



Earth Environmental
& Geotechnical

GeoEnvironmental Investigation

Barber Street

Hoyland

June 2016

On behalf of

Jacksons Plastering

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**GEOENVIRONMENTAL
INVESTIGATION**

BARBER STREET

HOYLAND

BARNSELY

Report Ref: A1331/16

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Prepared on Behalf of:

JACKSONS PLASTERING

By:

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GEOENVIRONMENTAL INVESTIGATION

BARBER STREET, HOYLAND, BARNSELEY

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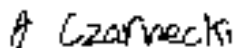
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TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	TERMS OF REFERENCE.....	1
1.3	LIMITATIONS OF THE STUDY	1
2.0	SITE LOCATION & INFORMATION	2
2.1	SITE LOCATION & DESCRIPTION.....	2
2.2	FORMER USE	2
2.2	PROPOSED DEVELOPMENT.....	3
3.0	ENVIRONMENTAL SETTING	4
3.1	GEOLOGY	4
3.2	GROUNDWORKINGS	4
3.3	MINING AND OTHER UNDERGROUND WORKINGS	5
3.4	RADON POTENTIAL	5
3.5	HYDROGEOLOGY AND HYDROLOGY	5
3.6	LANDFILL AND WASTE MANAGEMENT ACTIVITY.....	6
3.7	INDUSTRIAL LAND USE INFORMATION	6
3.8	ENVIRONMENTAL PERMITS, INCIDENTS AND REGISTERS	7
3.9	ENVIRONMENTALLY SENSITIVE SITES	7
3.10	ARCHAEOLOGY	8
3.11	POTENTIAL FLOOD RISKS	8
3.12	PREVIOUS SITE INVESTIGATIONS	8
4.0	SITE HISTORY	9
5.0	SITE INVESTIGATION	12
5.1	EXPLORATORY FIELDWORK.....	12
5.2	SUMMARY OF SITE INVESTIGATION OBSERVATIONS.....	13
5.2.1	<i>Ground Conditions.....</i>	<i>13</i>
5.2.2	<i>Observable Indications of Contamination</i>	<i>15</i>
5.2.3	<i>In-Situ Testing</i>	<i>15</i>
5.3	LABORATORY TESTING PROGRAMME.....	15
5.4	GROUNDWATER AND GROUND GAS MONITORING.....	16
6.0	RISK ASSESSMENT	17
6.1	TIER I HUMAN HEALTH SOIL DATA ASSESSMENT	17
6.2	GROUNDWATER RISK ASSESSMENT	18
6.3	GROUND GAS ASSESSMENT	19
7.0	GEOTECHNICAL ASSESSMENT.....	20
7.1	GEOTECHNICAL PARAMETERS.....	20
7.2	FOUNDATION CONDITIONS.....	20
7.3	BUILDING FLOOR SLABS	2
7.4	SUB-SURFACE CONCRETE	2
7.5	SOAKAWAYS.....	3
7.6	CONSTRUCTION ACTIVITY AND INSPECTION.....	3
7.7	GROUNDWATER CONTROL	3
7.8	ROADS AND CAR PARKING	4
8.0	CONCLUSIONS AND RECOMMENDATIONS	5
8.1	CONCLUSIONS.....	5
8.2	RECOMMENDATIONS.....	6

FIGURES

Figure 1	Site Location Plan
Figure 2	Former Layout
Figure 3	Proposed Development Plan
Figure 4	OS Map Extract 1855
Figure 5	OS Map Extract 1948
Figure 6	OS Map Extract 1968-1976
Figure 7	Google Earth Images 2002
Figure 8	Sampling Location Plan
Figure 9	Estimated Extent of Basements

TABLES

Table 3.8	Environmental Permits, Incidents and Registers
Table 4.0	Summary of Site History
Table 5.2	Summary of Ground Conditions
Table 5.4	Summary of Ground Gas and Groundwater Monitoring Results
Table 6.1	Assessment of Soil Chemical Data
Table 6.2	Assessment of Groundwater Chemical Data
Table 7.1	Summary of Geotechnical Test Data
Table 7.2	Summary of Foundation Conditions
Table 7.4	Summary of Sulphate Testing

APPENDICES

Appendix 1	Groundsure Reports
Appendix 2	Exploratory Hole Logs
Appendix 3	Groundwater and Ground Gas Monitoring Results
Appendix 4	Chemical Testing Results
Appendix 5	Geotechnical Testing Results
Appendix 6	Risk Assessment Criteria for Soils
Appendix 7	Report Limitations

1.0 INTRODUCTION

1.1 Background

A GeoEnvironmental Site Investigation has been commissioned by MP Consulting on behalf of Jacksons Plastering (the client) to examine ground conditions and retrieve soil samples for chemical and geotechnical testing at the site of a proposed residential development.

Planning permission has been granted by Barnsley Council for the erection of eleven two storey terraced houses with associated gardens and car parking (Ref 2010/1280).

1.2 Terms of Reference

Earth Environmental & Geotechnical Ltd were commissioned to undertake a GeoEnvironmental Investigation of the site in accordance with a proposal (A1331/16), dated 4th March 2016.

The objectives of the investigation outlined within the proposal were as follows:

- Complete a Phase 1 Environmental Desk Study for the site.
- Assess the presence and likely extent of any potential environmental hazards (soil, groundwater and ground gas contamination) associated within the areas of the site investigated.
- Assess ground conditions for foundation design purposes.
- Assess soil quality for offsite disposal purposes.

1.3 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. Earth Environmental and Geotechnical Ltd reserve the right to amend either conclusions or recommendations in light of 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 and trial pits, 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.

2.0 SITE LOCATION & INFORMATION

2.1 Site Location & Description

The site comprises approximately 0.2 hectares and is bound by Barber Street to the north-east, Victoria Street to the south-east, flats at Fitzwilliam Court to the south-west, and the rear gardens of residential property along Green Street to the north-west. The site entrance is located on Victoria Street. The National Grid Reference of the centre of the site is SE 37596 00650, the nearest postcode for the site is on Barber Street S74 9RE.

A location plan is shown below as Figure 1.

Figure 1: Site Location Plan



2.2 Former Use

The site was previously occupied by the Welcome Inn public house.

Figure 2, overleaf, shows the previous layout.

Figure 2: Former Layout



At the time of the investigation, the site was partially covered with hardstanding from historical land uses. The majority of the site was covered with demolition rubble with a stockpile of demolition rubble in the eastern corner of the site and along the side adjacent to Barber Street, approximately 1.5m high, 10m wide and 30m long.

2.2 Proposed Development

The proposed development consists of eleven terraced houses. Each plot will have a private garden and associated car parking.

Figure 3, below, shows the proposed Development Layout Plan.

Figure 3: Proposed Development Plan



3.0 ENVIRONMENTAL SETTING

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

Environmental conditions are covered by Environment Agency (EA) and British Geological Survey (BGS) online data and the site specific GroundSure EnviroInsight report (Appendix 1).

3.1 Geology

The site is not recorded as lying on infilled ground, however, given the history of the site, made ground is to be expected.

There are no records of superficial materials below the site.

Bedrock is shown to be clay, silt and sand of the Pennine Middle Coal Measures Formation. These rocks are described by the BGS as:

'Interbedded grey mudstone, siltstone, pale grey sandstone and commonly coal seams, with a bed of mudstone containing marine fossils at the base, and several such marine fossil-bearing mudstones in the upper half of the unit.'

Kents Rock – sandstone is shown to subcrop 8m to the south of the site.

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

The closest fault (inferred coal seam on the BGS maps) lies 125m to the south-west of the site.

There are 17 borehole records within 250m of the site. The closest available borehole records to the site in the BGS boreholes database are approximately 167m to the south west of the site. These boreholes show shallow depths of made ground (up to 1.4m deep) underlain by stoney clay over weathered sandstone.

The site is in an area where the hazard rating is negligible or very low with regard to landslides, ground dissolution, shrink/swell clays, compressible deposits, collapsible deposits, and running sands.

3.2 Ground Workings

There are no records from historical mapping of any historical surface ground working features within 250m of the site boundary.

There are 5 historical records indicating groundworks within 500m of the site, all of which are unspecified shafts. The closest lies 172m north-east of the site, shown on mapping from 1901 to 1951.

There are 5 current records indicating ceased groundworks within 500m of the site, the closest being a deep coal pit 173m north-east of the site.

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

3.3 Mining and Other Underground Workings

There are 5 historical records indicating groundworks within 500m of the site, all of which are unspecified shafts. There are 5 current records indicating ceased groundworks within 500m of the site, the closest being a deep coal pit 173m north-east of the site.

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

There are no non-coal mining cavities or natural cavities recorded within 1km of the site.

The site is situated within the specified search distance of an identified mining area. The site is not situated within a Development High Risk Area, however, there are several Development High Risk Areas in close proximity of the site, including an interpreted coal seam outcrop less than 100m south-east of the site.

The site is in an area where iron ore (bedded) mining may have occurred. The BGS state:

“Localised small scale underground mining may have occurred. Potential for difficult ground conditions are unlikely or localised and are at a level where they need not be considered.”

No underground railway lines or tunnels are identified on the site on historical mapping.

3.4 Radon Potential

The property is in a Radon Affected Area as defined by the Health Protection Agency as between 1% and 3% of properties are above the Action Level of exposure.

No radon protection measures are necessary.

3.5 Hydrogeology and Hydrology

The Pennine Middle Coal Measures Formation below the site 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.

The EA classifies the groundwater vulnerability and soil leaching potential on site as HU, a minor aquifer with high leaching potential. These soils are therefore assumed to be highly permeable in the absence of site-specific information.

There are 4 records for groundwater abstraction licences within 2km of the site, the closest being a historical license for groundwater from a borehole used for a lake and pond throughflow, this lies 1.3km north of site.

There are no surface water abstraction licences or potable water abstraction licences within 2km of the site.

There are no groundwater source protection zones within 500m of the site.

There are no source protection zones within the confined aquifer within 500m of the site.

There are 6 entries in the detailed river network records within 500m of the site, the closest being an unnamed culvert 381m north-east of the site.

There are no surface water features recorded within 250m.

There are no chemical or biological river quality records within 1.5km of the site.

3.6 Landfill and Waste Management Activity

1:10,000 scale historical OS mapping identifies 39 features indicative of potential infilled land within 500m of the site, the closest being an unspecified shaft 172m north-east of the site dated 1901. Also in the vicinity are unspecified shafts, unspecified heaps, unspecified ground workings, an unspecified quarry and numerous ponds.

The closest EA record for a historical landfill is for a site 306m south-east of the site at Cinder Cottage Site. There are no EA records of current landfill within 1km.

There is 1 record of BGS/DoE non-operational landfill sites within 1.5km of the site, the Cinder Cottage Site, 463m south-east of the site which is stated as having no risk to the aquifer.

There are 3 records of landfill from Local Authority records and historical mapping within 1.5km, the closest being a refuse tip 407m north of the site.

There are 2 records of waste treatment, transfer or disposal sites within 500m of the site based on historic mapping, the closest being a refuse heap 313m south of the site.

3.7 Industrial Land Use Information

1:10,000 scale mapping does not identify any historically contaminative uses on site, however there are 41 records within 50m of the site, the closest being an unspecified old shaft 172m north-east of the site. Also in the vicinity of the site there are records of several old shafts, refuse heaps, ground workings, a telephone exchange, a foundry, railway sidings, a fire station, and railway buildings.

There are no historical tank records within 500m of the site.

There are 15 historical energy features within 500m of the site, the closest being an electricity substation dated 1994, 103m south-east of the site.

There are no entries in the historical petrol and fuel site database within 500m of the site.

There are 17 entries in the historical garage and motor vehicle repair database within 500m of the site boundary. The closest relates to a garage 218m west of the site in 1992.

There are 9 records for current industrial data with potentially contaminative uses within 250m of the site, the closest being an electricity substation 6m south-west of the site and a vehicle repair, testing and servicing garage 47m south-west of the site. Other entries further afield, include colours, chemicals and water softeners and supplies, vehicle hire and rental, 4 electricity substations and another vehicle repair, testing and servicing garage.

There is 1 record of a petrol or fuel site, 499m north-west of the site.

There are no records of high voltage underground electricity transmission cables or high pressure gas transmission pipelines within 500m of the site.

3.8 Environmental Permits, Incidents and Registers

Searches of information provided by the Environment Agency and Local Authorities reveals the following within 500m of the property:

Table 3.8: Environmental Permits, Incidents and Registers

Historic IPC Authorisations	None
Part A (1) and IPPC Authorised Activities	None
Red List Discharge Consents	None
List 1 Dangerous Substances Inventory Sites	None
List 2 Dangerous Substances Inventory Sites	None
Part A (2) and Part B Activities and Enforcements	3
Category 3 or 4 Radioactive Substance Authorisations	None
Licensed Discharge Consents	2
Water Industry Referrals	None
Planning Hazardous Substance Consents and Enforcements	None
Dangerous or Hazardous (COMAH and NIHHS) Sites	None
National Incidents Recording System (Pollution Incidents), List 2	None
National Incidents Recording System (Pollution Incidents), List 1	4
Sites Determined as Contaminated Land under Part 2A EPA1990	None

The closest Part A (2) and Part B Activity is for petrol vapour recovery from an auto services, 303m north-west of the site at 65 market street, Hoyland.

The closest Licensed Discharge Consent is for a sewer storm overflow at Church Street, Hoyland.

The NIRS List 2 records are for incidents in 2001 and 2003 involving crude sewage which had no impact or minor land or water impacts. The closest was 322m to the north of the site.

3.9 Environmentally Sensitive Sites

There are 10 records of Ancient Woodland within 2km of the site, the closest being 1.2km south-west of the site.

There is 1 record of a Local Nature Reserve, the Elsecar Reservoir, 1.2km south of the site.

The site rests within a DEFRA classified Nitrate Vulnerable Zone.

There are 7 records of Green Belt land within 2km of the site, the closest being the Liverpool, Manchester and West Yorks Greenbelt, 213m north of the site within Barnsley District (B).

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

It should be noted that an ecological assessment of the site falls outside the brief of this report and that an ecological specialist should be consulted in this regard.

3.10 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.

3.11 Potential Flood Risks

Detailed assessment of flood risk is outside the scope of this report. However, the site is not within 250m of an EA Zone 2 or Zone 3 floodplain. The highest risk of flooding on site is very low.

There are no flood defences, areas benefitting from flood defences or areas used for flood storage within 250m of the site.

According to the BGS there are areas within 50m of the site boundary that may be susceptible to groundwater flooding from clearwater. This is noted to have limited potential and no further action is required.

3.12 Previous Site Investigations

We are not aware of any records of previous site investigations.

4.0 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 back to 1855.

The site history is summarised in Table 4.0 below.

Table 4.0: Summary of Site History

Date	Site	Surrounding Land Use
1855	Unoccupied. Farmland.	Agricultural and horticultural area with some residential property. Small town Nether Hoyland approximately 300m west of site. Milton Iron Works 450m south of the site. Hoyland mill 450m south of site. Numerous quarries and pits 450m NE of the site including coal and sandstone quarries.
1892-1893, 1893-1894, 1903-1905, 1905-1907, 1930-1931, 1938-1948	Residential estate now occupies southern portion of site, with the northern portion still unoccupied grassland.	Significant expansion of residential properties to W and S. Expansion of Hoyland town. Iron Works now Iron and Brass Foundry with expansion of number and size of quarries/pits. Mill no longer functioning. Expansion of residential properties surrounding old pits. Old shafts 500m NE of site. Police station 250m SW of site. Railway line 550m SW of site, in a NE-SW direction. (1903-1905)
1956, 1965-1966	Northern part of the site is now British Legion Club.	Significant urban expansion of residential properties with allotment gardens. Residential infill between towns. Iron and brass foundry ceases production (1956).
1968-1976, 1980-1982, 1989-1991	British Legion Club is now "Club". Residential properties are no longer shown, indicating demolition. A large square "Club" building is shown occupying a large part of the remainder of the site.	Increase in urbanisation. Iron and brass foundry area is now a recreation ground.
Google Earth Images	Club buildings demolished in 2009, plot unoccupied.	Area appears much as it can be found today.

Selected extracts from historical maps and aerial photographs are presented in the figures overleaf:

Figure 4: OS Map Extract 1855

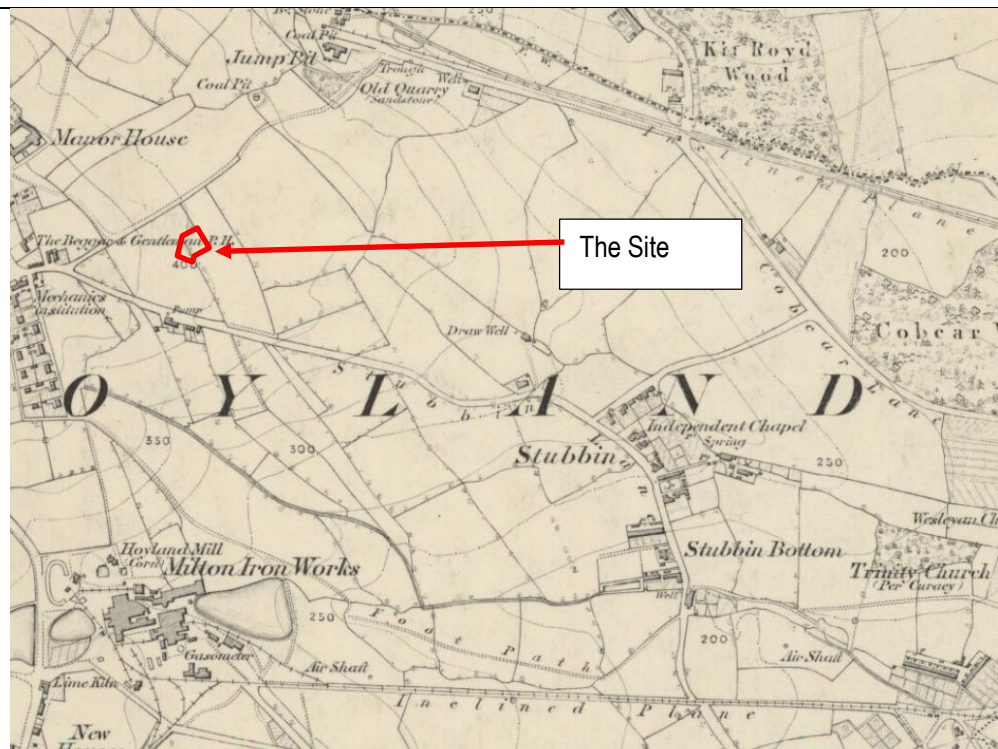


Figure 5: OS Map Extract 1948

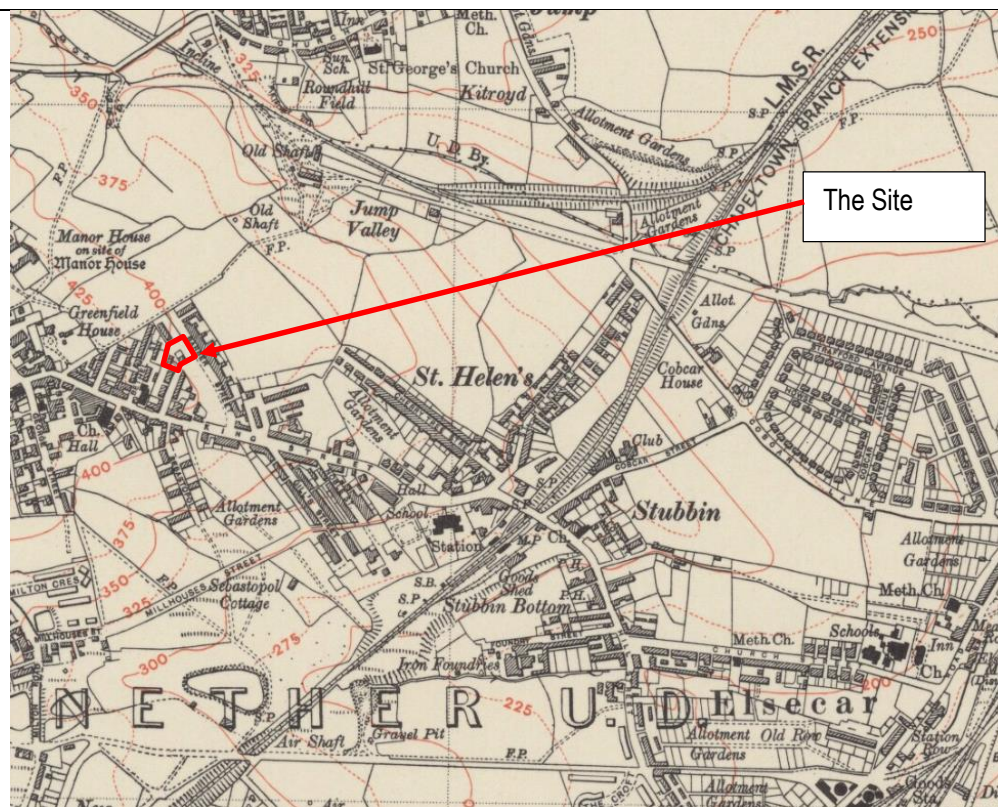


Figure 6: OS Map Extract 1968-1976



The Site

Figure 7: Google Earth Images 2002



The Site

5.0 SITE INVESTIGATION

5.1 Exploratory Fieldwork

The scope of the investigation was designed by Earth Engineering & Geotechnical, providing all round coverage and targeting the location of the former Welcome Inn and British Legion Club to determine the presence of basements.

The ground investigation works comprised of seven windowless sample boreholes (WS01 to WS07) and four machine excavated trial pits (TP01-TP04). The investigation was completed on the 12th April 2016. The exploratory hole logs are provided in Appendix 2.

WS01 to WS07 were each drilled to depths of between 1.2 and 3.8m below ground level (bgl) to determine the ground conditions in each location and confirm the depth to rockhead.

Trial Pits TP01 and TP02 were set out in the location of the former British Legion Club. TP03 and TP04 were set out in the location of the former club building (The Welcome Inn) to the rear of the former British Legion Club.

The site work was supervised full-time by a representative of Earth Environmental & Geotechnical Ltd, with logging of soils in accordance with BS5930:2015 Code of Practice for Site Investigations.

Soil samples destined for chemical testing were sealed in 1litre plastic tubs and 250ml amber glass jars and stored in a cool box. Details of the strata encountered and the samples taken are listed in the exploratory hole logs in Appendix 2.

Monitoring wells were installed in three of the windowless sample boreholes (WS03, WS05 and WS06) in order to obtain information on groundwater levels, ground water contamination, ground gas concentrations and flow rates.

The sampling locations are illustrated in Figure 8 (overleaf).

Figure 8: Sampling Location Plan



5.2 Summary of Site Investigation Observations

5.2.1 Ground Conditions

Trial pit TP01 found basements extending to 2.9m below ground filled with mixed demolition rubble, fragments of fibre reinforced cement materials (potential asbestos containing materials) were found in some horizons. At the lower levels the demolition rubble appeared to be loose and blackened, indicative of a significant fire.

Trial pits TP02, TP03 and TP04 did not find basements.

TP01 was extended to the north and west to identify the sides of the basement. An assessment of the potential extent of basements can be made by relating the findings of the investigation to the historical locations of the buildings.

Figure 9, overleaf, provides an estimate of the potential extent of the basements under the the former British Legion Club.

Figure 9: Estimated Extent of Basements

The exploratory holes (WS01 to WS07 and TP02 to TP04) revealed made ground overlying sandy clay or sand. Superficial materials were underlain by weak and weathered coal, sandstone, siltstone or mudstone at depths from 0.5 to 3.4m bgl.

The made ground across most of the site (to the northern, western and southern sides – outside the footprints of the former buildings) was found to be fairly shallow (depths between 0.1 and 1.1m below ground) and contained predominantly reworked natural materials. In the centre and eastern parts of the site (in the locations of the former buildings) made ground was found deeper (especially in the location of the former basements for the British Legion Club) and consisted predominantly demolition rubble.

Rockhead was encountered in most exploratory locations during the investigation, at depths between 0.5 and 3.4m below ground level.

A summary of the ground conditions at each sampling location is provided in Table 5.2 overleaf.

Table 5.2: Summary of Ground Conditions

Location	Base of Made Ground (m bgl)	Rockhead (m bgl)	Hole Final Depth (m bgl)
WS01	0.25	1.0	1.2
WS02	0.25	2.5	3.4
WS03	0.3	0.3	2.1
WS04	0.45	0.6	2.0
WS05	0.1	0.9	3.45
WS06	1.1	2.8	3.8
WS07	1.4	1.4	2.0
TP01	Not found	Not found	2.9
TP02	0.7	1.2	1.3
TP03	1.4	1.9	2.3
TP04	0.5	0.5	1.0

5.2.2 Observable Indications of Contamination

Made ground was observed to include broken brick, concrete, metals, glass, tarmac, ash, plastic, clayware and other similar demolition waste. Fragments of fibre reinforced cement (potential asbestos containing materials) were also identified within the backfill material in the former basement of the British Legion Club.

No notable visual or olfactory evidence of contamination was noted within the natural strata.

5.2.3 In-Situ Testing

In-situ standard penetration testing was undertaken (in accordance with BS1377 Part 9, 1990) within all windowless sample probeholes at 1m centres. The results are shown on the exploratory hole logs in Appendix 2.

5.3 Laboratory Testing Programme

Based upon the former land uses, four soil samples were selected for a wide range of analytes including asbestos, metals, pH, sulphate and sulphide, cyanide, phenols, total organic carbon (TOC), speciated petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAH).

Seven fragments of fibre reinforced cement were submitted for asbestos screening.

In addition, one sample of water has been recovered from installation (WS06) has also been assessed for contamination. The remaining two installations contained insufficient water available for testing.

Chemical analysis was undertaken by QTS Environmental Limited of Maidstone in accordance with MCERTS/UKAS procedures. Test certificates are included in Appendix 4.

Geotechnical testing has been performed on selected samples by Murray Rix of Stockport in accordance with UKAS procedures. Test certificates are included in Appendix 5.

5.4 Groundwater and Ground Gas Monitoring

Three of the boreholes were fitted with monitoring installations for groundwater and ground gas monitoring.

Ground gas monitoring has been conducted on six occasions by use of a portable GA2000 infra-red analyser with GFM610 flow meter. During monitoring, water levels were also recorded by use of an electronic dipmeter.

The installations were purged of all groundwater on the first monitoring visit and water samples were taken from the installations on the second visit.

The monitoring results are provided in Appendix 3 and are summarised in Table 5.4, below.

Table 5.4:
Summary of Ground Gas and Groundwater Monitoring Results

Location	Date	Max Methane (% vol/vol)	Max Carbon Dioxide (% vol/vol)	Min Oxygen (% vol/vol)	Flow Rate (litres/hour)	Water Level (m)	Atmospheric Pressure (mB)
WS03	20/04/16	0.0	0.4	19.9	0.0	Dry	1019 falling
WS05		0.0	3.1	17.0	0.0	2.83	
W06		0.0	0.8	18.7	0.0	3.0	
WS03	27/04/16	0.0	0.3	20.0	0.0	Dry	999 falling
WS05		0.0	2.6	18.3	0.0	2.96	
W06		0.0	0.7	19.2	0.0	3.17	
WS03	04/05/16	0.0	0.3	20.0	0.0	Dry	1013 falling
WS05		0.0	2.6	18.3	0.0	2.96	
W06		0.0	0.7	19.0	0.0	3.18	
WS03	11/05/16	0.0	0.1	20.3	0.0	Dry	998 steady
WS05		0.0	2.9	18.6	0.0	2.95	
W06		0.0	0.3	20.5	0.0	3.17	
WS03	19/05/16	0.0	0.1	20.3	0.0	Dry	999 falling
WS05		0.0	2.9	18.6	0.0	2.95	
W06		0.0	1.0	18.8	0.0	3.19	
WS03	25/05/16	0.0	0.4	19.5	0.0	Dry	1006 falling
WS05		0.0	3.3	17.7	0.0	2.94	
W06		0.0	1.0	19.3	0.0	3.14	

Notes for Table 5.4

Carbon Dioxide concentrations greater than 5.0% vol/vol shown in bold and italics.
Methane concentrations greater than 1% shown in bold.

6.0 RISK ASSESSMENT

The soil characteristics have been assessed with reference to DEFRA/Environment Agency Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV) for generic site land uses, soils and exposure. Where Environment Agency generic guidance is absent, reference has been made to the Chartered Institute of Environmental Health (CIEH) S4ULs for human health risk assessment.

In the case of lead a DEFRA Category 4 Screening Level has been adopted.

6.1 Tier I Human Health Soil Data Assessment

The soil chemical testing results are presented in Appendix 4 and summarised in Table 6.1, below. Appendix 6 provides a list of assessment criteria and their derivation.

All results have been compared to residential end use criteria, assuming a sandy soil with 1% organic matter.

Table 6.1: Assessment of Soil Chemical Data

Parameter	TP01	TP01	WS02	TP03	Assessment Criteria (mg/kg)
	0.50	1.50	0.60	0.60	
Arsenic	11	10	19	12	37
Boron	< 1	< 1	< 1	< 1	290
Beryllium	0.8	0.6	1.6	1.1	1.7
Cadmium	0.3	< 0.2	< 0.2	< 0.2	11
Chromium	20	33	15	15	910
Hexavalent Chromium	< 2	< 2	< 2	< 2	21
Copper	27	47	36	44	2400
Cyanide	< 2	< 2	< 2	< 2	41
Lead	54	1840	101	64	200
Mercury	< 1	< 1	< 1	< 1	40
Nickel	12	17	27	15	130
Monohydric Phenols	< 2	< 2	< 2	< 2	280
Selenium	< 3	< 3	< 3	< 3	250
Zinc	88	378	60	61	3700
pH	7.8	8	7.6	8.2	N/A
Naphthalene	< 0.1	0.22	< 0.1	< 0.1	2.3
Fluorene	0.54	4.01	< 0.1	< 0.1	170
Benzo(a)pyrene	4.39	13.2	< 0.1	0.24	5
Di-benzo (a,h) anthracene	0.35	0.86	< 0.1	< 0.1	0.24

Notes for Table 6.1

Sandy soil with 1% Soil Organic Matter assumed
Concentrations in red above assessment criteria

Based upon the long term protection of human health for a residential end use potential contaminants of concern were found in trial pit TP01. These samples were from the stockpile on the site and infilled basements below (the basements of the former British Legion Club).

Asbestos fibres as loose fibres of chrysotile and also within fragments of construction materials were detected in samples taken from TP01 at 1.20m and 1.5m bgl.

6.2 Groundwater Risk Assessment

One water sample has been recovered from the monitoring standpipes, and tested in order to assess the potential mobility of contaminants of concern. There was a limited volume of water within the installations for taking water samples. The monitoring pipes were purged completely on the visit prior to the sample collection visit and not purged on the day of sampling.

The results from the groundwater testing have been compared to UK Drinking Water Standards and Environmental Quality Standards (for the protection of ecology in waters).

The results of the screening are shown in Table 6.2, below.

Table 6.2: Assessment of Groundwater Chemical Data

Parameter	WS06	Assessment Criteria (µg/l)	Source
Arsenic, Dissolved	<5	10	UK DWS
Barium, Dissolved	33		
Beryllium, Dissolved	<3		
Boron	73	1000	UK DWS
Cadmium, Dissolved	<0.4	5.0	UK DWS
Chromium, Dissolved	<5	50	UK DWS
Hexavalent Chromium	<20		
Copper, Dissolved	<5	2000	UK DWS
Lead, Dissolved	<5	25	UK DWS
Mercury, Dissolved	<0.05	1	UK DWS
Nickel, Dissolved	<5	20	UK DWS
Selenium, Dissolved	<5	10	UK DWS
Vanadium, Dissolved	<5		
Zinc, Dissolved	3	5000	UK DWS
Benzo(a)pyrene	<0.01	0.01	WHO
Cyanide	<5	50	UK DWS
Fluorene	<0.01		
Naphthalene	<0.01	10	EQS Freshwater
pH	6.6		
Phenol	<10	30	EQS Freshwater

Notes for Table 6.2

Concentrations in **red** above assessment criteria

UKDWS: United Kingdom Drinking Water Standards

WHO: World Health Organisation Standard

EQS Freshwater: Environment Agency Environmental Quality Standard for Freshwater

All potential contaminants of concern are below conservative water quality standards.

6.3 Ground Gas Assessment

The potential impact on the development from ground gases has been assessed with reference to NHBC Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present, March 2007.

No elevated methane (>1% vol/vol) or carbon dioxide (>5% vol/vol) has been recorded during the monitoring period.

A maximum carbon dioxide (CO₂) of 3.3% v/v has been recorded in WS05 during the sixth visit. No significant flow rate was recorded from any monitoring well on any visit. Gas Screening Values (GSV) are therefore zero.

The site is classified as a Green Traffic Light condition as the Gas Screening Values are less than 0.16l/hr and 0.78l/hr for methane and carbon dioxide respectively.

No gas protection measures are necessary.

7.0 GEOTECHNICAL ASSESSMENT

7.1 Geotechnical Parameters

Soil samples were despatched to a laboratory for geotechnical index and strength testing.

Table 7.1 (below) provides a summary of the laboratory geotechnical test data.

Table 7.1: Summary of Geotechnical Test Data

Location	Depth (m)	Material	Plasticity	Moisture Content (%)	Modified Plasticity Index (%)	Volume Change Potential
WS05	0.5-0.9	Firm sandy silty CLAY	Intermediate	24	17	Low
WS06	1.5-2.0	Stiff sandy silty CLAY	Low	18	12	Low
Characteristic Value (GL-2m)				21	15	

Clays with low volume change potential were encountered.

Standard penetration testing has been undertaken in order to assess the relative density of granular materials. The results of the SPT tests are provided on the logs in Appendix 2.

7.2 Foundation Conditions

Table 7.2, below, provides a summary of anticipated depth and types of foundations that could be employed across the site. The table does not make any adjustments for proximity to any trees, either felled or retained.

Table 7.2: Summary of Foundation Conditions

Unit	Closest Exploratory Position	Made Ground Thickness (m)	Founding Depth (m)	Founding Material	Type of Foundation
1, 2 and 3	WS01, TP02	0.25 – 0.70	0.8	Firm sandy CLAY	SS/PA/TF
4, 5, 6 and 7	TP01, WS06	Est. approx. 3m	3m	SANDSTONE	VCC/VSC/P
8	WS06	1.1	1.2	Firm sandy CLAY	TF
9, 10 and 11	WS04, TP04, WS03	0.3 – 0.5	0.6	SANDSTONE	SS/PA

Notes for Table 7.2

SS Shallow Strip
PA Shallow pad foundation
TF MassTrench Fill

VCC Vibro concrete columns
VSC Vibro stone columns
P Piles

The definition of the use of either Trench Fill foundations or an alternative technique such as P/VCC/VSC is based on a depth of 2.0m, as this represents very approximately the cost effective limit for use of trench fill as opposed to the other techniques.

Ground conditions across the site are variable with the presence of deep made ground in the area of the basements below the former British Legion Club.

Foundation loadings should not be placed within made ground due to the potential for short and long term differential settlement.

Foundations for units 1 to 3 and 9 to 10 can be placed at shallow depth in the sandy clays to be found across the site. Based on a SPT N value of 12 in the sandy clay horizon an allowable bearing capacity of 100kN/m² has been estimated.

Foundations for the units in the location of the basement below the Former British Legion Club should be supported by piles or some form of ground improvement, such as vibro-stone columns. This appears most likely to affect Units 4, 5, 6 and 7 but may not affect all of these units.

Driven piles may lessen the volume of material requiring off-site disposal; however driving can induce some ground vibration. Assessment of any vibration risk to adjacent structures should be undertaken by the pile designer.

For piled foundations suspended floor slabs should be utilised. A pre-cast 'Beam and Block' concrete ground floor construction could be utilised, and suspended across the ring beams.

7.3 Building Floor Slabs

Ground bearing slabs are considered to be appropriate for the new building structures at Units 1 to 3 and 8 to 10.

Due to the presence of deep made ground in the locations of units 4 to 7, floor slabs should be suspended.

Where suspended floor slabs are employed ventilation of the under floor void may be required to prevent condensation issues.

7.4 Sub-Surface Concrete

The results of pH and soluble sulphate testing in cohesive soils is summarised overleaf in Table 7.4.

Table 7.4: Summary of Sulphate Testing

Location	Depth (m)	Sulphate 2:1 Water Extract (g/l)	pH	Classification
TP01	0.5	0.04	7.8	DS-1 AC-1
TP01	1.5	1.73	8.0	DS-3 AC-2
TP03	0.6	0.19	8.2	DS-1 AC-1
WS02	0.6	0.23	7.6	DS-1 AC-1
WS05	0.5 – 0.9	0.29	7.1	DS-1 AC-1
WS06	1.5 – 2.0	0.33	7.0	DS-1 AC-1

Based upon the testing results sub-surface concrete for the majority of the site should be designed as Design Sulphate Class DS-1 and ACEC class AC-1, in accordance with BRE Special Digest 1.

Foundations constructed in the location of the basements of the former British Legion Club should be designed as Design Sulphate Class DS-3 and ACEC class AC-2, in accordance with BRE Special Digest 1.

7.5 Soakaways

Permeable strata suitable to facilitate the construction of soakaways was not identified during the site investigation, though the underlying sandstone may prove adequate. Infiltration testing will be required to confirm whether this strata is suitable for drainage soakaway construction and to assist with the design process.

7.6 Construction Activity and Inspection

It is recommended that allowance be made for the inspection of foundation materials, proof rolling of slab areas and road subgrade conditions during construction. Inspections should be carried out by appropriately qualified and experienced geotechnical engineers.

The formation horizon across the site will consist of clays, which if exposed, will deteriorate in strength during periods of inclement weather.

Site observations indicated that excavations should be feasible in the near surface with normal plant; however obstructions were identified in the near surface including former foundations and former floor slabs. Any obstructions will need to be grubbed out during the site works.

7.7 Groundwater Control

No significant groundwater has been found on the site at shallow depths, though standing water has been monitored in the monitoring wells.

It would be prudent to make an allowance for sump pumping from excavations.

7.8 Roads and Car Parking

In-situ CBR testing should be performed at the formation level prior to construction. For preliminary design purposes a CBR value of 2% should be utilised.

Plate load bearing testing or Dynamic Cone Penetrometer testing, at the appropriate time, would confirm design criteria for highway design purposes.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The site investigation has confirmed the presence of variable ground conditions with made ground underlain in areas with sandy clays and sands, all over weak rock. Deeper made ground was found in the location of the basements of the former British Legion Club.

Chemical testing of soils has revealed an absence of elevated concentrations of potential contaminants of concern with respect to long term human health, for the planned residential end use across much of the site. No remedial works are necessary across most of the site.

However, asbestos, lead and PAH's have been found in the fill materials in the basement of the former British Legion Club. A significant proportion of this area will be covered by building and hardstand and will not be accessible to site occupiers. These materials may remain at or near to the surface of the site after the site has been excavated to formation level for the development and may therefore be potentially accessible by future users of the site. Further assessment is required to determine the remediation strategy in this area. The remediation strategy will need to be agreed with the Local Authority.

There is very little groundwater below the site. Chemical testing of one water sample has not revealed any significant contamination.

Ground gas monitoring has been undertaken on six separate occasions. No elevated concentrations of methane or carbon dioxide have been recorded, no gas flows have been measured and no ground gas protection measures are considered necessary.

Relict foundations have been found in the locations of the former buildings. These may need to be grubbed out and backfilled with stone locally to allow construction of foundations.

Surplus materials from excavations across a majority of the site could potentially be classified as inert for offsite disposal subject to further waste acceptance criteria testing.

Materials removed from the stockpile and removed from the site as waste will need to be classified for suitable waste disposal. No significant visual or olfactory contamination was noted in these materials and disposal is unlikely to be problematic.

Materials in the infilled basements contain elevated concentrations of lead, PAH's (Poly-Aromatic Hydrocarbons) and also fragments and fibres of asbestos. These were found in the blackened and ashy fill materials in the lower part of the basement and appear likely to be a mixture of broken historical building products and by-products of combustion. Materials removed from the basement as waste are potentially likely to be classified as Hazardous Waste. These materials should be segregated from all other waste materials and will need to be classified for suitable waste disposal.

Shallow foundations and ground bearing slabs are suitable for most of the site. Deeper foundations or ground improvement with suspended floors will be necessary in the location of the basements from the former British Legion Club.

Sub-surface concrete for the majority of the site should be designed as Design Sulphate Class DS-1 and ACEC class AC-1, in accordance with BRE Special Digest 1. Foundations

constructed in the location of the basements of the former British Legion Club should be designed as Design Sulphate Class DS-3 and ACEC class AC-2.

Soakaways may be suitable subject to infiltration testing.

8.2 Recommendations

Further assessment is required to determine the remediation strategy in the area of the former British Legion Club. The remediation strategy will need to be agreed with the Local Authority.

Materials in the stockpile should be classified for suitable waste disposal.

Materials removed from the former basement as waste should be segregated from all other waste materials. These materials should be classified for suitable waste disposal.

Shallow foundations and ground bearing slabs are suitable for most of the site. Deeper foundations or ground improvement with suspended floors will be necessary in the location of the basements from the former British Legion Club.

Sub-surface concrete for the majority of the site should be designed as Design Sulphate Class DS-1 and ACEC class AC-1, in accordance with BRE Special Digest 1. Foundations constructed in the location of the basements of the former British Legion Club should be designed as Design Sulphate Class DS-3 and ACEC class AC-2.

Infiltration testing should be completed to determine whether soakaway drainage is suitable for the development.

APPENDIX 1

GROUNDSURE REPORTS

APPENDIX 2

EXPLORATORY HOLE LOGS

APPENDIX 3

GROUNDWATER AND GROUND GAS MONITORING RESULTS

APPENDIX 4

CHEMICAL TESTING RESULTS

APPENDIX 5

GEOTECHNICAL TESTING RESULTS

APPENDIX 6

RISK ASSESSMENT CRITERIA FOR SOILS

Tier I Values for Residential Land Use (with plant uptake)
Based on Sandy Loamy Soil

Arsenic	mg/kg	37	CIEH S4UL based on 6% SOM
Boron	mg/kg	290	CIEH S4UL based on 6% SOM
Beryllium	mg/kg	1.7	CIEH S4UL based on 6% SOM
Cadmium	mg/kg	11	CIEH S4UL based on 6% SOM
Chromium (III)	mg/kg	910	CIEH S4UL based on 6% SOM
Chromium (IV)	mg/kg	21	Category 4 Screening level based on 6% SOM
Lead	mg/kg	200	Category 4 Screening level based on 6% SOM
Mercury (Inorganic)	mg/kg	40	CIEH S4UL based on 6% SOM
Selenium	mg/kg	250	CIEH S4UL based on 6% SOM
Nickel	mg/kg	130	CIEH S4UL based on 6% SOM (Revised, Aug 2015)
Copper	mg/kg	2400	CIEH S4UL based on 6% SOM
Toluene	mg/kg	130	CIEH S4UL based on 6% SOM
Benzene	mg/kg	0.087	CIEH S4UL based on 6% SOM.
Ethylbenzene	mg/kg	47	CIEH S4UL based on 6% SOM
Xylene	mg/kg	56	CIEH S4UL based on 6% SOM
Trichlorethene (TCE)	mg/kg	0.016	CIEH S4UL based on 6% SOM
Tetrachloroethene (PCE)	mg/kg	0.18	CIEH S4UL based on 6% SOM
Zinc	mg/kg	3700	CIEH S4UL based on 6% SOM
Cyanide - Free	mg/kg	41	Based on acute risk to 0-6yr old child, HPA
Phenols	mg/kg	280	CIEH S4UL based on 6% SOM
PCB	mg/kg	1.4	CLEA 1.06 modelling with 1% SOM
Benzo(a)pyrene	mg/kg	5	Category 4 Screening level based on 6% SOM
Dibenzo(a,h)Anthracene	mg/kg	0.24	CIEH S4UL based on 6% SOM
Fluorene	mg/kg	170	CIEH S4UL based on 6% SOM
Naphthalene	mg/kg	2.3	CIEH S4UL based on 6% SOM
Vanadium	mg/kg	410	CIEH S4UL based on 6% SOM

TPH Ali C5-C6	mg/kg	42	CIEH S4UL based on 6% SOM
TPH Ali C6-C8	mg/kg	100	CIEH S4UL based on 6% SOM
TPH Ali C8-C10	mg/kg	27	CIEH S4UL based on 6% SOM
TPH Ali C10-C12	mg/kg	130	CIEH S4UL based on 6% SOM
TPH Ali C12-C16	mg/kg	1100	CIEH S4UL based on 6% SOM
TPH Ali C16-C35	mg/kg	65000	CIEH S4UL based on 6% SOM
TPH Ali C35-C44	mg/kg	65000	CIEH S4UL based on 6% SOM
TPH Aro C5-C7	mg/kg	70	CIEH S4UL based on 6% SOM
TPH Aro C7-C8	mg/kg	130	CIEH S4UL based on 6% SOM
TPH Aro C8-C10	mg/kg	34	CIEH S4UL based on 6% SOM
TPH Aro C10-C12	mg/kg	74	CIEH S4UL based on 6% SOM
TPH Aro C12-C16	mg/kg	140	CIEH S4UL based on 6% SOM
TPH Aro C16-C21	mg/kg	260	CIEH S4UL based on 6% SOM
TPH Aro C21-C35	mg/kg	1100	CIEH S4UL based on 6% SOM
TPH Aro C35-C44	mg/kg	1100	CIEH S4UL based on 6% SOM

APPENDIX 7

REPORT LIMITATIONS

LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd on the basis of 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 2016 and should be read in light of 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 from those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further 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.