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PHASE 2

GEO-ENVIRONMENTAL REPORT

job number	C4260/24/E/6523
date	24/05/2024
site address	Goldthorpe Housing Project Victoria Street Goldthorpe, Rotherham S63 9HN
written by	J.Finch
checked by	S.Alexander
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Report on a Phase 2 Geo-environmental Investigation

Location:	Goldthorpe Housing Project Victoria Street, Goldthorpe, Rotherham, S63 9HN
For:	Barnsley Metropolitan Borough Council
Report No.	C4260/24/E/6523 Report date: May 2024

For and on behalf of **Rogers Geotechnical Services Ltd**

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Graduate Engineer

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Report Summary[1]

Item	Comments	Section
Development	Ten semi-detached dwellings with associated parking and garden areas.	1.
Geology	Superficial geology – None. Solid geology – Middle Coal Measures Formation (Southwest of the Site), Ackworth Rock (Northeast of the Site)	5.
Strata Conditions	Topsoil and made ground over firm to stiff clay and shallow mudstone.	6.
Groundwater	None encountered during investigation.	6.2
Foundation Design	Shallow strip or spread foundation on firm to stiff clays and shallow rock.	9.1
Effect of Sulphates	DC-1 concrete.	9.4
Contamination	Arsenic and PAH contamination revealed at some locations.	10.

[1] This summary should not be relied upon to provide a comprehensive review. All of the information contained in this document should be considered.

1. Introduction

It is understood that the Goldthorpe Housing Estate is to be developed by the demolition of several of the existing terraced houses and the construction of ten semi-detached dwellings with associated parking and garden areas. Consequently, a site investigation has been undertaken in accordance with the specification prepared by Hamson Barron Smith ref 2023.24.F055 P1 dated 28th February 2024. This work was required in order to determine the nature of the underlying soils, to assess their engineering properties and to assist in the design of safe and economical foundations for the proposed development. This investigation also takes into consideration the risk of any contamination present. This report describes the work undertaken, presents the data obtained and discusses the ground conditions in relation to the proposed works.

2. Limitations

The recommendations made and opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site and of the laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between borehole positions, these are for guidance only and no liability can be accepted for their accuracy.

This report has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of issue.

3. Desk Study

A Phase 1 Desk Study has been undertaken by Rogers Geotechnical Services (RGS) and the results were presented as report number C4260/24/E/6522 in April 2024. This report has been used extensively during the current intrusive investigation.

4. Fieldworks

The fieldworks were undertaken on the 19th April 2024 and included the following:

- Eight handheld windowless sample boreholes.
- Four gas monitoring standpipes.

The investigatory locations are shown on the site plan which is presented in Appendix 1 to this report.

4.1 Windowless Sample Boreholes

These boreholes were sunk using a handheld drive-in windowless sampler. The cores were undertaken in 1m lengths in 57mm diameter through to a maximum depth of 2m. The recovered cores were sealed and returned to the laboratory for logging and subsequent testing. The soils were described in general accordance with BS5930: 2015 +A1: 2020 and full descriptions are given on the windowless sample records which are presented in Appendix 2. Also included on these records are the core diameters and percentages of core recovered.

4.2 Gas Monitoring Standpipes

Gas monitoring standpipes were installed between 1.0m and 2.0m depth in BH02, BH04, BH05, and BH08 and the installation details are shown on the appropriate borehole records. In the case of the 2.0m installs, the monitoring standpipe consisted of a perforated pipe from the base of the borehole to 1.0m below surface, 0.5m in the case of the 1m install, with a non-perforated pipe to ground level. The response zone was filled with pea gravel, with a bentonite seal at the base and above, and the installation was capped with a stop box cover in a concrete surround.

5. Geology

The available published geological data for the site has been examined and the following table presents the anticipated geology.

Table 1: Geological Data for the Site

Strata Type	Strata Name[2]	Previous Name[3]	Description[3]
Superficial Geology	N/A	N/A	Not indicated to underlie the site.
Solid Geology	Pennine Middle Coal Measures Formation (Southwest of the Site)	Grey Measures of Yorkshire And Nottingham	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.
	Ackworth Rock (Northeast of the Site)	-	Sandstone.

[2] Sources: British Geological Survey (NERC) Map Sheet 87; Barnsley; Solid and Drift Edition, and Geology of Britain Viewer [*online resource from www.bgs.ac.uk*]
[3] Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [*online resource from www.bgs.ac.uk*]

6. Strata Conditions

In accordance with the geology of the area, the succession has been shown to include the following:

Table 2: Generalised Strata Profile

Depth m below ground level to underside of layer	**Strata Type**	**Positions Encountered**	**Groundwater Strikes** m below ground level
0.10 – 0.30	TOPSOIL	BH01, BH05, BH07, BH08	None
0.10 – 0.45	MADE GROUND (Cohesive)	BH01, BH02, BH03, BH04, BH06, BH08	None
0.30 – 075	Firm sandy gravelly CLAY	BH01, BH02, BH04, BH05, BH07, BH08	None
0.40	Firm silty sandy CLAY	BH06	None
0.65 – +2.00m	Stiff silty CLAY	ALL	None
1.55	COAL	BH04	None
+1.00 - +2.00	MUDSTONE	BH03, BH04, BH05, BH06, BH07, BH08	None

'+' denotes that the strata extended below the termination depth of the investigated positions, thus the extent of the deposit is only proven to the depths indicated

6.1 General Strata

In general, the borehole records indicate that beneath a 0.10m to 0.45m capping of topsoil and cohesive made ground, firm to stiff grey and brown sandy, sandy gravelly and silty clays were revealed to depths of between 0.65m and 2.00m below ground level (begl) within each borehole. Within BH03, BH04, BH05, BH06, BH07 and BH08 this clay was underlain by mudstone to the base of the boreholes. Coal was recorded from 1.35m to 1.55m begl in BH04.

It is considered that these mudstones represent the Pennine Middle Coal Measures and that the clays above represent the weathered fraction.

6.2 Groundwater

No groundwater strikes were observed during the site investigation. However, it should be appreciated that the normal rate of boring does not permit the recording of an equilibrium water level for any one strike, moreover, groundwater levels are subject to seasonal variation or changes on local drainage conditions.

7. Laboratory Testing - Geotechnical

The following programme of laboratory testing has been undertaken on samples obtained during this investigation:

- Determination of water content — BS EN ISO 17892-1:2014
- Determination of liquid and plastic limits — BS EN ISO 17892-12:2018
- pH value — BS 1377-3:2018+A1:2021: Pt3: 12

The test results are presented in Appendix 5 and are summarised below:

Table 3: Summary of Geotechnical Test Results

Test type	Number of tests	Range of results		Comments
Water content determinations	9	20% to 30%		Generally reducing with depth.
Index properties (4 Point)	7	LL PL PI	43 to 62% 21 to 30% 22 to 34%	Clay of intermediate to high plasticity. Consistency index 0.7 to 1.1 NHBC Class - Medium
Soluble sulphate & pH	3	SO_4 pH	0.09 to 0.13g/l 7.19 & 7.57	Natural ground.

In cohesive soil the approximate cohesion, c_u, and coefficient of consolidation, m_v, may be obtained from the equivalent SPT 'N' value using the following expressions (Stroud 1975).

$c_u = f_1 N$

$m_v = \frac{1}{f_2 N}$

where:

c = cohesion (kN/m^2).
m_v = Coefficient of consolidation (m^2/MN).
f_1 & f_2 = factors based on plasticity index.
N = SPT 'N_{300}' value.

For the cohesive soils revealed at this site the highest (worst case) plasticity index[4] of 34% could be employed, which suggests an f_1 value of 4.4 and an f_2 value of 0.44.

7.1 Geotechnical Properties

The idealised geotechnical properties employed in design are summarised below.

Table 4: Summary of Geotechnical Properties

Property	Range of values		Comments
Volume change potential (NHBC)	Medium		CLAY
Shear strength parameters (at 0.90m)	c_u	65kN/m^2	Conservative shear strength from in-situ hand shear vane testing
Concrete classification	DC1		Natural ground locations (Static water)

[4] See paragraph 6.2 'Index Property Tests'

8. Laboratory Testing - Environmental

A suite of testing was conducted on samples from across the site and the following regime was undertaken.

- Metals – Cd, Cr^{VI}, Cu, Hg, Ni, Pb, V and Zn.
- Semi and Non-Metals - As, Se, Free CN^- and Phenols.
- Polycyclic aromatic hydrocarbons (PAHs).
- Petroleum hydrocarbons (TPHs).
- Others – pH, organic content and total/soluble SO_4^{2-}.
- Asbestos.

This testing was undertaken by i2 Analytical Ltd and the results of all of the chemical testing are presented in Appendix 5 of this report.

9. Discussion of Ground Conditions - Geotechnical

9.1 Foundations

It is considered that foundations could include the provision of strip and spread footings. The results of this investigation indicate that firm to stiff clay transitioning mudstone will be revealed at depths ranging between 0.75m and 2.0m.

It is considered such deposits are likely to represent a suitable founding strata and foundations could be placed at a minimum depth of 0.90m based on a medium volume change potential on clays with at least a firm in-situ condition. Such clays are likely to present a cohesion of at least 65kN/m^2. It is considered that strip or spread foundations constructed within this material, at a minimum depth of say 0.9m, could be designed assuming an allowable increase in stress given in the following table:

Table 5: Allowable Increase in Stress

Foundation Type		Strip Footings			Spread/Pad Footings		
Foundation Breadth	B (m)	0.6	0.9	1.2	1.0	1.5	2.0
Foundation Depth	D (m)	0.9			0.9		
Allowable Increase in Stress	(kN/m²)	145	135	130	160	155	150
Net Allowable Bearing Capacity[5]	(kN/m²)	165	155	150	180	175	170

Should foundations be placed on the mudstone this material would possess a significant bearing capacity, probably being in excess of 250kN/m^2. Therefore, at a typical foundation load for a house the factor of safety against general shear failure will be high, probably exceeding 10. In addition, it is considered that nominal settlements will occur under the action of the proposed increase in load.

The stability of excavation faces cannot be guaranteed thus temporary support to the excavation faces may become necessary unless the foundations are constructed using trench-fill techniques. In this method the foundation trenches should be excavated, inspected and backfilled with concrete as a continuous operation. Under no circumstances should operatives be allowed to enter unsupported excavations.

[5] Assumes bulk density of material removed from footing excavations to be 20kN/m³

Should the excavations be required to stand open, it is considered that a blinding layer of lean-mixed concrete be placed over the sub-grade. This expedient will reduce loosening or softening of the underling soil due to both physical disturbance and the ingress of surface water.

Should seepage of groundwater be encountered it is considered that it could be dealt with using a simple form of de-watering. Such a system could include the excavation of sumps from which the water could be pumped.

9.2 Ground-floors

In light of the competent clays, which were encountered from a maximum depth of 0.45m, it is recommended that ground bearing ground floor slabs should be employed.

Further to the above, due to the volume change potential at the site, should the floor be placed within the zone of influence of any existing, or proposed, trees and shrubs, an allowance for soil volume change should be included. Further guidance is available in the NHBC standards, however, soil volume change can typically be catered for by providing a suitable void or utilize proprietary materials beneath the floor slab.

9.3 Hard-standing Areas

It is considered that any hard-standing at the site could be constructed employing traditional pavement design. A design California Bearing Ratio (CBR) of 2% could be employed in the pavement design[6]. However, it is recommended that proof rolling of the sub-grade be undertaken to establish the suitability of the soils, to expose any soft or weak ground and to ensure the sub-grade is well compacted prior to construction. Any areas of soft or weak ground should be remediated by increasing the sub-base thickness. Alternatively, weak material could be locally removed and replaced with a compacted granular capping layer. If construction were to be undertaken during the winter or after periods of prolonged rainfall, it may be prudent to employ a geotextile and/or a geogrid between the sub-base and sub-grade.

9.4 Effect of Sulphates

In view of the nature of the underlying soils it is considered that the design sulphate class be assessed with reference to Table C2[7], which is provided in BRE Special Digest 1, *Concrete in aggressive ground*: Part C. On the basis of this table and considering the soluble sulphate contents recorded, it can be shown that well compacted buried concrete should be designed in accordance with Class DS-1 requirements. Assuming static groundwater, the table also indicates that the aggressive chemical environment for concrete (ACEC) classification is AC-1s.

In order to evaluate the design chemical (DC) class for the buried concrete at this site reference should be made to Table D1[8], which can be found in Part D, *Specifying concrete for general cast-in-situ use,* of BRE Special Digest 1. From this table it may be shown that for an intended working life of at least 50 years the concrete design class DC-1 is required.

[6] Table 11.1, *Reproduction of TRRL Report LR1132 (1984)*, Smith (2006), Smith's Elements of Soil Mechanics, 8th ed.
[7] Table C2, *Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations*
[8] Table D1, *Selection of the DC Class and the number of APMs for concrete elements where the hydraulic gradient due to groundwater is 5 or less: for general in-situ use of concrete.*

10. Discussion of Ground Conditions - Environmental

10.1 Discussion of Test Results

It is understood that the Goldthorpe Housing Estate is to be developed by the demolition of several of the existing terraced houses and the construction of ten semi-detached dwellings with associated parking and garden areas. Consequently, the site may be classified as residential with plant uptake.

10.1.1 Soil Samples

The results of the chemical testing undertaken on soil samples obtained during this investigation have been compared to the ATRISK soil screening values (SSVs) as compiled by WS Atkins plc. With respect to the results it should be appreciated that the soil organic matter (SOM) content for the samples tested was found to range between 1.8% and 8.9%. On this basis, it is considered that the screening values associated with 1% SOM should be adopted. These values have been derived in such a way as to adhere to the principles within the revised CLEA model and include the most current release of the SGVs. A list of subscribers is provided within the website[9] and these include many local authorities.

A comparison of the results of the testing, together with the data given above, can be found within Appendix 5. These results indicate the following:

Table 6: Summary of Contaminated Areas

Location	Depth (m)	Contaminants found to be exceeding SSVs (Residential with plant uptake)
BH01	0.3	Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Benzo[g,h,i]perylene
BH02	0.45	Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene, Benzo[g,h,i]perylene
BH03	0.2	Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Benzo[g,h,i]perylene
BH04	0.3	Benzo[g,h,i]perylene
BH05	0.25	Arsenic, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Benzo[g,h,i]perylene
BH06	0.35	Indeno(1,2,3-c,d)Pyrene
BH07	0.3	Arsenic, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Benzo[g,h,i]perylene
BH08	0.55	None

Concentrations of cadmium, chromium^{VI}, mercury, free cyanide, phenols (total) and total petroleum hydrocarbons (aliphatic C5 to C21; aromatic C5 to C10) were below the detection limits for all tests. Detectable levels of all other contaminants were recorded in at least one position, but these fell below the associated Atrisk Soil Screening Values. In addition, no asbestos was detected within the soils samples tested.

It should be appreciated that the soil screening values for PAHs and TPHs (where appropriate) represents vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of

[9] http://www.atrisksoil.co.uk/pages/general/subscribers.asp

total exposure, which is unlikely to significantly affect the combined assessment criterion[10]. In view of this, the ATRISK soil SSVs notes that the users may wish to consider using a combined assessment criterion if free product is not observed, the values for which are also provided on the summary of contamination analysis. It is therefore considered that the criteria for no free product should be adopted for the PAHs and TPHs at this site. The results of the contaminants found to exceed these screening values are tabulated below:

Table 7: Summary of Areas Contaminated by PAHs & TPHs

Location	Depth (m)	Contaminants found to be exceeding SSVs (Residential with Plant Uptake)
BH01	0.3	Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[a]pyrene
BH02	0.45	Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene
BH03	0.2	Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[a]pyrene
BH04	0.3	Benzo[g,h,i]perylene
BH05	0.25	Arsenic
BH06	0.35	None
BH07	0.3	Arsenic
BH08	0.55	None

On the basis of the above information, the results of the investigation have concluded that the site is contaminated. Indeed, PAHs have been observed to exceed the relevant SSVs in BH01 – BH04 while there is an exceedance of arsenic in BH05 and BH06. These positions correspond to the rear gardens of 10, 16, 18, 19 and 23 Cooperative Street and 16 Victoria Street.

It is understood that areas of public open space will also be allocated onsite, positions BH01, BH02 and BH03 were undertaken nearest to these areas. Therefore, these potions have also been considered with regards to the SSVs for Public Open Space end use and all three have been found to have exceedances of Benzo[a]anthracene and Benzo[b]fluoranthene.

[10] Ref: ATRISK soil, SSVs derived using CLEA v1.071 for 6% SOM, Residential with home grown produce land use, 23.06.17.

10.2 Site Specific Risk Assessment

10.2.1 Approach

The presence of contamination hazards and the risks associated with them should be assessed in accordance with industry practice and the 'suitable for use' approach. This has been conducted with reference to The Department for Environment, Food and Rural Affairs (DEFRA) and The Environment Agency[11] advice on the assessment of risks arising from the presence of contamination in soils and using the source-pathway-receptor approach.[12] This method dictates that there must be a risk of contaminant produced at a 'source' in sufficient concentration to cause harm and there must be a 'pathway' for the contaminant to reach an identifiable 'receptor' for the linkage to be proved and a contamination hazard to be considered present. Not all substances are contaminants and not all contaminants are considered to be a risk. Indeed DEFRA and The Environment Agency state that 'a contaminant is a substance which has the potential to cause harm, while a risk itself is considered to exist if such a substance is present in sufficient concentration to cause harm and a pathway exists for a receptor to be exposed to the substance.'[13]

10.2.2 Conceptual Ground Model and Risk Assessment

In view of the results of the chemical testing undertaken the conceptual site model is presented accordingly as Table 8. Sources of contamination include the following:

On-site – Made Ground/Topsoil (Arsenic and PAHs).

The preliminary risk assessment has been evaluated with reference to the following ratings and definitions:

N/A -	A source-pathway-receptor linkage is not considered to exist and therefore a risk assessment is not required.
Low -	A pollution linkage is unlikely and/or the likelihood of harm occurring is low and of minor consequence.
Moderate -	The linkage exists but the likelihood of harm occurring is not considered to be significant although remedial action may be necessary
High -	The linkage exists and the available data indicates that significant harm may be caused and remedial action could be necessary.

The results of the risk assessment are presented in Table 10.

[11] R&D Publication CLR 8, 'Assessment of Risks to Human Health from Land Contamination: An overview of the Development of Soil Guideline Values and Related Research'.
[12] The pollution linkage approach was developed by 'Circular 2/2000 Contaminated Land: Implementation of Part II of The Environmental Protection Act 1990' which provides meanings for the terms contained in The Environmental Protection Act 1990 Part IIA, the primary legislation for addressing the issues of contaminated land.
[13] See 'Circular 2/2000 Contaminated Land: Implementation of Part II of The Environmental Protection Act 1990', appendix A.

Table 8: Conceptual Site Model and Site-Specific Risk Assessment [Contamination: Arsenic and PAHs]				
Conceptual Site Model			**Site Specific Risk Assessment**	
Pathways	**Receptor**	**Linkage Present?**	**Risk Rating**	**Notes**
Direct contact/dermal absorption/soil ingestion	Operative	Yes – contamination found to be present at the site and contact with soil likely during works.	High	Some contamination is present in the soils underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways.
	End User	Yes – contamination found to be present at the site and site to be developed into residential dwellings with garden areas	High	
	Neighbours	Yes – contamination found to be present at the site and a populated residential and commercial area surrounds the site.	Moderate	
Inhalation of Dust/Vapours	Operative	Yes – dust may be derived from contaminated soils.	Moderate	Some contamination is present underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways. Measures to prevent dust generation and mitigate offsite escape to neighbours.
	End User	Yes – dust may be derived from contaminated soils.	Moderate	
	Neighbours	Yes – contamination found to be present at the site and residential and commercial properties located immediately adjacent to the site. Possible generation of dust during site activity.	Moderate	
Ingestion of fruit/vegetables and/or waters	Operative	No – no edible plants or contained water sources in the area of the proposed new works.	N/A	Some contamination is present underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways.
	End User	Yes – contamination found to be present at the site and site to be developed into residential dwellings with garden areas	Moderate	
	Neighbours	Yes – contamination found to be present at the site and residential area adjoins the site.	Moderate	
Spillage/loss/run off direct to receiving water	Controlled Waters	No – no known controlled waters within 250m.	N/A	Some contamination is present underlying the site. Remediation will be required to either remove the contamination or break pathways. Old services to be removed or capped.
Migration via permeable unsaturated strata	Controlled Waters	Yes – secondary A aquifer is present beneath the site. However, the site is underlain by cohesive soils of low permeability. Contamination is not anticipated to be significantly mobile.	Moderate	
Run off via drainage/sewers etc	Controlled Waters	Yes – old services may be present on site.	Low	

Direct contact with contaminated soils	Plants	Yes – significant contamination present at the site which may affect plants.	High	Some contamination is present underlying the site. Remediation will be required to either remove the contamination or break pathways.
Uptake via root system			High	
Direct contact with contaminated soils	Building Materials	Yes – PAH contamination revealed at the site may represent a significant risk to building materials or plastic water pipes. Moreover, testing indicates that the aggressive chemical environment for concrete classification is AC-1s.	Moderate (plastic services) Low (buried concrete)	Please see section 11.3.3 for information on good building practice.
Direct contact with contaminated groundwater				
Exposure to Radon	Operative	Yes – site currently indicated to be present in a low risk radon affected area[14].	Low	Between 1% and 3% of properties are affected. The publication BR211 states that no protection measures are necessary.
	End User			

[14] Radon interactive map [*online resource https://www.ukradon.org/radonmaps/*] It should be appreciated that radon maps are subject to change and are updated regularly.

10.3 Indicative Remediation Strategy

In view of the site specific risk assessment it is considered that remediation will be required at this site. Such a strategy should include the following main elements.

10.3.1 Remediation Objectives

Based on the site-specific risk assessment the object of the remediation is likely to be as follows.

- To protect the site operatives during the construction process from the ingestion of soil or dust, dermal contact with the soil and inhalation of dust and vapours.
- To protect the end user from the ingestion of soil or dust, dermal contact with the soil and inhalation of dust and vapours.
- To protect neighbours from the inhalation and ingestion dust during the construction process.
- To protect operatives, end users and neighbours from the ingestion of contaminated fruit and vegetables.
- To protect plants from direct contact with contamination and prevent uptake via root system.
- To ensure that contamination cannot enter the former services occupying the site which may return to controlled waters.
- To protect plastic services from being penetrated by, or degrading due to the presence of, contamination in the soil or groundwaters.
- To protect site operatives and the end user from vapours associated with local elevated levels of PAHs within the made ground.

10.3.2 Development Requirements

Whilst the precise nature of this development has not been finalised it is understood that it is to be developed by the construction of ten semi-detached residential dwellings with associated parking and garden areas. In view of the above a site-specific remediation strategy should be undertaken after the proposed development has been finalised. However, for preliminary design and costing the following remediation proposals are offered.

10.3.3 Outline Strategy

In order to fulfil the objectives defined above it is likely that the following remedial strategy could be utilised. It is recommended that a pragmatic approach be undertaken, with observational techniques being employed at each stage of the work.

Ground-works

During the ground-works phase of the development, protection to the site operatives is required. The risk to site operatives is considered under the Health and Safety at Work Act 1974, together with regulations made under the act, which includes the Control of Substances Hazardous to Health (COSHH) regulations. Therefore, the risks to site personnel must be considered under the Construction Design and Management (CDM) regulations at the planning stage and be included in the contractor's Health and Safety Plan and site specific Method Statements. These documents should include the following main elements.

- Site operatives at all levels should be made aware of the hazards of working with contaminated soils and the potential hazards associated with materials containing volatile hydrocarbons.
- Personal hygiene facilities, including washing and messing, must be provided and site operatives be encouraged to use them.
- Where work is undertaken in dry weather the site should be dampened down to avoid dust. In addition, dust masks must be provided to all site operatives for use in dry weather.
- In order for contaminated soils to be disposed of to an appropriate landfill, it may be necessary to carry out Waste Acceptance Criteria (WAC) testing in accordance with BS EN 12457.
- Any stockpiles of contaminated soil on site should be sheeted over to prevent excessive amounts of airborne dust and cross contamination of imported fill.
- Where vehicles are transferring soil to the landfill site they should be covered to prevent contamination of the surrounding area by dust.
- Where work is undertaken in wet weather, vehicle and wheel washing facilities are required to ensure that the vehicles leaving the site do not transfer contamination to surrounding areas.

On completion of the ground-works a careful site inspection of the sub-grade would be required. Should visual or olfactory evidence of contamination be revealed then further testing may become necessary.

Construction

During the construction phase of the contract the following items are required to protect the end user from the potential contaminants revealed at this site.

- Beneath buildings, pavements and hard-standings clean inert granular sub-base should be employed.
- Any redundant services revealed at this site should be de-commissioned and piped services sealed. Any existing services that are to be employed in the new development should be carefully inspected to ensure that they are serviceable.
- New plastic services should be constructed in a surround of clean inert material and selected in accordance with the recommendation given in the United Kingdom Water Industry Research (UKWIR) website under Report Ref. No. 10/WM/03/21 - 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites'. The statutory water authority for the area in which site is located may have a risk assessment form to complete which allows these recommendations to be met. However, further determinand specification contamination testing may be necessary.
- For buried concrete the results of the sulphate and pH testing indicate that the design sulphate class for the site should be DS-1.

Landscaped Areas

It is understood that there is proposed to include garden areas and public open spaces. In view of this and the potential contamination on site, it is considered that landscaped areas will require some

remediation. The clean cover should comprise a minimum of 150mm of topsoil underlain by a minimum of 450mm of suitably screened and tested subsoil. Such subsoil may be site won natural material or imported.

10.4 Fill Materials

It should also be appreciated that any fill material, either site-won or imported, to be employed at the site should be subjected to the following assessment to determine its suitability.

Fill materials should be initially screened, by a suitably qualified engineer to establish that:

- It is a suitable growing media if it is to be employed as such, including compliance with BS3882 (2015)
- It is free from obvious contamination i.e. visual or olfactory evidence
- It has not come from areas where Japanese Knotweed or other invasive or injurious plants are suspected to be growing
- It is not a statutory nuisance, such as being odorous
- It is free from unsuitable material i.e. whole bricks, brick ties, timber or glass.

It should also be appreciated that any fill should be subjected to validation testing to assess its suitability. The following table has been taken from YALPAG[15] documentation and may be used as a guide. Depending on the origin and nature of the material, not all fill will require the sampling frequency and testing indicated, although this should be in agreement with any regulatory bodies (such as the Local Authority).

Table 9: Validation Sampling and Testing

Fill Type	Frequency	Minimum Determinands
Virgin Quarried Material	1 or 2 depending on the type of stone utilised, to confirm the inert nature of the material.	Standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn)
Crushed Hardcore, Stone, Brick	Minimum 1 per 500m³	Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, total TPH. Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).
Greenfield/ Manufactured Soils	Minimum 3 Dependent on source and receptor, between 1 per 50m^3 and 1 per 250m^3	Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, pH and soil organic matter (SOM) (or calculated from total organic carbon (TOC)).
Brownfield/ Screened Soils	Minimum 6 Dependent on source and receptor, between 1 per 50m^3 and 1 per 100m^3	Standard metals/ metalloids (as above), PAH (16 USEPA speciation), TPH (CWG banded), asbestos, pH and SOM (or calculated from TOC). Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).

The screening values for the above regime should also be agreed with any regulatory bodies; however, the following is recommended in the first instance.

[15] *YALPAG Technical Guidance for Developers, Landowners and Consultants – Verification Requirements for Cover Systems V4 .1* Appendix 1a, June 2021

Table 10: Fill Screening Values			
Contaminant	Screening Value (Residential with Plant Uptake) (mg/kg)		Reference
	1% SOM	6% SOM	
As	37	37	Atrisk^{SOIL} SSVs
Cd	22.1	22.1	Atrisk^{SOIL} SSVs
Cr(VI)	3.62	3.63	Atrisk^{SOIL} SSVs
Cu	4730	4790	Atrisk^{SOIL} SSVs
Hg	8.81	15.8	Atrisk^{SOIL} SSVs
Ni	136	136	Atrisk^{SOIL} SSVs
Pb	200	200	Atrisk^{SOIL} SSVs
V	136	138	Atrisk^{SOIL} SSVs
Zn	20000	20300	Atrisk^{SOIL} SSVs

Please see summary sheet within Appendix 6 for full screening values including PAHs & TPHs.

The above screening values should be considered with respect to the Soil Organic Matter (SOM) of the subject material i.e. 1% SOM would be typical for granular fill and 6% SOM for topsoil. Testing should comply with UKAS and MCERTS, where applicable, and undertaken by an accredited laboratory.

Where the material has been derived from a commercial company, certificates or other industry quality protocol compliance i.e. WRAP should be obtained. However, it will be necessary to ensure that this documentation specifically related to the material being imported, it is no more than two months old and complies with the screening and frequency requirements given above.

Suitable fill materials should be either placed immediately or sufficiently quarantined to prevent cross-contamination. If it is necessary, the quarantined material should be placed on appropriate sheeting and covered to prevent it becoming mixed with contaminated soils or dust, or penetrated by mobile contaminants.

10.5 Verification Report

In order to demonstrate that the remedial works and provision of clean cover has been sufficiently carried out where applicable, it will be necessary to produce a verification report for submission to any statutory authorities.

It will be necessary for this report to include the following:

- The extents of any areas where made ground has been removed.
- Characterisation of the suitability of the clean material including the derivation of the material, comments from a visual screen, the tests results of chemical screening, delivery tickets where appropriate and the conditions by which the clean material has been stored and handled on site.
- Photographic and logged evidence the clean material has been handled on site and placed in a sufficient thickness over areas where made ground remains. This may be either at the time of placement or after placement by means of hand excavated trialpits. Photographs should include visual site references or reference boards to prove the location and date taken. A measurement reference should be visible in the photographs to substantiate the thickness of material placed. Please note that it may also be necessary to undertake a topographical survey and the requirement for which should be checked with any statutory authorities.

The report detailed above should be produced by a suitably qualified engineer. The number of verification areas for the development should be confirmed with any statutory authorities for the site.

11. Recommendations for Further Work

- This report should be forwarded to the relevant authorities as soon as practicable to ensure they have sufficient time to review and discuss any issues.
- Discussions with ground work contractors in relation to the requirement for testing of materials to be disposed off-site (Waste Acceptance Criteria) and the suitability of imported materials.
- Discussions with service providers regarding suitable materials for pipe work given the nature of chemical determinands found within the soils on site.
- Produce a validation report to demonstrate that the geo-environmental risks discussed in this report have been mitigated.
- Detailed design of the sub-structure.

Clearly Rogers Geotechnical Services Ltd would be happy to offer advice with respect to the above and assist where necessary.

12. References

- British Geological Survey (NERC) (2024), BGS, Keyworth.
  - Geology of Britain Viewer: (*http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html)*
  - Lexicon of Named Rock Units:
  - (*http://www.bgs.ac.uk/lexicon/)*
- British Standards Institution (1990) BS1377: *British standard methods of test for soils for civil engineering purposes,* B.S.I., London.
- British Standard Institution (2005 +A1: 2011) BS EN ISO 22476-2: *Geotechnical investigation and testing – Field testing, Part 2: Dynamic Probing,* B.S.I., London.
- British Standard Institution (2005 +A1: 2011) BS EN ISO 22476-3: *Geotechnical investigation and testing – Field testing, Part 3: Standard penetration test,* B.S.I., London.
- British Standards Institution (2015 +A1: 2020) BS 5930: *Code of practice for ground investigations,* B.S.I., London.
- British Standards Institution (2011), BS 10175: *Investigation of potentially contaminated sites – Code of Practice,* British Standards Institute.
- British Standards Institution (2015 +A1:2019) BS8485: *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings,* B.S.I., London.
- British Standards Institution (2013), BS 8576 Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds.
- British Standards Institution (2017) BS EN ISO 14688: *Geotechnical investigation and testing – Identification and classification of soil*, B.S.I., London.
- Building Research Establishment (BRE) Special Digest 1 (2005), Third Edition: Concrete in aggressive ground, BRE Press, Garston.
  - Part C: *Assessing the aggressive chemical environment.*
  - Part D: *Specifying concrete for general cast-in-situ use.*
- Department for Environment, Food and Rural Affairs and the Environment Agency (2009) DEFRA Science Report – Final SC050021/SR2, *Human Health toxicological assessment of contaminants in soil*. Environment Agency, Bristol.
- Department for Environment, Food and Rural Affairs and the Environment Agency (2009) DEFRA Science Report – SC050021/SR3, *Updated technical background to the CLEA model*. Environment Agency, Bristol.
- Department for Environment, Food and Rural Affairs (2014) SP1010: *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document*.
- Wilson S, Oliver S, Mallet H, Hutchings H, Card G, *Assessing risks posed by ground gasses to buildings,* CIRIA Report C665.

Appendix 1

Site Plans

Notes:

Investigation positions approximated from site operative's notes.

RGS Environmental Geotechnical Specialists

Rogers Geotechnical Services Ltd

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Telephone: 0843 50 66 87
www.rogersgeotech.co.uk

Client:	Barnsley Council
Job Number:	C/4260/24/E/6523
Project Details:	Goldthorpe Housing Estate
Scale:	Not to scale - reference only

Notes:

Investigation positions approximated from site operative's notes.

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Rogers Geotechnical Services Ltd

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HD8 8LU

Telephone: 0843 50 66 87
www.rogersgeotech.co.uk

Client:	Barnsley Council
Job Number:	C/4260/24/E/6523
Project Details:	Goldthorpe Housing Estate
Scale:	Not to scale - reference only

Appendix 2

Borehole Records

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **BH01**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30					0.30			TOPSOIL (Black slightly sandy slightly gravelly SILT. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.50		57	90		0.40			MADE GROUND (Grey slightly sandy slightly gravelly silty CLAY. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.50				HVP=39				
		0.70				HVP=48	0.75			Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular fine sandstone and coal.
		0.85				HVP=65				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
		1.20					1.20			Firm laminated light brown mottled light grey silty CLAY.
		1.20				HVP=124				
		1.40				HVP=132				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
				57	100					Stiff laminated light grey becoming dark grey mottled brown silty CLAY.
		1.60				HVP=115				
		1.80				HVP=149				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
							2.00			End of Borehole at 2.00m

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 2m.

AGS

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **BH02**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.45		67	85		0.45			MADE GROUND (Grey slightly sandy gravelly silty CLAY. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal). *Brick*
		0.65				HVP=87	0.65			Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular fine sandstone and coal.
		0.70 0.75 0.85				HVP=87 HVP=90				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
		1.10				HVP=93	1.00			Firm laminated light brown mottled light grey silty CLAY.
		1.20				HVP=112				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
		1.30 1.30 1.40		57	100	HVP=118 HVP=135				Stiff laminated light grey becoming dark grey mottled brown silty CLAY. RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
G							2.00			End of Borehole at 2.00m

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 2m.

AGS

Borehole Log

Borehole No. **BH03**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.20					0.20			MADE GROUND (Grey slightly sandy gravelly silty CLAY. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.40								Firm laminated light brown mottled light grey silty CLAY.
		0.40		57	100	HVP=82				
		0.60				HVP=90				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
		0.80				HVP=90				
				57	65		1.40			Weathered dark grey and brown MUDSTONE.
										PENNINE MIDDLE COAL MEASURES FORMATION
							2.00			End of Borehole at 2.00m

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 2m.

Borehole Log

Borehole No. **BH04**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30					0.10			MADE GROUND (Grey slightly sandy gravelly silty CLAY. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.10				HVP=73	0.30			Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular fine sandstone and coal.
		0.45		57	80	HVP=84				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
		0.55								
		0.60				HVP=98				Firm to stiff laminated dark grey and brown silty CLAY.
		0.80				HVP=87				RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
				57	80		1.35			Black COAL.
							1.55			Weathered dark grey and brown MUDSTONE.
										PENNINE MIDDLE COAL MEASURES FORMATION
							2.00			End of Borehole at 2.00m

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 2m.

Borehole Log

Borehole No. **BH05**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.20								TOPSOIL (Black slightly sandy slightly gravelly SILT. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.35					0.30			Firm to stiff greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular fine sandstone and coal.
		0.50		57	100	HVP=90	0.50			RESIDUAL ACKWORTH ROCK
		0.80				HVP=124				Stiff laminated light brown mottled light grey silty CLAY.
		0.90				HVP=98				RESIDUAL ACKWORTH ROCK
		1.10								
				57	100		1.30			Weathered dark grey and brown MUDSTONE.
										ACKWORTH ROCK
							2.00			End of Borehole at 2.00m

1 2 3 4 5

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 2m.

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **BH06**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:	Hole Type WLS
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:	Scale 1:25
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024	Logged By JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.35					0.10			MADE GROUND (Grey slightly sandy slightly gravelly silty CLAY. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.45 0.55		57	100	HVP=65	0.40			Firm greyish brown slightly sandy slightly silty CLAY. Sand is fine. Gravel is subangular fine sandstone and coal. RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
							0.65			Soft to firm laminated light brown mottled light grey silty CLAY. RESIDUAL PENNINE MIDDLE COAL MEASURES FORMATION
							1.00			Weathered dark grey and brown MUDSTONE. PENNINE MIDDLE COAL MEASURES FORMATION End of Borehole at 1.00m

1 2 3 4 5

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 1m.

AGS

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **BH07**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30					0.25			TOPSOIL (Black slightly sandy slightly gravelly SILT. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.30				HVP=84	0.35			Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular fine sandstone and coal.
		0.50		67	100	HVP=84				RESIDUAL ACKWORTH ROCK
		0.60				HVP=107				Firm laminated light brown mottled light grey silty CLAY.
		0.70				HVP=87				RESIDUAL ACKWORTH ROCK
		0.80					0.90			Stiff laminated dark grey mottled brown silty CLAY.
		0.80				HVP=84				RESIDUAL ACKWORTH ROCK
		1.10		57	100		1.40			Weathered dark grey and brown MUDSTONE.
							1.60			ACKWORTH ROCK
										End of Borehole at 1.60m

1 2 3 4 5

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 1.6m.

AGS

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **BH08**

Sheet 1 of 1

Project Name:	Goldthorpe Housing Project	Project No. C4260/24/E/6523	Co-ords:
Location:	Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN		Level:
Client:	Barnsley Metropolitan Borough Council		Dates: 19/04/2024

Hole Type: WLS

Scale: 1:25

Logged By: JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.20 - 0.55					0.10			TOPSOIL (Black slightly sandy slightly gravelly SILT. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.20				HVP=70	0.15			
		0.30				HVP=76				MADE GROUND (Grey slightly sandy slightly gravelly silty CLAY. Sand is fine. Gravel is subangular fine to medium brick, sandstone and coal).
		0.50		57	100	HVP=84	0.45			
		0.60								Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular fine sandstone and coal.
		0.60				HVP=82				
G		0.70				HVP=87	0.75			RESIDUAL ACKWORTH ROCK
							1.00			Firm laminated light brown mottled light grey silty CLAY.
										RESIDUAL ACKWORTH ROCK
										Weathered dark grey and brown MUDSTONE.
										ACKWORTH ROCK
										End of Borehole at 1.00m

1 2 3 4 5

Remarks

Cleared with CAT scanner. Borehole driven using handheld sampler. No groundwater encountered. Refusal at 1m.

AGS

Appendix 3

Laboratory Testing

Environmental
Geotechnical
Specialists

LABORATORY REPORT

job number	C/4260/24/E/6523
date	03/05/2024
site address	Goldthorpe Housing Project Victoria Street, Goldthorpe, Rotherham, S63 9HN
date scheduled	25/04/2024
date issued	03/05/2024
issued by	H J Letch

Please consider the environment before printing this report.

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8948

Schedule of UKAS Accredited Laboratory Tests

RGS

1. CLASSIFICATION OF SOIL	BS 1377-2:1990	BS EN ISO 17892	Accredited (A)	Unaccredited (U)
1.1 Moisture / Water content determination				
i. Oven drying	Pt 2 : 3.2	Pt 1 : 2014 Pt 12 : 2018 : 5.3 / 5.5	A	
ii. Saturation m/c of chalk	Pt 2 : 3.3			U
1.2 Index Properties				
i. Liquid limit – cone penetrometer	Pt 2 : 4.3		A	
ii. Plastic limit	Pt 2 : 5.3		A	
iii. Shrinkage limit	Pt 2 : 6.3			U
iv. Linear shrinkage	Pt 2 : 6.5		A	
1.3 Particle Density				
i. Gas jar	Pt 2 : 8.2		A	
ii. Large pyknometer	Pt 2 : 8.3			U
iii. Small pyknometer	Pt 2 : 8.4	Pt 3 : 2015 : 5.1		U
1.4 Density Tests				
i. Linear measurement	Pt 2 : 7.2	Pt 2 : 2014 : 5.1	A	
ii. Immersion in water	Pt 2 : 7.3	Pt 2 : 2014 : 5.2		U
iii. Fluid / Water displacement	Pt 2 : 7.4	Pt 2 : 2014 : 5.3		U
iv. Sand replacement	Pt 9 : 2.1, 2.2			U
v. Core cutter	Pt 9 : 2.4			U
1.5 Particle Size Distribution				
i. Dry Sieve	Pt 2 : 9.2	Pt 4 : 2016 : 5.2	A	
ii. Wet Sieve	Pt 2 : 9.3	Pt 4 : 2016 : 5.2	A	
iii. Sedimentation by pipette	Pt 2 : 9.4	Pt 4 : 2016 : 5.3 / 5.4	A	
iv. Sedimentation by hydrometer	Pt 2 : 9.5			U
2. CHEMICAL TESTS	**BS 1377-3:2018**			
ii. Mass loss on ignition	Pt 3 : 4			U
3. COMPACTION RELATED TESTS	**BS 1377-4:1990**			
3.1 Dry density/moisture relationship				
i. 2.5kg rammer – 1 litre mould	Pt 4 : 3		A	
- CBR mould	Pt 4 : 3		A	
ii. 4.5kg rammer – 1 litre mould	Pt 4 : 3		A	
- CBR mould	Pt 4 : 3		A	
3.2 Moisture Condition Value				
i. Single point test	Pt 4 : 5.4			U
ii. MCV/moisture content relationship	Pt 4 : 5.5			U
3.3 California Bearing Ratio				
i. Undisturbed sample	Pt 5 : 7		A	
ii. Recompacted sample	Pt 5 : 7		A	
iii. Soaked, inc measurement of swell	Pt 5 : 7		A	
4. COMPRESSIBILITY OF SOIL	**BS 1377-5:1990**			
i. One dimensional consolidation	Pt 5 : 3		A	
ii. Swelling pressure test	Pt 5 : 3			U
5. SHEAR STRENGTH OF SOIL	**BS 1377-7:1990**			
i. Hand shear vane	Makers instructions			U
ii. Shear box (100mm square sample)	BS 1377 : Pt 7 : 4			U
iii. Triaxial – quick undrained	BS 1377 : Pt 7 : 8, 9		A	
6. PERMEABILITY				
i. Falling head	K. H. Head Vol 2			U
ii. Constant head	BS 1377 : Pt 6 : 6			U
iii Triaxial cell	BS 1377 : Pt 6 : 6			U
7. ROCK TESTS				
7.1 Classification Tests				
i. Natural moisture content	-			U
ii. Saturated moisture content	-			U
iii. Natural density	-			U
iv. Porosity	-			U
7.2 Strength Tests				
i. Point load index	ISRM '85			U
ii. Uniaxial compression test	ISRM '81			U

Disclaimer

The results reported herein relate only to the material supplied to the laboratory.

GEOTECHNICAL TESTING RESULTS

Please consider the environment before printing this report.

RGS Environmental Geotechnical Specialists

Rogers Geotechnical Services Ltd
Offices 1 & 2 Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU
01484 604354 Company No. 5130864

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Summary of Classification Test Results

Project No.
C4260/24/E/6523

Project Name
Goldthorpe Housing Project

Hole No.	Sample				Soil Description	Density bulk Mg/m^3	Density dry Mg/m^3	*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m^3	1pt/4pt	Date	Increase/Decrease
	Ref	Top	Base	Type												
BH01	2	0.50			Firm greyish brown slightly sandy slightly gravelly CLAY.			29							25-Apr	
BH01	3	1.20			Firm laminated light brown mottled light grey silty CLAY.			27	99	43	21	22		4pt	25-Apr	Increase
BH02	6	1.30			Stiff laminated light grey becoming dark grey mottled brown silty CLAY.			20	100	53	22	31		4pt	25-Apr	Increase
BH03	8	0.40			Firm laminated light brown mottled light grey silty CLAY.			30	98	62	28	34		4pt	25-Apr	Increase
BH04	10	0.55			Firm to stiff laminated dark grey and brown silty CLAY.			28	98	46	22	24		4pt	25-Apr	Increase
BH05	13	1.10			Stiff laminated light brown mottled light grey silty CLAY.			21	95	46	22	24		4pt	25-Apr	Increase
BH06	15	0.55			Soft to firm laminated light brown mottled light grey silty CLAY.			28							25-Apr	
BH07	17	0.80			Firm laminated light brown mottled light grey silty CLAY.			27	96	56	30	26		4pt	25-Apr	Increase
BH08	20	0.60			Firm laminated light brown mottled light grey silty CLAY.			30	99	58	28	30		4pt	25-Apr	Increase

All tests performed in accordance with BS1377-2:2022 and BS EN ISO 17892 Part 1 A1 2022 unless specified otherwise
All Liquid Limit Tests performed on a 80g/30 Degree Cone unless specified otherwise

Key

Density test
Linear measurement unless :
wd - water displacement
wi - immersion in water

Liquid Limit
4pt cone unless :
cas - Casagrande method
1pt - single point test

Particle density
sp - small pyknometer
gj - gas jar

Date Printed
01/05/2024

Approved By
Harry

Table
1

sheet
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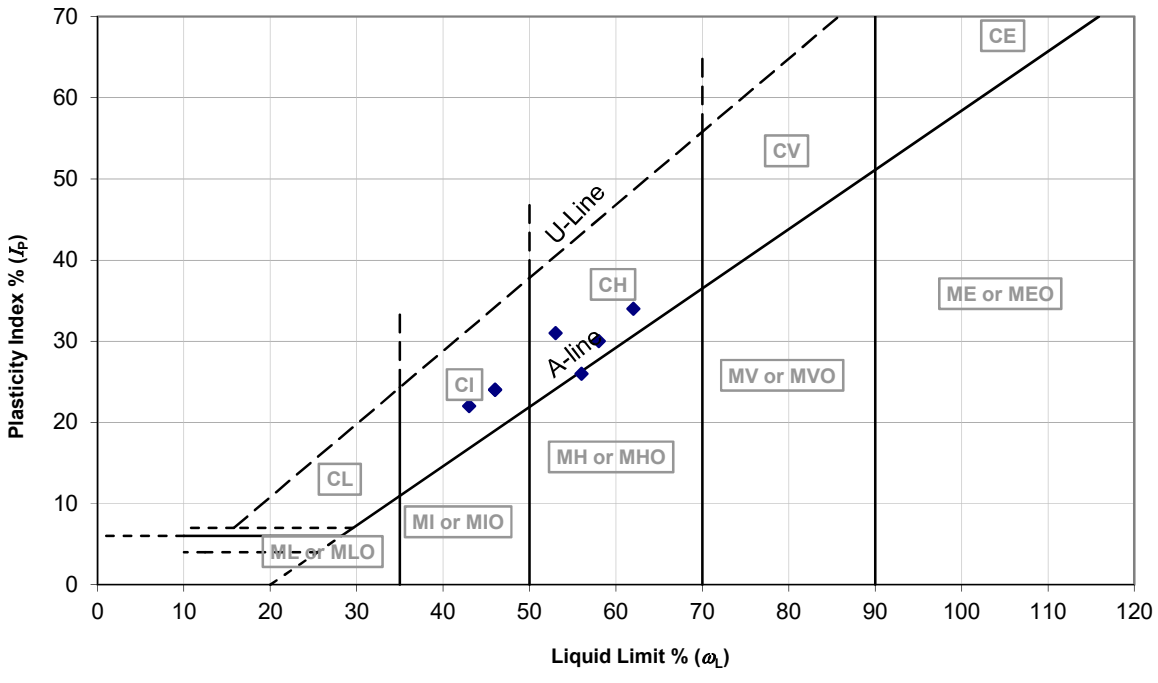
Rogers Geotechnical Services Ltd. Offices 1&2, Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU	**Classification of Index Properties**	**C4260/24/E/6523**
Project Name: Goldthorpe Housing Project	**BS 1377-2:2022 Clause 1,5,6**	Fig. 2 / Sheet. 1
Location:		Input By: Harry
Client: Barnsley Metropolitan Borough Council		Check By: Harry

Location	Depth (m)	Water Content (ω) (%)	Liquid Limit (ω_L) (%)	Plastic Limit (ω_P) (%)	Plasticity Index (I_P) (%)	Retained by 0.425mm (%)	Modified (ω) (ω') (%)	Modified (I_P) (I_P') (%)	Liquidity/ Consistency (I_L) (%)	Liquidity/ Consistency (I_C) (%)	Casagrande Class	N.H.B.C Class (%)
BH01	1.20	27	43	21	22	1	27	22	0.3	0.7	C I	MEDIUM
BH02	1.30	20	53	22	31	0	20	31	-0.1	1.1	C H	MEDIUM
BH03	0.40	30	62	28	34	2	31	33	0.1	0.9	C H	MEDIUM
BH04	0.55	28	46	22	24	2	29	24	0.3	0.8	C I	MEDIUM
BH05	1.10	21	46	22	24	5	22	23	0.0	1.0	C I	MEDIUM
BH07	0.80	27	56	30	26	4	28	25	-0.1	1.1	M H	MEDIUM
BH08	0.60	30	58	28	30	1	30	30	0.1	0.9	C H	MEDIUM



Summary of Geotechnical Chemical Test Results

Project No.: C4260/24/E/6523

Project Name: Goldthorpe Housing Project

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Org %	LOI %	pH	Sulphate as SO_4 Total acid sol. %	Sulphate as SO_4 2:1 water:soil g/l	Sulphate as SO_4 ground water g/l	Chloride, Cl water sol. %	Chloride, Cl acid sol. %	CO_2 %	TDS mg/l	<2mm %	Remarks
BH02	5	0.70			Firm laminated light brown mottled light grey silty CLAY.			7.4		0.13							
BH05	12	0.35			Firm to stiff greyish brown slightly sandy slightly gravelly CLAY.			7.57		0.09							
BH07	18	1.10			Stiff laminated dark grey mottled brown silty CLAY.			7.19		0.09							

Key

Tests performed in accordance with BS 1377 unless annotated otherwise

Org Organic matter content

LOI Mass loss on ignition at 440°C

Cl Chloride content

CO_2 Carbonate content (rapid titration)

TDS Total Dissolved Solids

Date Printed: 01/05/2024

Approved By: HJL

Table: 3

sheet: 1

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ENVIRONMENTAL TESTING RESULTS

<ENVIRONMENTAL><GEOTECHNICAL>

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UKAS United Kingdom Accreditation Service

RGS Environmental Geotechnical Specialists

Rogers Geotechnical Services Ltd
Offices 1 & 2 Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU
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t: 01923 225404
f: 01923 237404
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Analytical Report Number : 24-016665

Project / Site name:	Goldthorpe Housing Estate	**Samples received on:**	26/04/2024
Your job number:	C4260-24-E-6523	**Samples instructed on/ Analysis started on:**	26/04/2024
Your order number:		**Analysis completed by:**	02/05/2024
Report Issue Number:	1	**Report issued on:**	02/05/2024
Samples Analysed:	8 soil samples		

Signed: JSzwagrak

Joanna Szwagrzak
Reporting Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41-711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 24-016665
Project / Site name: Goldthorpe Housing Estate

Lab Sample Number				183172	183173	183174	183175	183176
Sample Reference				BH01	BH02	BH03	BH04	BH05
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.30	0.00-0.45	0.00-0.20	0.00-0.30	0.00-0.25
Date Sampled				24/04/2024	24/04/2024	24/04/2024	24/04/2024	24/04/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	37.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	16	16	19	20	21
Total mass of sample received	kg	0.1	NONE	1.3	1.3	1.3	1.3	1.4
Asbestos								
Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	MLO	MLO	MLO	MLO	MLO
General Inorganics								
pH (L099)	pH Units	N/A	MCERTS	8.4	9.1	7.7	7.9	7.9
Free Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Sulphate as SO_4	%	0.005	MCERTS	0.081	0.113	0.157	0.044	0.107
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	86	390	840	24	87
Water Soluble SO_4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	42.8	196	421	12.2	43.5
Organic Matter (automated)	%	0.1	MCERTS	5.2	2.2	3.5	2.6	8.9
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.67	0.38	0.33	< 0.05	0.59
Acenaphthylene	mg/kg	0.05	MCERTS	2.2	1.6	1.3	< 0.05	0.07
Acenaphthene	mg/kg	0.05	MCERTS	0.26	0.15	0.15	< 0.05	0.08
Fluorene	mg/kg	0.05	MCERTS	1.2	0.69	0.72	< 0.05	0.07
Phenanthrene	mg/kg	0.05	MCERTS	17	7.4	10	0.11	1.1
Anthracene	mg/kg	0.05	MCERTS	5.7	4	4.4	< 0.05	0.21
Fluoranthene	mg/kg	0.05	MCERTS	39	28	27	0.14	3
Pyrene	mg/kg	0.05	MCERTS	35	27	25	0.14	2.7
Benzo(a)anthracene	mg/kg	0.05	MCERTS	19	15	12	< 0.05	1.7
Chrysene	mg/kg	0.05	MCERTS	17	15	12	0.09	2
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	18	16	13	< 0.05	2.2
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	9	8	5.8	< 0.05	1
Benzo(a)pyrene	mg/kg	0.05	MCERTS	19	17	13	< 0.05	1.8
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	7.2	6.5	5.3	< 0.05	1.2
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	1.2	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	7.6	7.1	5.8	0.06	1.2
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	198	155	135	< 0.80	18.7

Analytical Report Number: 24-016665
Project / Site name: Goldthorpe Housing Estate

Lab Sample Number				183172	183173	183174	183175	183176
Sample Reference				BH01	BH02	BH03	BH04	BH05
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.30	0.00-0.45	0.00-0.20	0.00-0.30	0.00-0.25
Date Sampled				24/04/2024	24/04/2024	24/04/2024	24/04/2024	24/04/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	25	17	20	22	42
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	22	21	22	29
Copper (aqua regia extractable)	mg/kg	1	MCERTS	51	31	30	25	250
Lead (aqua regia extractable)	mg/kg	1	MCERTS	120	95	63	46	120
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	22	16	18	18	22
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	1.3	< 1.0	< 1.0	< 1.0	1.4
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	36	27	33	31	34
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	240	110	110	110	2500
Petroleum Hydrocarbons								
TPHCWG - Aliphatic >C5 - C6 HS_1D_AL	mg/kg	0.02	NONE	< 0.020 ###	< 0.020 ###	< 0.020 ###	< 0.020 ###	< 0.020 ###
TPHCWG - Aliphatic >C6 - C8 HS_1D_AL	mg/kg	0.02	NONE	< 0.020 ###	< 0.020 ###	< 0.020 ###	< 0.020 ###	< 0.020 ###
TPHCWG - Aliphatic >C8 - C10 HS_1D_AL	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
TPHCWG - Aliphatic >C10 - C12 EH_CU_1D_AL	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPHCWG - Aliphatic >C12 - C16 EH_CU_1D_AL	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPHCWG - Aliphatic >C16 - C21 EH_CU_1D_AL	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPHCWG - Aliphatic >C21 - C35 EH_CU_1D_AL	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	8.5
TPHCWG - Aliphatic >C5 - C35 EH_CU+HS_1D_AL	mg/kg	10	NONE	< 10 ###	< 10 ###	< 10 ###	< 10 ###	< 10 ###
TPHCWG - Aromatic >EC5 - EC7 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC7 - EC8 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC8 - EC10 HS_1D_AR	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
TPHCWG - Aromatic >EC10 - EC12 EH_CU_1D_AR	mg/kg	1	MCERTS	4.2	< 1.0	1.3	< 1.0	< 1.0
TPHCWG - Aromatic >EC12 - EC16 EH_CU_1D_AR	mg/kg	2	MCERTS	18	7.9	3.9	< 2.0	< 2.0
TPHCWG - Aromatic >EC16 - EC21 EH_CU_1D_AR	mg/kg	10	MCERTS	120	77	70	< 10	< 10
TPHCWG - Aromatic >EC21 - EC35 EH_CU_1D_AR	mg/kg	10	MCERTS	240	170	110	< 10	19
TPHCWG - Aromatic >EC5 - EC35 EH_CU+HS_1D_AR	mg/kg	10	NONE	390	260	190	< 10	19
VOCs								
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
p & m-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
o-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number: 24-016665
Project / Site name: Goldthorpe Housing Estate

Lab Sample Number				183177	183178	183179
Sample Reference				BH06	BH07	BH08
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.35	0.00-0.30	0.20-0.55
Date Sampled				24/04/2024	24/04/2024	24/04/2024
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	18	22	17
Total mass of sample received	kg	0.1	NONE	1.1	1.4	1.1
Asbestos						
Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	MLO	MLO	MLO
General Inorganics						
pH (L099)	pH Units	N/A	MCERTS	8.2	7.8	7.9
Free Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Total Sulphate as SO_4	%	0.005	MCERTS	0.037	0.109	0.04
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	21	61	35
Water Soluble SO_4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	10.4	30.4	17.4
Organic Matter (automated)	%	0.1	MCERTS	2.3	8.1	1.8
Total Phenols						
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Speciated PAHs						
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	0.62	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	0.16	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	0.06	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	0.07	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.1	1.1	0.07
Anthracene	mg/kg	0.05	MCERTS	< 0.05	0.28	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.17	4.2	< 0.05
Pyrene	mg/kg	0.05	MCERTS	0.19	3.9	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.1	2.7	< 0.05
Chrysene	mg/kg	0.05	MCERTS	0.13	3	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	3.9	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	1.5	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.09	3.1	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.08	1.7	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	1.9	< 0.05
Total PAH						
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	0.86	28	< 0.80

Analytical Report Number: 24-016665
Project / Site name: Goldthorpe Housing Estate

Lab Sample Number				183177	183178	183179
Sample Reference				BH06	BH07	BH08
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.35	0.00-0.30	0.20-0.55
Date Sampled				24/04/2024	24/04/2024	24/04/2024
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Heavy Metals / Metalloids						
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	14	43	15
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	30	23
Copper (aqua regia extractable)	mg/kg	1	MCERTS	21	80	23
Lead (aqua regia extractable)	mg/kg	1	MCERTS	50	170	33
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	16	29	18
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	28	44	30
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	84	340	78
Petroleum Hydrocarbons						
TPHCWG - Aliphatic >C5 - C6 HS_1D_AL	mg/kg	0.02	NONE	< 0.020 ###	< 0.020 ###	< 0.020 ###
TPHCWG - Aliphatic >C6 - C8 HS_1D_AL	mg/kg	0.02	NONE	< 0.020 ###	< 0.020 ###	< 0.020 ###
TPHCWG - Aliphatic >C8 - C10 HS_1D_AL	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050
TPHCWG - Aliphatic >C10 - C12 EH_CU_1D_AL	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
TPHCWG - Aliphatic >C12 - C16 EH_CU_1D_AL	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0
TPHCWG - Aliphatic >C16 - C21 EH_CU_1D_AL	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0
TPHCWG - Aliphatic >C21 - C35 EH_CU_1D_AL	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0
TPHCWG - Aliphatic >C5 - C35 EH_CU+HS_1D_AL	mg/kg	10	NONE	< 10 ###	< 10 ###	< 10 ###
TPHCWG - Aromatic >EC5 - EC7 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC7 - EC8 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC8 - EC10 HS_1D_AR	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050
TPHCWG - Aromatic >EC10 - EC12 EH_CU_1D_AR	mg/kg	1	MCERTS	< 1.0	1.2	< 1.0
TPHCWG - Aromatic >EC12 - EC16 EH_CU_1D_AR	mg/kg	2	MCERTS	< 2.0	3.1	< 2.0
TPHCWG - Aromatic >EC16 - EC21 EH_CU_1D_AR	mg/kg	10	MCERTS	< 10	15	< 10
TPHCWG - Aromatic >EC21 - EC35 EH_CU_1D_AR	mg/kg	10	MCERTS	< 10	32	< 10
TPHCWG - Aromatic >EC5 - EC35 EH_CU+HS_1D_AR	mg/kg	10	NONE	< 10	51	< 10
VOCs						
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
p & m-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
o-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

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* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
183172	BH01	None Supplied	0.00-0.30	Brown loam and clay with gravel and brick
183173	BH02	None Supplied	0.00-0.45	Brown loam and clay with gravel and brick
183174	BH03	None Supplied	0.00-0.20	Brown loam and clay with gravel and brick
183175	BH04	None Supplied	0.00-0.30	Brown clay and sand
183176	BH05	None Supplied	0.00-0.25	Brown loam with paper and vegetation
183177	BH06	None Supplied	0.00-0.35	Brown clay and sand
183178	BH07	None Supplied	0.00-0.30	Brown loam with gravel and vegetation
183179	BH08	None Supplied	0.20-0.55	Brown clay and sand

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Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in Soil	Asbestos Identification with the use of polarised light microscopy in conjunction with dispersion staining techniques	In-house method based on HSG 248, 2021	A001B	D	ISO 17025
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate (Walkley Black Method)	In-house method	L009B	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically (up to 30°C)	In-house method	L019B	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight	In-house method based on British Standard Methods and MCERTS requirements.	L019B	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L038B	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES	In-house method	L038B	D	MCERTS
Sulphate, water soluble, in soil (16hr extraction)	Sulphate, water soluble, in soil (16hr extraction)	In-house method	L038B	D	MCERTS
Speciated EPA-16 PAHs and/or Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds (including PAH) in soil by extraction in dichloromethane and hexane followed by GC-MS	In-house method based on USEPA 8270	L064B	D	MCERTS
BTEX and/or Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS	In-house method based on USEPA 8260	L073B	W	MCERTS
Total petroleum hydrocarbons with carbon banding by GC-FID/GC-MS HS in soil	Determination of total petroleum hydrocarbons in soil by GC-FID/GC-MS HS with carbon banding aliphatic and aromatic	In-house method	L076B/L088	D/W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in NaOH and addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method	L080	W	MCERTS
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	MCERTS
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	MCERTS

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Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement	In-house method	L099	D	MCERTS

For method numbers ending in 'UK' or 'A' analysis have been carried out in our laboratory in the United Kingdom (Watford).
For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).
For method numbers ending in 'PL' or 'B' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.
Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total

- Quality control parameter failure associated with this result; other checks applied prior to reporting the data have been accepted. The result should be considered as being deviating and may be compromised.

End of Report

RGS Environmental Geotechnical Specialists
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Appendix 4

Fill Screening Values

Rogers Geotechnical Services Ltd.

Atkins ATRISK Soil Screening Values (SSVs) - Residential With Plant Uptake Landuse

Tox Data Report No.	Compound	Residential with Homegrown Produce Landuse (mg/kg)				Reference
	Metals	**SOM: 1%**		**SOM: 6%**		
3	Cadmium	22.1		22.1		C
4	Chromium VI	3.62	20.5	3.63	20.5	B/C
	Copper	4730		4790		A+
7	Mercury	8.81		15.80		A/D
8	Nickel	136		136		A+
	Lead	200		200		C
	Zinc	20000		20300		A+
	Vanadium	136		138		A+
	Semi and Non Metals					
1	Arsenic	37		37		C
10	Selenium	375		375		A
	Free Cyanide	34		34		A
9	Phenols (total)	267		1200		A
	Poly Aromatic Hydrocarbons	Free product	No free product	Free product	No free product	
20	Napthalene	0.829		12.2		A+
	Acenaphthene	157	608	2760		A+
	Fluorene	735		2610		A+
	Anthracene	10200		26200		A+
	Fluoranthene	983		2980		A+
	Pyrene	668		2120		A+
	Benzo(a)anthracene	1.71	4.52			A
2	Chrysene	0.44	585			A
2	Benzo(b)fluoranthene	1.22	7.72			A
2	Benzo(k)fluoranthene	0.686	84.4			A
2	Benzo(a)pyrene	1.51	4.95	2.05	4.95	B/C
2	Dibenzo(a,h)anthracene	0.00393	0.838			A*
2	Indeno(1,2,3-cd)pyrene	0.0614	7.31			A
2	Benzo(g,h,i)perylene	0.0187	96.2			A
	Petroleum Hydrocarbons					
	Aliphatic C5-C6	42.7		369		A+
	Aliphatic C6-C8	99.3		768	1240	A+
	Aliphatic C8-C10	13.9		204		A+
	Aliphatic C10-C12	49.9	81.7	297	1180	A+
	Aliphatic C12-C16	20.9	385	125	4130	A+
	Aliphatic C16-C21	210000		210100		A+
	Aliphatic C21-C35	210000		210100		A+
	Aromatic C5-C7 (Benzene)	0.137		0.871		A+
	Aromatic C7-C8 (Toluene)	113		780		A+
	Aromatic C8-C10	20.5		232		A+
	Aromatic C10-C12	70		468		A+
	Aromatic C12-C16	155	165	830		A+
	Aromatic C16-C21	319		1040		A+
	Aromatic C21-C35	1120		1710		A+
Others						
Asbestos Not Detected						
A+ = Values update June 2017.						
A* Atrisk's SSV is lower than Chemtest's detectable limit for this compound.						
B = Health Criterion Values (available from toxicological reviews published in the C4SL project methodology report).						
C = Catergory 4 Screening Levels (C4SLs).						
D = SSV provided is for Methyl Mercury.						