk	Moderate risk	Moderate to low risk	Low risk
	Low Likelihood	Moderate risk	Moderate to low risk	Low risk	Very low risk
	Unlikely	Moderate to low risk	Low risk	Very low risk	Very low risk

5.2 Potential Sources

Historically, the site was part of a larger agricultural field until the late 1930s, where a structure was constructed on site. The structure is not recorded as a residential property and was present between 1938 - 1956. The existing building on site is recorded on site from 1967, along with a detached garage/ outbuilding. The site remained largely the same until the late 1980s, where a rear extension was added to the property. Aerial images between 2000 - 2022 show the ground surrounding the property to be largely soft standing with an area of hardstanding to the north of the building.

Off the site, the surrounding area was occupied by agricultural fields since the start of historical mapping, with sporadic residential properties to the southwest and southeast of the site. A sand pit was located approximately 200m south of the site and was partially infilled in the late 1920s. A golf course was first mapped in the early 1900s to the north of the site and has been present since. Extensive residential development took place surrounding the site between the 1960s - 1990s.

There is therefore a limited potential for contamination on the site.

5.3 Potential Receptors

The following receptors have been considered for the construction and operational stages of the proposed development.

- Current site users;
- Adjacent land users;
- Future land users;
- Construction workers during site development works;
- Surface water and Groundwater within the underlying aquifer

5.4 Potential Pathways

The following pathways have been considered for the construction and operational stages of the proposed development.

- Dermal contact, ingestion, inhalation pathways of potentially contaminated soils;
- Downward vertical migration of leachate to surface waters and shallow groundwater;
- Vertical or lateral migration of ground gas.

5.5 Preliminary Conceptual Model

The PCM/PRA is based on the planned development proposal that the site be continued for a residential end use.

Table 5: Preliminary Conceptual Model and Risk Assessment

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
Potential soil contamination E.g., Heavy Metals, PAH, and ACM	Dermal contact, ingestion, and inhalation of soils dust	Current Site Users	Unlikely	Moderate	Low	The site is currently an occupied residential property. Due to the low potential for contamination on the site, the risk is considered to be LOW .
		Adjacent land users	Unlikely	Moderate	Low	The site is generally surrounded by residential properties. Usual dust control measures should be implemented as part of good site working practices during construction to reduce dust generation. Therefore, the risk is considered LOW .
		Future land users	Unlikely	Moderate	Low	The proposed development comprises the demolition of the existing bungalow and the development of a new 3-storey residential dwelling. Due to the low potential for contamination on the site, the risk to future site users via direct exposure is LOW .
		Construction Workers	Low Likelihood	Moderate	Moderate to Low	Construction workers may be exposed to potentially contaminated soils during construction works, however exposure duration will be short-term only. The risk to construction workers is considered MODERATE to LOW . Appropriate health and safety measures (in line with CDM and other relevant health and safety guidance) will reduce the risk to LOW .
	Downward vertical migration of leachate to shallow groundwater	Groundwater within the Underlying Aquifer	Low Likelihood	Moderate	Moderate to Low	The site is underlain by bedrock geology classified as a Secondary A Aquifer with a fracture flow type and a high to moderate permeability. There are 14 groundwater abstraction licences located within 2km of the site, with the closest located 224m north, however this is for a historical licence. The risk to groundwater is therefore considered MODERATE to LOW .
	Lateral migration in surface waters	Surface water	Low Likelihood	Moderate	Moderate to Low	The site is underlain by superficial deposits classified as a Secondary A Aquifer with an intergranular flow type and a very high to high permeability. There are 2 surface water abstraction licence records

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
	Vertical or lateral migration of ground gas					within 2km of the site, with the closest located 1691m from the site. There are no surface water features within 250m of the site. Therefore, the perceived risk to surface waters is MODERATE to LOW .
		Current Site Users	Unlikely	Moderate	Low	The site is currently an occupied residential property. Due to the low potential for gas generation on the site, the risk is considered to be LOW .
		Adjacent land users	Unlikely	Moderate	Low	The site is generally surrounded by residential properties. The BGS states that the site is underlain by superficial deposits of glaciofluvial sand & gravel. Due to the low potential for gas generation surrounding the site, the risk to adjacent land users is considered to be LOW .
		Future land users	Likely	Moderate	Low	The proposed development comprises the demolition of the existing bungalow and the development of a new 3-storey residential dwelling. Areas of made ground are not anticipated and the site is located in an area where <1% of properties are above the radon action level. The risk to future site users is considered LOW .
		Construction Workers	Unlikely	Moderate	Low	Construction workers may be exposed to ground gas/depleted oxygen conditions in confined spaces and excavations; however, the duration will be short term. The risk to construction workers from ground gas is considered LOW .
Asbestos Containing Material (ACM)		Current Site Users	Low Likelihood	Moderate	Moderate to Low	The site is currently an occupied residential property. Due to the age of the existing property, the risk is considered to be MODERATE to LOW .
		Adjacent land users	Unlikely	Moderate	Low	The site is generally surrounded by residential properties. Asbestos may be present in small areas due to previous developments. Disturbance of soil during the construction phase may allow fibres to become airborne. Dust control measures (dampening down) should be implemented as part of good site working practices. Therefore, the risk is considered LOW .
		Future land users	Unlikely	Moderate	Low	The proposed development comprises the demolition of the existing bungalow and the

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
						development of a new 3-storey residential dwelling. Asbestos may be present in small areas due to previous developments. Asbestos is only harmful when disturbed. The risk is therefore considered LOW .
		Construction Workers	Low Likelihood	Moderate	Moderate to Low	There is a low probability for ACMs to be present in soils at the site. Disturbance of soil during the construction phase may allow fibres to become airborne. The risk is therefore considered MODERATE to LOW . Dust control measures (dampening down) should be implemented as part of good site working practices to reduce the risk to LOW .

6.0 GEOTECHNICAL HAZARDS ASSOCIATED WITH THE DEVELOPMENT

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 activities. Local Authorities follow NPPF (2012) which requires that a site be suitable for its new use considering of ground conditions and land instability, including from natural hazards to former activities such as mining. A summary of the geotechnical considerations is provided below in Table 6.

Table 6: Summary of Geotechnical Hazards

Geohazards:	
Highly Compressible Ground	Negligible risk
Collapsible Soils	Very low risk
Swelling Clay	Negligible risk
Running Sand	Very low risk
Ground Dissolution	Negligible risk
Landslip	Very low risk
Mining & Quarrying	The site is located within an identified coal mining area however it is not within a development high risk area. Records show no evidence of mining in the area, with the closest underground working located 601m northeast of the site. The risk regarding mining and quarrying is therefore considered LOW.
Geotechnical Design Considerations	
Site Clearance	The site is occupied by the residential dwelling of 23 Ringley Road. The site is free of stockpiles of materials.
Trees	The site has been largely stripped of large trees. Only bushes on the northwest boundary and at the edge of the front garden remain.
Existing Buildings/Obstructions	The existing residential dwelling and outbuilding/ garage on site.
Foundations	The depth and type of proposed foundations would depend on the ground conditions present on site. An intrusive ground investigation is recommended prior to any construction works taking place to discover the most suitable foundation options for the site.
Geotechnical Design Considerations	
Floor Slabs	Again, an intrusive geotechnical investigation is recommended prior to any construction works to discover the most suitable floor slab design for the on-site ground conditions.
Groundwater	Exact groundwater conditions are not known at this stage. However, it is recorded that the site is underlain by a Secondary A aquifer. The highest risk of groundwater flooding on site is recorded as negligible.
Earthworks	The proposed development area is located on a flat and level surface, and it is not expected that extensive earthworks will be necessary.

Slopes	The development area lies on a flat and level surface.
Retaining Walls	There are no retaining walls present on site.
Chemically aggressive ground conditions	Chemically aggressive grounds are not anticipated beneath the site.

7.0 SITE INVESTIGATION

7.1 Exploratory Fieldwork

The fieldwork was carried out by EEG on the 10th of March 2023 and comprised:

- Four window sample boreholes (designated WS1 to WS4 inclusive) were each sunk to a maximum depth of 6.00m below existing ground level. Window sampler boring is carried out with a small, track-mounted rig, which uses a chain-driven trip hammer to drive sampling tubes or penetrometers into the ground. These tools are coupled to the anvil of the hammer by solid drill rods. Sampling tubes comprise “windowless samplers,” which are plain sampler tubes in which a continuous disturbed sample is recovered within a semi-rigid plastic liner. To reduce friction within the borehole, sampling tubes of progressively smaller diameter are used as the borehole depth increases. Sampler diameters generally range from between approximately 90mm to 50mm. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Groundwater observations were noted where possible. These observations relate to the time of the investigation only, and do not necessarily reflect seasonal fluctuations. Window sample borehole logs are included in Appendix 2.
- One hand dug, trial pit was excavated to a maximum depth of 0.66m bgl, for the purpose of soil sampling for chemical testing.

Exploratory hole locations were selected on-site by an EEG engineer based on the proposed development layout and avoiding known services. Each exploratory location was scanned using a Cable Avoidance Tool (CAT) in order to locate unrecorded underground services, and the exploratory locations were repositioned if necessary.

Table 7 Sampling Location Justification

Exploratory Hole	Location Justification
WS1	Below proposed building footprint
WS2	Below proposed building footprint
WS3	Below proposed building footprint
WS4	Contamination sampling near historical greenhouse & placement of groundwater installation near proposed soakaway
TP1	Contamination sampling in close proximity to existing & proposed footprint

On completion, samples recovered from the site were taken to specialist laboratories for chemical and geotechnical testing.

Soil samples of approximately 250g were recovered in amber jars for volatile analysis as well as 1kg plastic tubs for general analysis. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the DETs laboratory.

If collection was not possible the same day, then samples were stored in the sample storage fridge at the EEG offices below 4°C.

Samples were tracked using appropriate Chain of Custody forms provided by DETs.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III).

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930^(2015+A1:2020) except where superseded by the soil and rock description methodology in BS EN14688-1⁽²⁰⁰²⁾, BS EN 14688-2⁽²⁰⁰⁴⁾ and BS EN 14689-1⁽²⁰⁰³⁾.

All sampling locations were surveyed by use of a hand-held Trimble GeoXH GPS instrument that is capable of surveying to an accuracy of less than 10mm depending on satellite coverage, proximity to trees and building structures.

The descriptive terminologies such as firm, etc formerly used within older versions of BS5930 to describe strength now solely relate to consistency. Shear strength is now defined related to results obtained in the field (using a hand vane for example) or in the laboratory (from triaxial tests), as detailed in Table 8 below.

Table 8 Shear Strength Definitions

Term based on measurement	Undrained Strength (c_u) definition in kN/m ² (from BS EN ISO 14688-2: 2004, 5.3, Table 5)
Extremely Low Strength	<10
Very Low Strength	10 to 20
Low Strength	20 to 40
Medium Strength	40 to 75
High Strength	75 to 150
Very High Strength	130 to 300
Extremely High Strength	300 to 600

An Exploratory Hole Location Plan is presented as Figure 8 overleaf.

A summary of exploratory holes undertaken during the investigation are presented in Table 9 below.

Table 9: Summary of Exploratory Holes Undertaken

Hole	Type*	Depth (m)	Date Started	Date Finished	Easting (m)	Northing (m)	Backfill Details**
WS1	WS	6.00	10/03/2023	10/03/2023	379941	405756	SP
WS2	WS	6.00	10/03/2023	10/03/2023	379953	405755	SP
WS3	WS	6.00	10/03/2023	10/03/2023	379943	405738	SP
WS4	WS	6.00	10/03/2023	10/03/2023	379956	405727	SP
TP1	HP	0.66	10/03/2023	10/03/2023	379955	405735	A
*WS = Window Sample Borehole, HP=Hand Pit							
**SP=Standpipe, A=Arising							

Figure 8 Exploratory Hole Location Plan



7.2 Laboratory Testing

7.2.1 Geotechnical Testing

A programme of laboratory testing was carried out on samples taken from the various strata to assist in classification and determine the engineering properties of the materials underlying the site. The tests were scheduled by EEG and carried out by Murray Rix. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 10 below.

Table 10: Summary of Laboratory Geotechnical Tests Undertaken

TEST	STANDARD	No.
Particle size distribution (wet)	BS1377:1990 Part 2, Clause 9.2	4
Sulphate content of 2:1 soil: water extract	BS1377:1990 Part 3, Clause 5	4
pH value	BS1377:1990 Part 3, Clause 9	4

The results of the laboratory geotechnical tests are discussed in Section 9 and included in Appendix 3.

7.2.2 Environmental Testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by EEG, and carried out by DETS, a UKAS and MCERTS accredited laboratory.

Chemical analyses were carried out on five soil samples and were submitted for the following suite of determinants:

Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO₄), Sulphide, pH, Soil Organic Matter, and Speciated Polycyclic Aromatic Hydrocarbons (PAH).

The results of the laboratory contamination tests are discussed in Section 11 and included in Appendix 4.

8.0 GROUND CONDITIONS ENCOUNTERED

8.1 Soil Profile Encountered

BGS digital mapping shows the site is underlain by superficial deposits of Glaciofluvial sand & gravel with solid geology beneath the site of the Nob End Rock, part of the Pennine Middle Coal Measures Formation, comprising sandstone. The sequence of strata encountered beneath the site was as follows:

- **Made Ground** - was encountered exclusively in WS1 and WS3, at ground level, comprising:
 - Asphalt.
 - Slightly silty, slightly gravelly SAND, containing gravel of concrete, red brick, sandstone, and rare clinker.
 - Silty, slightly gravelly SAND, containing gravel of sandstone.
- **Topsoil** - was encountered at ground level in WS2, WS4 and TP1, at ground level, comprising:
 - Clayey, slightly silty, slightly gravelly, loamy SAND, containing gravel of sandstone and rare red brick.
- **Sand** - was encountered in all exploratory hole locations, comprising:
 - Medium dense, slightly silty, slightly gravelly SAND, containing gravel of sandstone and rare coal.
 - Medium dense, silty, slightly gravelly SAND, containing gravel of sandstone.
 - Medium dense, very silty SAND.

The depths of the various materials encountered in the exploratory holes are summarised in Table 11 below.

Table 11: Summary of Ground Conditions Encountered

Hole	Depth to Stratum (m bgl)			GROUNDWATER (m bgl)
	MADE GROUND	TOPSOIL	SAND	
WS1	GL - 0.70	-	0.70 - 6.00+	-
WS2	-	GL - 0.30	0.30 - 6.00+	-
WS3	GL - 1.00	-	1.00 - 6.00+	-
WS4	-	GL - 0.40	0.40 - 6.00+	-
TP1	-	GL - 0.26	0.26 - 0.66+	-

8.2 Observable Indications of Contamination

No visual or olfactory signs of contamination were encountered during the fieldwork.

8.3 Obstructions

No man-made obstructions were observed during the fieldwork.

8.4 Groundwater

Groundwater was not encountered during the site investigation or during the subsequent groundwater monitoring visit.

9.0 ENGINEERING PROPERTIES OF SOILS ENCOUNTERED

9.1 General

The following sections discuss the engineering properties of the strata encountered, based on results of in situ and laboratory testing obtained during this investigation.

Table 12: Summary of Laboratory Geotechnical Test Results

Location	Depth (m)	Strata*	CLASSIFICATION											STRENGTH	CHEMICAL		
			Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Modified Plasticity Index (%)	PSD Cobbles (%)	PSD Gravel (%)	PSD Sand (%)	PSD Silt (%)	PSD Clay (%)	Bulk Density Mg/m ³	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	pH Value	Water Soluble Sulphate SO ₄ (mg/l)
WS1	2.40	SAND	-	-	-	-	-	-	1	86	13	-	-	-	-	7.2	120
WS2	1.90	SAND	-	-	-	-	-	-	0	75	25	-	-	-	-	7.2	170
WS3	1.50	SAND	-	-	-	-	-	-	0	78	22	-	-	-	-	7.5	130
WS4	3.50	SAND	-	-	-	-	-	-	5	36	56	7	-	-	-	7.2	130

9.2 Granular

Sand was encountered in all exploratory boreholes between a minimum depth of 0.30m bgl to a maximum depth of 6.00m bgl.

SPT tests carried out in the granular material were corrected for SPT hammer energy efficiency and overburden pressure and resulted in N1(60) values between 17 and 27, as shown on the SPT v Depth Plot in Figure 5 (overleaf). This result suggests the granular material is medium dense.

For design purposes, N values of 17 - 22 have been adopted. Based on the correlation by Peck, Hanson and Thornburn⁽¹⁹⁷⁴⁾, this gives an **angle of shearing resistance** of between $\phi=32 - 34^\circ$.

Particle Size Distribution (PSD) tests were carried out on four sand samples. A breakdown of the test results is shown in Table 12 above and in Appendix 3.

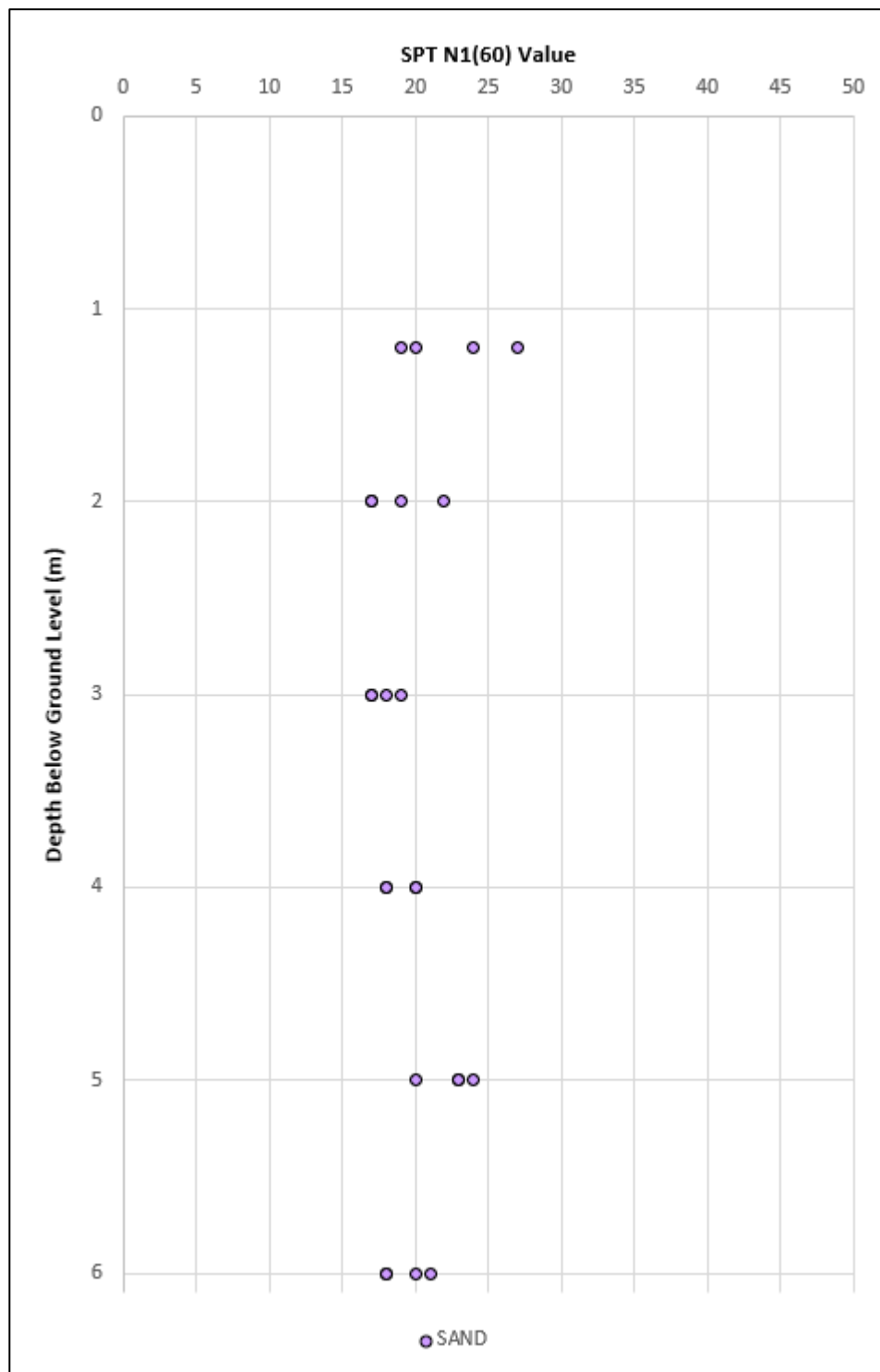
The **water-soluble sulphate** content of the four sand samples ranged from 120mg/l to 170mg/l SO₄, together with **pH values** of 7.2 to 7.5.

Table 13: Summary of Design Parameters (Granular)

Depth	SPT N Value Range	Average N Value	Design N Value*	Equivalent Soil Density	Angle of Internal Friction (degrees ^o)**
1.20	19 - 27	23	20	Medium Dense	33°
2.00	17 - 22	19	17	Medium Dense	32°
3.00	17 - 19	18	17	Medium Dense	32°
4.00	18 - 20	19	18	Medium Dense	32°
5.00	20 - 24	23	22	Medium Dense	34°
6.00	18 - 21	19	18	Medium Dense	32°

*Based on lower quartile N1(60) value **Based on the correlation by Peck, Hanson and Thornburn⁽¹⁹⁷⁴⁾

Figure 9 SPT N1(60) v Depth Plot



10.0 GEOTECHNICAL ASSESSMENT

10.1 Proposed Development

It is understood that the Client intends to demolish the existing bungalow and detached outbuilding, and construct a new three-storey, residential dwelling. The development will include substantial vehicular parking to the front of the property, with a proposed soakaway solution in the rear garden.

At the time of writing this report the anticipated structural loadings were not known.

10.2 Ground Conditions Encountered

The exploratory holes generally encountered topsoil, overlying variable, medium dense SAND, to a maximum depth of 6.00m bgl.

Made ground was recorded between ground level and to a maximum depth of 1.00m bgl in WS1 and WS3, in place of the topsoil.

Groundwater was not encountered during the site investigation or during the subsequent groundwater monitoring visit.

10.3 Foundation Considerations

Based on the ground conditions encountered conventional shallow depth foundations (strip/pad), placed in the natural sand, should be suitable at 1.00m below ground level, depending on allowable bearing pressures and tolerance of structures to settlement.

Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered, such as ground improvement and piles.

10.3.1 Conventional Shallow Depth Strip/Pad Foundations

Shallow foundations should be taken down below any Topsoil or Made Ground and placed in the natural sand. If any Made Ground, particularly loose or soft material, is encountered at foundation level this should be excavated and replaced with suitable granular fill or the foundation extended at least 150mm into suitable natural strata.

Foundations should be placed in materials of similar bearing and consolidation characteristics to avoid potential differential settlement occurring.

Table 14 overleaf summarises anticipated allowable bearing pressures for shallow foundations placed in the natural clay and sand. The bearing capacities are calculated based on Hansen's ⁽¹⁹⁷⁸⁾ method and assuming a factor of safety against bearing capacity failure of 3.

As groundwater was not encountered during the investigation, for the purpose of the calculation, groundwater has been assumed to be at 5.00m bgl, roughly the base of the monitoring installations.

Table 14: Summary of Allowable Bearing Pressures

Foundation Strata	Design Value (Section 6)	Foundation Depth (m bgl)	Foundation Type	Foundation Size (m)	Allowable Bearing Pressure (kN/m ²)
GRANULAR	$\phi = 33^\circ$	1.0	Strip	0.4	237
				0.9	258
			Pad	1.0 x 1.0	357
				2.0 x 2.0	378
	$\phi = 33^\circ$	1.5	Strip	0.4	348
				0.9	368
			Pad	1.0 x 1.0	534
				2.0 x 2.0	542
	$\phi = 32^\circ$	2.0	Strip	0.4	409
				0.9	424
			Pad	1.0 x 1.0	628
				2.0 x 2.0	625
	$\phi = 32^\circ$	2.5	Strip	0.4	509
				0.9	524
			Pad	1.0 x 1.0	788
				2.0 x 2.0	780

Table 15 below summarises anticipated settlements of the above foundations in sand based on design values discussed in Section 9. Settlement in granular soils typically comprises a large amount of immediate settlement as loads are applied and a smaller proportion of consolidation settlement, which will occur over a longer period of time. As the proposed foundation loading is not known, for the purposes of these calculations a foundation loading of 75kN/m² has been used.

Table 15: Summary of Anticipated Settlement (Granular)

Foundation Depth (m bgl)	Foundation Strata	Foundation Type	Foundation Size (m)	Pad Foundation Loading (kN/m ²)	Settlement* (mm)		
					Lower Limit	Upper Limit	Best Estimate
1.0 – 1.5	SAND	Strip	0.4	75	1	4	1
			0.9	75	1	7	3
		Pad	1.0 x 1.0	75	1	5	2
			2.0 x 2.0	75	1	8	3
2.0 - 2.5	SAND	Strip	0.4	75	1	5	2
			0.9	75	2	9	3
		Pad	1.0 x 1.0	75	1	6	2
			2.0 x 2.0	75	2	10	4

*Immediate settlement

Floor slabs should be designed as suspended if Made Ground of 600mm thickness or greater is present. Made ground is not considered an appropriate bearing stratum due to its variable nature. Floor slabs may be designed as ground bearing where Made Ground is excavated and replaced with suitable granular fill.

All foundation excavations should be inspected by a suitable qualified engineer to prove that the founding strata is suitable and uniform along the length of the foundation, and capable of taking the anticipated structural loadings. If foundations cross from granular to cohesive soils, nominal reinforcement should be incorporated.

10.4 Pavement Design

The ground investigation identified the soil type at subgrade level to typically be granular. Based on the recommendations for design CBR values provided in Interim advice note 73/06, Revision 1 (2009), a CBR value for granular soils would be 20-60% and for clay would be 4-5%.

A conservative design CBR value of 1% should be adopted in areas where Made Ground is encountered at subgrade level.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable made ground. In this context a flexible pavement design may be required.

Consideration should also be given to the use of geotextiles to allow reduction of capping thickness. For examples biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce capping thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site. For guidance, the following table gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

Table 16: Comparison of Capping Thickness with and without Geotextile

CBR	Unreinforced			Reinforced with Tensar Geogrid				
	Sub-base	Capping	Total	Sub-base	Capping	No. of grids	Total	Thickness saving
0.5%	Design not suitable			200mm	400mm	2	600mm	-
1.0%	150mm	600mm	750mm	400mm	0	1	400mm	350mm
1.5%	150mm	600mm	750mm	310mm	0	1	310mm	440mm
2.0%	150mm	600mm	750mm	260mm	0	1	260mm	490mm
3.0%	150mm	350mm	500mm	210mm	0	1	210mm	290mm
4.0%	150mm	300mm	450mm	175mm	0	1	175mm	275mm
5.0%	150mm	250mm	400mm	160mm	0	1	160mm	240mm
These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements, the advice of specialist contractor should be sought.								

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

10.5 Soil Permeability Testing

Falling head testing has been conducted within all four monitoring installations across the site in accordance with the methods described in BS5930 (Code of Practice for Site Investigations).

Measured infiltration rates determined across the site are presented in Table 17 overleaf and presented in full in Appendix 6.

Table 17: Results of Falling Head Testing

Location/Test	Test No.	Test Duration (secs)	Infiltration Rate (metres/sec)
WS1	Test 1	900	4.21E-07
WS1	Test 2	1800	3.93E-07
WS1	Test 3	2400	3.69E-07
WS2	Test 1	2700	2.12E-07
WS2	Test 2	3600	1.73E-07
WS2	Test 3	3600	1.59E-07
WS3	Test 1	1800	3.22E-07
WS3	Test 2	1500	2.53E-07
WS3	Test 3	2400	2.72E-07
WS4	Test 1	5400	3.22E-07
WS4	Test 2	6300	3.54E-07

10.6 Chemical Attack on Buried Concrete

Chemical tests (see Appendices) show low levels of water-soluble sulphates and near neutral conditions. Based on these conditions, it is recommended that for concrete placed in natural strata the Design Sulphate Class for the site, as defined in BRE Special Digest 1⁽²⁰⁰⁵⁾, be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s. The recommendations of BRE Special Digest 1 should be followed for concrete foundations and ground bearing floor slabs.

10.7 Suitability of Excavated Materials

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer once these have been prepared by the relevant parties.

Near surface soft natural clays/sands are unlikely to be suitable as structural fill and should be used for landscaping purposes only, providing they are not contaminated.

Granular Made Ground could be suitable for re-use as structural fill, providing it is not contaminated and does not contain excessive amounts of clay and providing moisture contents are controlled during placement. The control of moisture contents will be important as the cohesive content of this stratum is likely to be sensitive to moisture content changes.

10.8 Temporary Works

Formations will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations in Made Ground are likely to be unstable and should be battered back to an angle of 1 in 2, or a system of close sheeting and shoring adopted to ensure stability, and in particular

where personnel are required to enter excavations. All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered near surface within excavations, particularly during the wetter months of the year. Pumping of excavations from a suitable located sump is likely to be required to keep excavations dry.

All natural materials on site should be capable of being excavated using conventional excavating machinery.

11.0 SOIL CONTAMINATION RISK ASSESSMENT

11.1 Tier I Human Health Soil Risk Assessment – Groundworkers During Development

To assess the risk of soil contamination to construction and ground workers during development, guidelines from the HSE Document 'Protection of workers and the public during development of contaminated land' ⁽¹⁹⁹¹⁾ are used. The document assesses soil contamination test results and classifies the site as being uncontaminated or contaminated with varying degrees of contamination from 'slight' to 'unusually heavy.' The guideline values and laboratory test results are summarised in the following table:

Table 18: Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land

Contaminant	Typical Values* for:					Test Results	Class
	Uncontaminated Soils	Slight Contamination	Contaminated	Heavy Contamination	Unusually Heavy Contamination		
	Class A	Class B	Class C	Class D	Class E		
pH (acid)	6 - 7	5 - 6	4 - 5	2 - 4	<2	6.5	A
pH (alkaline)	7 - 8	8 - 9	9 - 10	10 - 12	12	7.2 - 7.7	A
Arsenic	0 - 30	30 - 50	50 - 100	100 - 500	500	3 - 42	A - B
Cadmium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 0.2	A
Chromium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	3 - 12	A
Copper	0 - 100	100 - 200	200 - 500	500 - 2500	2500	4 - 23	A
Lead	0 - 500	500 - 1000	1000 - 2000	2000 - 1%	1.0%	3 - 76	A
Mercury	0 - 1	1 - 3	3 - 10	10 - 50	50	< 1	A
Nickel	0 - 20	20 - 50	50 - 200	200 - 1000	1000	3 - 9	A
Zinc	0 - 250	250 - 500	500 - 1000	1000 - 5000	5000	14 - 60	A
Boron	0 - 2	2 - 5	5 - 50	50 - 250	250	< 1	A
Selenium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 2	A
Barium	0-500	500-1000	1000-2000	2000-1.0%	1.0%	7 - 71	A
Beryllium	0 - 5	5 - 10	10 - 20	20 - 50	50	< 0.5 - 0.5	A
Vanadium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	5 - 20	A
Sulphate	0 - 2000	2000 - 5000	5000 - 1%	1% - 5%	5.05%	< 200 - 280	A
Sulphide	0 - 10	10 - 20	20 - 100	100 - 500	500	< 5	A
Cyanide (free)	0 - 1	1 - 5	5 - 50	50 - 100	100	< 1	A
Phenol	0 - 2	2 - 5	5 - 50	50 - 250	250	< 2	A

Based on the above results there is a **LOW** potential risk from soil contamination to construction workers, ground workers and members of the public during construction. Appropriate measures, such as PPE, site health plans, and appropriate disposal of material arisings will be required to mitigate this risk.

11.2 Tier I Human Health Soil Risk Assessment – Future Site Users

The following section provides a Human Health Soil Assessment for future site users. Based on the proposed development type, the following section compares the results of contamination analyses to commercial types of end development as specified by Defra/LQM/CIEH. As part of the contamination assessment, the chemical results obtained by EEG have been screened against accepted compliance criteria, namely:

- Defra C4SL Health Criteria Values (March 2014), where available; and
- Tier 1 assessment values - based on LQM/CIEH Suitable 4 Use ⁽²⁰¹⁵⁾ (S4ULs).

The soil chemical testing results are summarised in Table 19 below.

Table 19: Soil Results Comparison with C4SL/S4UL Values

Determinand	C4SL/S4UL Levels Residential (mg/kg)	WS1 0.40m	WS2 0.50m	WS3 0.80m	WS4 0.30m	TP1 0.20m	No of Exceedances
Metals							
Arsenic	37	42	8	4	3	14	1
Beryllium	1.7	0.5	< 0.5	< 0.5	< 0.5	0.5	0
Boron	290	< 1	< 1	< 1	< 1	< 1	0
Cadmium	22	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0
Chromium	910	7	7	5	3	12	0
Chromium VI	21	< 2	< 2	< 2	< 2	< 2	0
Copper	2400	20	13	4	5	23	0
Lead	200	75	32	6	3	76	0
Mercury	40	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	8	6	3	3	9	0
Selenium	250	< 2	< 2	< 2	< 2	< 2	0
Vanadium	410	16	12	7	5	20	0
Zinc	3700	59	30	21	14	60	0
Polycyclic Aromatic Hydrocarbons							
Naphthalene	2.3	< 0.1	< 0.1	0.12	< 0.1	< 0.1	0
Acenaphthylene	210	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	170	< 0.1	< 0.1	0.67	< 0.1	< 0.1	0
Fluorene	170	< 0.1	< 0.1	0.71	< 0.1	< 0.1	0
Phenanthrene	95	0.27	< 0.1	6.43	0.11	0.34	0
Anthracene	2400	< 0.1	< 0.1	2.39	< 0.1	< 0.1	0
Fluoranthene	280	1.65	0.16	11.1	0.22	0.52	0
Pyrene	620	1.7	0.15	9.68	0.19	0.48	0
Benzo(a)anthracene	7.2	0.78	< 0.1	3.42	< 0.1	0.17	0
Chrysene	15	0.82	< 0.1	3.39	< 0.1	0.23	0
Benzo(a)pyrene	5	0.86	< 0.1	2.89	< 0.1	0.16	0
Benzo(b)fluoranthene	2.6	1	< 0.1	3.2	< 0.1	0.25	1
Benzo(k)fluoranthene	77	0.35	< 0.1	1.13	< 0.1	< 0.1	0
Indeno(1,2,3-cd)pyrene	27	0.42	< 0.1	1.53	< 0.1	< 0.1	0
Dibenz(a,h)anthracene	0.24	< 0.1	< 0.1	0.3	< 0.1	< 0.1	1
Benzo(ghi)perylene	320	0.35	< 0.1	1.37	< 0.1	< 0.1	0
Phenols							
Phenol	280	< 2	< 2	< 2	< 2	< 2	0

Based on the above table, three contaminant concentrations were found in exceedance of the screening criteria relevant to a Residential End Use in two of the tested samples. This refers to an exceedance of arsenic in WS1 at 0.40m bgl, and exceedances of benzo(b)fluoranthene and dibenz(a,h)anthracene in WS3 at 0.80m bgl.

Asbestos fibres were not identified in any of the samples tested.

11.3 Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of June 2018, "Guidance on the classification and assessment of waste" has been carried out on soils recovered from the site, using HazWasteOnline.

The results are summarised in Table 20 below and presented in full in Appendix 5.

Table 20: Waste Classification of Soils

Location	Depth (m bgl)	WM3.1 Classification	Comments
WS1	0.40	Non-Hazardous	-
WS2	0.50	Non-Hazardous	-
WS3	0.80	Non-Hazardous	-
WS4	0.30	Non-Hazardous	-
TP1	0.20	Non-Hazardous	-

The above table shows that all the soil samples collected during this investigation were classified as **Non-Hazardous** in accordance with WM3.1.

Further Waste Acceptance Criteria (WAC) testing may prove that this material is acceptable as inert waste.

12.0 CONCLUSIONS & RECOMMENDATIONS

12.1 Soil Contamination

There is a **LOW** potential risk from soil contamination to construction workers and ground workers during development, and appropriate measures such as PPE, site health plans, appropriate disposal of material arisings will be required to mitigate this risk. The groundworks contractor must provide a soil management plan including methods of dealing with unanticipated soil contamination encountered during groundworks.

Based on the results of the chemical testing, three contaminant concentrations were found in exceedance of the screening criteria relevant to a Residential End Use in two tested samples. The exceedances refer to arsenic, identified in the sample tested from WS1 at 0.40m bgl and benzo(b)fluoranthene and dibenz(a,h)anthracene in WS3 at 0.80m bgl.

Based on the proposed development plan, both of the contamination hotspot areas are to be covered by hardstanding, therefore removing the contamination pathway. The risk to end users is therefore considered to be **LOW** and remedial measures are not deemed necessary.

12.2 Asbestos

Asbestos fibres were not identified in any of the soil samples tested.

12.3 Foundations

Shallow strip/pad foundations placed in the natural sand should be appropriate for the current proposed development, dependent on allowable bearing pressures and tolerance of structures to settlement.

Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered, such as ground improvement and piles.

12.4 Soil Disposal

Soils should be disposed of at a suitable site, registered to take the levels of contamination encountered.

All the soils collected from the site have been classified as Non-Hazardous (see Table 20) for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

Further waste acceptance criteria testing could render the material as suitable for disposal at an inert waste facility.

12.5 Soakaways/Soil Permeability

The infiltration rates determined from the falling head testing carried out on site suggest that soakaways are feasible for the site.

12.6 Risk to Buried (Water) Services

It is considered that due to the low levels of contamination encountered standard materials are likely to be appropriate for new water pipes. Further advice should be sought from the local water company.

Previous guidance on buried water pipes was contained in Water Regulations Advisory Scheme (WRAS) Guidance Note No. 9-04-03⁽²⁰⁰²⁾, however this has been superseded by the UK Water Industry Research Report 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' Ref 10/WM/03/21 (January 2011).

12.7 Site Personnel

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on-site washing facilities should be available.

12.8 Other Matters

Due diligence is required during the construction period, and should any further evidence of contamination be found, appropriate investigation and / or action should be taken. The significance of any contamination not discovered by this investigation is outside the scope of this report.

APPENDIX 1

GROUNDSURE REPORT

APPENDIX 2

EXPLORATORY HOLE LOGS

APPENDIX 3

GEOTECHNICAL TESTING RESULTS

APPENDIX 4

CHEMICAL TESTING RESULTS

APPENDIX 5

SOIL WASTE ASSESSMENT

APPENDIX 6

FALLING HEAD TESTING RESULTS

APPENDIX 7

REPORT LIMITATIONS

REPORT LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd based on a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget, and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd 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 Earth Environmental & Geotechnical Ltd.

If a third party relies on this report, it does so wholly at its own and sole risk and Earth Environmental & Geotechnical Ltd disclaims any liability to such parties.

It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important 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 will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2023 and should be read considering any subsequent changes in legislation, statutory requirements, and industry best 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 Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd 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 Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd 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, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd 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 Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full of 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 Earth Environmental & Geotechnical Ltd 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. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data 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 Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

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 Earth Environmental & Geotechnical Ltd] 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.