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GEOTECHNICAL ENVIRONMENTAL

PHASE 2 GEO-ENVIRONMENTAL REPORT

job number C1675/21/E/2596	date 26/07/21

site address
To Your Home Ltd, Century Works
Manchester Road,
Millhouse Green,
Barnsley S36 9LQ

written by C. Campion	checked by R.A. Palmer
issued by R.A. Palmer	

Rogers Geotechnical Services Ltd
Telephone 0843 50 666 87 Fax 0843 51 599 30
Email enquiries@rogersgeotech.co.uk
www.rogersgeotech.co.uk
Offices 1 & 2, Barncliffe Business Park, Near Bank, Shelley, Huddersfield, West Yorkshire HD8 8LU.

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Report on a Phase 2 Geo-environmental Investigation

Location:	To Your Home Ltd, Century Works, Manchester Road, Millhouse Green, Barnsley, S36 9LQ
For:	To Your Home Ltd
Consultants:	Matrix Consulting Engineers
Report No.	C1675/21/E/2596 Report date: July 2021

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

Charlotte Campion MGeoSci FGS
Geo-environmental Engineer

Rob Palmer MSc FGS ACIEH
Senior Geo-environmental Engineer

Report Summary[1]

Item	Comments	Section
Development	Construction of a new industrial unit and associated service yard.	1.
Geology	Superficial geology – None recorded. Solid geology – Stanningley Rock and Pennine Lower Coal Measures Formation.	5.
Strata Conditions	Up to 3m of made ground. Cohesive weathered Pennine Lower Coal Measures Formation overlying mudstone, sandstone and siltstone.	6.
Groundwater	Groundwater was encountered locally within the made ground and at 4.5m depth within the cohesive weathered Pennine Lower Coal Measures Formation strata.	6.2
Mining Legacy	Grouted mine workings appear to be present between depths of 5m and 7m.	10.
Foundation Design	Piled foundation solution.	11.1
Effect of Sulphates	DC-3 concrete.	11.5
Contamination	Contamination levels did not exceed the appropriate screening values.	12.

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

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1. Introduction

It is understood that the land at Century Works, Manchester Road, Millhouse Green, Barnsley S36 9LQ is to be developed by the construction of a new industrial unit and associated service yard. Consequently, a site investigation has been undertaken in accordance with the instruction from the client. 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

Rogers Geotechnical Services (RGS) have not produced and have not been provided with a Phase 1 Desk Study report for the site, the following report has been produced without a prior conceptual site model and risk assessment.

4. Fieldworks

The fieldworks were undertaken between the 7th and 9th of June 2021 and included the following:

- Three windowless sample boreholes.
- Standard penetration tests within one borehole.
- Three dynamic probes.
- Three rotary open boreholes.
- Three gas monitoring standpipes.

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

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4.1 Acquisition of Coal Authority Permit

In order to undertake this investigation, it was necessary to obtain permission to enter or disturb Coal Authority interests. This permission was granted as permit reference number 22114, which is presented in Appendix 2 to this report. In accordance with the joint Coal Authority and Health and Safety Executive positioning statement, and under the requirements of the permit, the works were undertaken employing water flush drilling techniques with gas monitoring of the boreholes during the fieldworks.

4.2 Rotary Open-hole Boreholes

The boreholes were sunk using a Comacchio 205 rotary drilling rig using rotary open-hole drilling techniques and employing 130mm diameter drag and tricone roller bits. Where necessary, 140mm diameter casing was temporarily installed through the overburden to support the bore. The investigation was undertaken using water flush drilling techniques in accordance with the Coal Authority and Health and Safety Executive positioning statement. Drill chippings brought to surface in the flush returns were inspected by the driller on a screen, which forms part of the re-circulation tanks. The borehole positions are shown on the site plan, which is presented in Appendix 1 and the strata conditions are presented on the borehole records in Appendix 3.

The required termination depth of the boreholes was reviewed during the course of the fieldworks. In this case, borehole BH01 was terminated at 15m depth, BH02 at 16.5m depth and BH03 at 16.0m depth. This was on the basis that sufficient data had been obtained, proving workings were not present within influencing distance of the surface and 10m of rock was encountered below the base of the made ground and superficial deposits. It should be noted that suspected concrete was encountered at depths of between 5.0.m to 7.0m in all boreholes, with natural strata encountered above and below, this may represent treated, previously grouted workings.

4.3 Windowless Sample Boreholes

These boreholes were sunk using a drive-in windowless sampler. The cores were undertaken in 1m 90mm diameter lengths. 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 3.

4.4 Standard Penetration Tests

A Standard penetration test (SPT) was undertaken at 2.0m depth within windowless sample borehole WS01. The SPT was conducted in accordance with the procedures given in BS EN ISO 22476: Part 3: 2005 +A1: 2011, and the results are summarised on the borehole record. During this work an automatic trip hammer of 63.5kg falling through 750mm was employed to drive either a split barrel sampler assembly into the ground and the recovered barrel samples were retained in air tight plastic containers.

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4.5 Dynamic Probes

Dynamic penetration tests were undertaken adjacent to the windowless sample boreholes in accordance with the procedure given in BS EN ISO 22476: Part 2: 2005 +A1: 2011, using the super heavy penetrometer (DPSH). This probe consists of a 63.5kg mass falling through 750mm onto an anvil, which drives a 50mm diameter cone into the ground. The number of blows required to drive the cone through successive 100mm increments are recorded as the N_{100} values. The results of the dynamic penetration tests are tabulated and presented as bar charts of N_{100} values versus depth in Appendix 4.

4.6 Gas Monitoring Standpipes

Gas monitoring standpipes were installed between 3.0m and 4.0m depth, one each in WS02, BH02 and BH03, and the installation details are shown on the appropriate borehole records. In all cases, the monitoring standpipe consisted of a perforated pipe from the base of the borehole to 1.0m below surface, 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	-	-	None recorded.
Solid Geology	Stanningley Rock	-	Sandstone member within the Pennine Lower Coal Measures Formation.
	Pennine Lower Coal Measures Formation	Grey Measures of Yorkshire And Nottingham Lower Coal Measure	Interbedded grey mudstone, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower part, and more numerous and thicker coal seams in the upper part.

It should be appreciated that the Stanningley Rock, a named sandstone member, is recorded to underlie the western half of the site. Whereas undifferentiated strata of the Pennine Lower Coal Measures Formation, more likely to comprise sandstone interbedded with mudstone and siltstone, is indicated to be present beneath the eastern half.

[2] Sources: British Geological Survey (NERC) Map Sheet 86; Glossop; 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*]

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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
0.6 – +2.9	MADE GROUND (Cohesive)	WS01, WS02 & WS03	None
+1.2 – 1.8	MADE GROUND (Granular)	WS01, WS02 & WS03	1.3m (WS01)
3.0	MADE GROUND (Colliery fill)	BH01, BH02 & BH03	None
2.9	Slightly gravelly sandy CLAY	WS02	None
+3.0	Clayey sandy GRAVEL	WS02	None
4.5 – 6.0	Grey CLAY	BH01, BH02 & BH03	4.50m (BH02 & BH03)
5.0	Yellow CLAY.	BH03	None
7.0	MADE GROUND (Very hard white possible concrete)	BH01, BH02 & BH03	None
+15 – +16.5	Interbedded yellow and grey SANDSTONE / MUDSTONE / SILTSTONE.	BH01, BH02 & BH03	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

Made ground was encountered across the site and was fully penetrated in WS02 and in the three deeper rotary open boreholes at depths of between 1.8m and 3.0m. The made ground, considered to represent colliery fill, variably comprised:

- Clayey sandy brick concrete, glass, brick, coal, ironstone, slag, mudstone, wood, quartzite, sandstone and limestone gravel.
- Silt with gravel and cobbles of sandstone, coal and rare ironstone.
- Clayey silty sand with gravel of sandstone, slag, glass, coal and mudstone.
- Silty sandy clay with gravel of sandstone, brick and coal and, locally, cobbles of sandstone.

In boreholes WS02, BH02 and BH03, the made ground was underlain by yellowish brown mottled light grey clay with gravel of sandstone, grey clay and yellow clay to depths of between 2.9m and 6.0m. These clays are considered representative of weathered Pennine Lower Coal Measures Formation strata. In WS02, below the clay, yellowish brown mottled light grey clayey sandy sandstone gravel was encountered to the termination depth of the borehole at 3.0m. This is also considered representative of weathered Pennine Lower Coal Measures Formation strata.

Below the made ground and below the weathered fraction of the Pennine Lower Coal Measures Formation strata, rock comprising interbedded sandstone, mudstone and siltstone was encountered to the base of the rotary open boreholes at depth of between 15.0m and 16.5m.

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It should be noted, however, that suspected concrete, considered likely to represent grouted treated former coal workings was encountered at depths of between 5.0m and 7.0m depth, as a band within the natural strata.

6.2 Groundwater

Groundwater was encountered in WS01 at 1.3m within the made ground and within rotary boreholes BH02 and BH03 at 4.5m depth within the cohesive weathered Pennine Lower Coal Measures Formation strata. 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 and use of water flush during rotary boring may mask other water strikes. Moreover, groundwater levels are subject to seasonal variation or changes on local drainage conditions.

7. Insitu Testing

7.1 Standard Penetration Tests

The standard penetration tests carried out in BH2 are summarised in the following table:

Table 3: Summary of Standard Penetration Tests

Strata	Depth Range (m)	SPT 'N' (Blows/300mm)		Comments
		Granular soils	Cohesive soils	
MADE GROUND (cohesive)	1.80 – 2.45	-	23	SPT's indicate a stiff in-situ condition

7.2 Dynamic Penetration Tests

Dynamic penetration tests were undertaken adjacent to the windowless sample borehole positions. A summary of the results is presented below:

Table 4: Summary of Dynamic Penetration Tests

Position	Blows/100mm			Refusal type (Effective/ Abrupt*)	Comments
	0 - 2	3 - 10	10+		
	Depth to which blow count range was observed (m)				
DP01	3.0	3.8	3.83	Abrupt	Low results recorded in the made ground to 3.0m depth. Followed by consistent moderate blow counts to 3.8m within the weathered Pennine Lower Coal Measures Formation. Abrupt refusal, presumably on rock of the Pennine Lower Coal Measures Formation, at 3.83m depth.

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DP02	2.5	3.1	3.135	Abrupt	Low results recorded in the made ground to 2.5m depth. Followed by consistent moderate blow counts to 3.1m within the weathered Pennine Lower Coal Measures Formation. Abrupt refusal, presumably on rock of the Pennine Lower Coal Measures Formation, at 3.135m depth.
DP03	2.0 3.4	3.0 4.4	4.505	Abrupt	Low results recorded in the made ground to 3.4m depth, with a moderate blow counts recorded at between 2.0m and 3.0m. Followed by consistent moderate blow counts to 4.4m within the weathered Pennine Lower Coal Measures Formation. Abrupt refusal, presumably on rock of the Pennine Lower Coal Measures Formation, at 4.505m depth.

*Abrupt refusal: obstruction or bedrock encountered. Effective refusal: +25 blows/100mm.

7.3 Gas and Water Level Monitoring

The standpipes were monitored between the 16th June and 7th July 2021. The results of the gas monitoring undertaken to date are tabulated below.

Table 5: Gas Monitoring

Location	Date	CH_4 (%)	CO_2 (%)	O_2 (%)	Flow (l/h)	Barometric Pressure (mb)	Water Level (m)	Standpipe Depth (m)
BH02	16.06.21	0.1	1.7	18.7	0.1	982↑	3.70	-
	23.06.21	0.1	4.6	16.4	0.1	994↑	3.70	
	30.06.21	0.0	5.4	14.9	0.1	989↑	4.05	
	07.07.21	0.0	3.5	11.8	0.1	979↑	3.33	
BH03	16.06.21	0.1	0.1	20.8	0.1	983↑	1.3	-
	23.06.21	0.1	0.1	16.0	0.1	995↑	2.1	
	30.06.21	0.3	0.4	10.0	0.1	990↑	2.15	
	07.07.21	0.4	0.8	6.3	0.1	980↑	2.00	
WS02	16.06.21	0.1	6.6	16.0	0.1	983↑	2.30	-
	23.06.21	0.0	2.7	17.8	0.1	995↑	2.80	
	30.06.21	0.0	1.8	19.0	0.1	990↑	-	
	07.07.21	0.0	6.9	12.7	0.1	980↑	2.90	

↑ - rising pressure ↓ - falling pressure ↔ -steady pressure

This work was undertaken using a Geotechnical Instruments (UK) Ltd. GA5000 (serial No G503524) which was last calibrated on the 5th May 2021.

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8. Laboratory Testing - Geotechnical

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

- Moisture content determinations — BS EN ISO 17892-1:2014
- Index properties (1 point) — BS EN ISO 17892-12:2018
- Linear shrinkage — BS 1377: 1990: Pt2: 6.3

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

Table 6: Summary of Geotechnical Test Results

Test type	Number of tests	Range of results		Comments
Moisture content determinations	2	14.1% to 26.4%		Slightly above plastic limit.
Index properties (1 Point)	2	LL PL PI LS	33 to 46% 13 to 23% 20 to 23% 08 to 11%	Clay of low to intermediate plasticity. Consistency index 0.9 (both) Liquidity index 0.1% (both) NHBC Class – Low to Medium

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 23% could be employed, which suggests an f_1 value of 5.1 and a f_2 value of 0.5.

8.1 Geotechnical Properties

The idealised geotechnical properties employed in design are summarised below.

Table 7: Summary of Geotechnical Properties

Property	Range of values		Comments
Volume change potential (NHBC)	Medium		Slightly gravelly sandy CLAY
Shear strength parameters (at 3.0m depth)	c_u	40.8kN/m^2	Stroud (1974) where $c_u = f_1 N$ and assuming an N value of 8.
Consolidation characteristics	m_v	0.25m^2/MN	Stroud (1974) where $m_v = 1/f_2 N$
Concrete classification	DS-2, AC-3		Brownfield ground locations (Mobile water)

[4] See paragraph 6.2 'Index Property Tests'

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9. 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 screen.

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

10. Coal Mining Legacy

On the basis of all of the information provided above it is apparent that there is one treated and grouted worked coal seam at a depth of between 5.0m and 7.0m. The Matrix Consulting Engineers Scope of Ground Investigation Work (Document reference: 21032-MCE-XX-ZZ-RP-S-101, dated: 10/03/2021) includes information on the coal outcrops and Coal Authority data. This document suggests that the 36 Yard Coal seam outcrops on site and may be present below the site within 10m of the site surface. As such, it is considered that this 1.0m to 2.0m thick band of potential grout encountered at depths of between 5.0m and 7.0m likely represents the worked 36 Yard coal that has been treated. No coal seams, voids or flush loss was encountered during the drilling works. In addition, no elevated levels of hazardous gases were recorded during drilling works.

In view of all the information obtained in this investigation, it is considered that there is a low risk of ground movement as a consequence of coal workings beneath the site and it is not considered that remediation is required. Nonetheless, discussions with the Coal Authority are recommended to confirm this.

11. Discussion of Ground Conditions - Geotechnical

It is understood that the site is to be developed by the construction of a new industrial unit and associated service yard. At the time of writing this report the precise layout and method of construction is not known, thus the discussion below is of a generalised nature.

It cannot be recommended that foundations be constructed directly within the made ground present to depths of up to 3.0m. It should be appreciated that foundations placed directly in the made ground would likely be subject to excessive total and or differential settlement under moderately light surface loading.

In light of the above, it cannot be recommended that shallow footings or a raft foundation be considered for the development and piles should be adopted in order to transfer foundation loads

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through the weak and variable made ground into the rock at depth. A piled foundation will have the advantage of limiting differential settlement of the new units across the site. It should be appreciated that the following foundation recommendation is based on the proviso that any ground stability issues associated with historic coal workings present beneath the site have been minimised through grouting.

11.1 Piled Foundations

There are a number of piling options that could be considered for use at this site, which include:

- Driven large-displacement piles.
- Continuous flight auger bored piles.
- Drilled piles.

In order to formulate a suitable design it is recommended that the advice of specialist piling contractors be sought. It should be noted that a piling contractor may determine that the piles may be required to fully penetrate the suspected treated, grouted, mine workings encountered at between 5.0m and 7.0m depth, in order to transfer loads to the rock below. Therefore, certain piles types may be deemed unsuitable. However, for preliminary design and estimating purposes the following discussion is presented.

It is considered that driven pre-cast concrete piles could be adopted at this site, although, it would be prudent to utilise a driving shoe or a lead steel section to minimise the risk of pile breakages, whilst penetrating the piles into the underlying rock. In order to reduce the risk of pile breakage, steel tubular driven piles may be employed, which could include thin walled bottom drive piles or thick walled top drive piles. It should be appreciated that thin walled piles will need to be concrete filled and possibly reinforced as the steel casing alone would not be sufficient to carry vertical or horizontal imposed loads. However, this is not necessarily the case with thick walled tubular piles.

For both pile types care is required to ensure that the connection between the pile and pile cap is adequate. In addition, it is recommended that any relict structures relating to the site's previous use (i.e. drainage and footings) are removed to ensure that there are no 'hard-spots' within the footprint of the proposed development.

Should the piles be required to resist a combination of axial compression or tension loading and a coexistent bending moment, a positive connection between segmental piles should be employed to transfer loads between the pile segments. Moreover, in view of the weak and variable nature of the soils encountered to depths of 3.4m, it will be necessary to check the buckling performance of the piles.

Consideration may also be given to the use of bored cast-in-place piles using continuous flight augers (CFA). In this type of piling an auger borehole is formed and concrete placed via the hollow stem of the auger as they are withdrawn. A reinforcement cage is then placed into the fluid concrete filled hole to complete the pile. Given the appropriate rock auger, CFA piles can achieve significant end-bearing capacity on rock. However, spoil will be produced at the surface which will need to be disposed of. Moreover, should such piles encounter an obstruction or the underlying bedrock, a condition known as 'flighting' may occur. Flighting is where loose soils immediately adjacent to the pile borehole are pulled laterally into the drill string when the augers rotate quickly with little downward penetration.

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It should be noted that the above mentioned piles types may not be able to penetrate the rock above the grouted workings. Should a piling contractor deem it necessary to extend piles beyond the apparent treated workings, then drill and cased piles (Odex, Symmetrix or similar) could be employed at this site. These methods employ down the hole hammers which have the capacity to bore through obstructions and into the underlying hard stratum to form a rock socket. Through the overburden, the drill bit is attached to casing which prevents the pile borehole collapsing. When rock is encountered the drilling can continue using open hole drilling techniques. On completion of the boring operations, concrete is then pumped into the hole and a steel reinforcing cage can be installed. The steel casing can be removed or left in place.

Irrespective of the method of pile installation a working platform must be provided, the thickness of which will be determined by the type of piling rig employed and the strength of the near surface soils. The design of the platform should be undertaken in accordance with the procedures and specification given in the BRE publication entitled *Working platforms for tracked plant*.

In addition, the cohesive fraction of the superficial geology has been found to possess medium volume change potential in most onerous case. Therefore, piles should be able to cater for shrinkage or swelling of the cohesive soils should they be installed within the zone of any existing trees or shrubs. For design purposes, in particular the derivation of heave forces on the piles, the zone of desiccation may be considered as equivalent to the minimum foundation depth recommended for a shallow footing in the NHBC Standards, Chapter 4.2 – *Building Near Trees.* The results of the moisture content testing undertaken in this investigation may also be taken into consideration in determining the zone of desiccation. However, it should be appreciated that soil moisture content is subject to seasonal variation and the most onerous conditions may not have been observed. With potential heave forces in mind, it must be noted that the piles may be required to resist significant vertical tension forces, thus it will be necessary to ensure that the sections of driven piles are suitably reinforced. Moreover, it is possible that sufficient resistance cannot be derived from the soils above the rock head; therefore, care must be taken to establish that driven piles will achieve sufficient embedment into the rock in order to resist any upward forces. Should it be determined that satisfactory embedment is unlikely, the use of bored or drilled piles will be necessary.

Further investigation work may be requested by piling contractors, particularly for drill and cased piles, in order to establish the precise nature of the rock at depth. For this site, rotary open-hole drilling methods should be utilised through the overburden with follow-on rotary coring within the rock and grout. The depth of such investigations may be required to extend below estimated pile toe levels by 3 times the base width of the largest individual pile, the largest pile group width or 5m, whichever the greater. However, this could be reduced to 2m below the estimated pile toe level if distinct competent strata are revealed.

11.2 General Comments for Excavations

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.

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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.

11.3 Ground-floors

In light of the made ground and soft near surface soils, which were revealed to depths of up to 3.4m, it is not recommended that ground bearing ground floor slabs be employed. In this instance it would be necessary to suspend floors between foundation positions, such that the floor loads are transmitted via the foundations to competent soils at depth.

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. It is recommended reference is made to guidance such as is available in the NHBC standards. However, soil volume change can typically be catered for by providing a suitable void or utilise proprietary materials beneath the floor slab.

11.4 Hard-standing Areas

It is considered that any hard-standing at the site could be constructed employing traditional pavement design. It is recommended that in situ plate load testing is undertaken at the site to inform the design of the surface yard hard-standing. At this stage, a design California Bearing Ratio (CBR) of <2% could be employed in the pavement design[5]. 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.

11.5 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[6], 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-2 requirements. Assuming mobile groundwater, the table also indicates that the aggressive chemical environment for concrete (ACEC) classification is AC-3.

[5] Table 11.1, *Reproduction of TRRL Report LR1132 (1984)*, Smith (2006), Smith's Elements of Soil Mechanics, 8th ed.
[6] Table C2, *Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations*

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In order to evaluate the design chemical (DC) class for the buried concrete at this site reference should be made to Table D1[7], 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-3 is required.

12. Discussion of Ground Conditions - Environmental

12.1 Discussion of Test Results

It is understood that the site is to be developed by the construction of new industrial unit and associated service yard. Consequently, the site may be classified as commercial end use.

12.1.1 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 6.0% and 69.0%. On this basis, it is considered that the screening values associated with 6% 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[8] 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 8: Summary of Contaminated Areas

Location	Depth (m)	Contaminants found to be exceeding SSVs (Commercial)
WS01	0.5	None identified.
WS02	1.2	None Identified.
WS03	0.8	None identified.

Concentrations of chromium^{VI}, free cyanide, phenols (total), PAHs with the exception of fluoranthene and pyrene and total petroleum hydrocarbons (aliphatic C5 to C6, aliphatic C6 to C8, aliphatic C8 to C10, aliphatic C10 to C12, aliphatic C12 to C16, aliphatic C35 to C44, aromatic C5 to C7, aromatic C7 to C8, aromatic C8 to C10, aromatic C10 to C12) were below the detection limits for the tests. Detectable levels of all other contaminants were recorded, but these fell below the associated Atrisk Soil Screening Values. In addition, no asbestos was detected within the soils samples tested.

[7] 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.*
[8] http://www.atrisksoil.co.uk/pages/general/subscribers.asp

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On the basis of the above information, the results of the investigation have concluded that the site can be considered as uncontaminated for a commercial end use.

12.1.2 Gas Concentrations

With respect to ground gas, the results of the monitoring visits indicated a maximum concentration of 0.4% methane, with concentrations of carbon dioxide ranging between 0.1% and 6.9%, in association with oxygen levels of between 6.3% and 20.8%. It should be appreciated that on non contaminated sites there is generally about 20% by volume of oxygen, associated with low levels of carbon dioxide. In this respect, depleted oxygen has been identified, this suggests other gasses such as nitrogen or carbon monoxide may be present in greater concentrations than would be expected. In addition, a maximum flow rate of 0.1 litres per hour was recorded and will be employed in the following calculations.

The principal driving force for initiating the movement of gas in the ground is a change in barometric pressure. The most onerous gas condition on a site is usually observed on days of low or falling barometric pressure, preferably below 1000mb. It has been noted that measurements undertaken solely during high pressure conditions may be of lesser value. At this site the readings undertaken to date were at atmospheric pressures of between 979mb and 995mb.

In order to establish the gas screening value (GSV) for carbon dioxide or methane, the maximum gas concentration (expressed as a decimal) is multiplied by the borehole flow rate (l/hr). In this case 0.4% (0.004) methane was recorded along with 6.9% (0.069) carbon dioxide, in association with a maximum flow rate of 0.1 l/hr. This results in a GSV of 0.0004 l/hr for methane and a GSV of 0.0069 l/hr for carbon dioxide.

In accordance with Table 2 of BS8485: 2015*, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings,* and because carbon dioxide concentrations have been identified in excess of 5% the site may be characterised as *Characteristic Situation Level 2*. As such, gas protection measures will be required in accordance with Table 8.6, *Typical scope of gas protection measures,* of CIRIA report C665.

With regard to the number of monitoring visits required reference is made to Tables 5.5a and 5.5b of CIRIA report C665 (2007)[9]. Accepting that the proposed development is of low sensitivity and that the generation potential is very low, these tables suggest that 4 readings should be undertaken over a period of 1 month. However, C665 notes that *not all sites will require gas monitoring for the period and frequency indicated in Tables 5.5a and 5.5b.*

Nonetheless, a total of 4 monitoring visits were undertaken over a 4-week (1 month) time period and for the purpose of this assessment the ground gas monitoring is complete and it is considered that the site can be fully classified as Characteristic Situation Level 2. As such, gas protection measures are required.

[9] Adapted from tables 5.5a and 5.5b of CIRIA C665, 2007, *Assessing risks posed by hazardous ground gas to buildings, p60.*

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12.2 Site Specific Risk Assessment

12.2.1 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[10] advice on the assessment of risks arising from the presence of contamination in soils and using the source-pathway-receptor approach.[11] 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.'[12]

12.2.2 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 9. Sources of contamination include the following:

On-site – No chemical contamination identified, for commercial end use. Elevated carbon dioxide identified.

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 9.

[10] 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'.
[11] 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.
[12] See 'Circular 2/2000 Contaminated Land: Implementation of Part II of The Environmental Protection Act 1990', appendix A.

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Table 9: Conceptual Site Model and Site Specific Risk Assessment [Chemical contamination: None identified]				
Conceptual Site Model			**Site Specific Risk Assessment**	
Pathways	**Receptor**	**Linkage Present?**	**Risk Rating**	**Notes**
Direct contact/dermal absorption/soil ingestion	Operative	No – no significant contamination found to be present at the site.	N/A	No further action required.
	End User		N/A	
	Neighbours		N/A	
Inhalation of Dust/Vapours	Operative	Yes – dust may be derived from soils.	Moderate	Precautionary measures will be required during the construction phase. Remediation will be required to control dust during the construction phase.
	End User	No – no significant contamination found to be present at the site.	N/A	
	Neighbours	Yes – dust may be derived from soils and commercial properties located within 250m radius of the site and possible inhalation of dust during the works.	Moderate	
Ingestion of fruit/vegetables and/or waters	Operative	No – no significant contamination found to be present at the site.	N/A	No further action required.
	End User		N/A	
	Neighbours		N/A	
Migration of hazardous gases via permeable strata or shallow mining activity	Operative	Yes – elevated concentrations of carbon dioxide has been found to be present at the site (*Characteristic Situation Level 2*).	High	Low concentrations of methane but moderate concentrations of carbon dioxide were detected at the site. Special precautionary measures are required. Remediation will be required to either remove the contamination or break pathways.
	End User		High	

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	Neighbours	No – whilst concentrations of ground gas have been found to be present at the site (assuming *Characteristic Situation Level 2*), no structures directly adjoin the site, therefore gases migrating from the site would vent to atmosphere before reaching neighbouring structures.	N/A	
Spillage/loss/run off direct to receiving water	Controlled Waters	Yes – known controlled waters within 250m. Although contamination considered harmful to human health has not been identified, contamination that may impact controlled waters may be present. However, the site is underlain by cohesive soils of low permeability. It is also considered that any contamination would only be mobilised during periods of heavy rainfall, whereby any contamination would be diluted. Moreover, the proposals include the majority of the site being covered with buildings or hardstanding, thus reducing infiltration.	Low	Old services to be removed or capped, no further action required.
Migration via permeable unsaturated strata	Controlled Waters	Yes – a Secondary A Aquifer is present beneath the site. Although contamination considered harmful to human health has not been identified, contamination that may impact controlled waters may be present. However, the site is underlain by cohesive soils of low permeability. Moreover, the proposals include the majority of the site being covered with buildings or hardstanding, thus reducing infiltration.	Low	
Run off via drainage/sewers etc	Controlled Waters	Yes – old services may be present on site. However, the site is underlain by cohesive soils of low permeability. Moreover, the proposals include the majority of the site being covered with buildings or hardstanding, thus reducing infiltration.	Low	
Direct contact with contaminated soils	Plants	No – no significant contamination found to be present at the site.	N/A	No further action required.
Uptake via root system			N/A	
Direct contact with contaminated soils	Building Materials	Yes – discussion with relevant water authority as to the requirements for plastic water pipes. Moreover, testing indicates that the aggressive chemical environment for concrete classification is AC-3.	Moderate (plastic services)	Please see section 12.3.3 for information on good building practice.
Direct contact with contaminated groundwater			Moderate (buried concrete)	
Exposure to Radon	Operative / End User	No – Not in a radon affected area.	N/A	Less than 1% of properties are above the action level. No radon protection measures required.

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12.3 Indicative Remediation Strategy

In view of the site specific risk assessment it is considered that it will not be necessary to undertake any specific remediation to soils at this site. It should be appreciated, however, that careful inspection of the subgrade should be made during the groundworks. Should areas of contamination be detected then further testing may become necessary. Moreover, remediation to protect end users from harmful ground gases will be required.

12.3.1 General Approach to Construction

Based on the site specific risk assessment the following approach to construction 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.
- To protect the end user from the elevated levels of ground gas.
- To protect neighbours from the inhalation and ingestion dust during the construction process.
- To protect plastic services from being penetrated by, or degrading, due to the presence of any contamination in the soil or groundwater.

12.3.2 Development Requirements

Whilst the precise nature of this development has not been finalised it is understood that the site is to be developed by the construction of a new industrial unit and associated service yard. In view of the above a site specific remediation strategy (gas protection measures design and verification plan) should be undertaken after the proposed development has been finalised. However, for preliminary design and costing the following remediation proposals are offered.

11.3.3 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

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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 fundamental principles of identifying potentially contaminated soils and the hazards of working with such soils not identified by the ground investigation.

- 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.
- 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 potential 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 development the following items are required to protect the structure 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-3.

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Gas Protection Measures

In order to assess the protection measures required BS8485: 2015+A1:2019: *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* has been employed. In accordance with Table 3, *Building types,* of the code, the development may be considered to conform to Type D. Therefore, on the basis of Table 4 *Gas protection score by CS and type of building,* the minimum gas protection score (points) is 1.5. The gas protection system should consist of at least two different elements. The elements work independently and collaboratively, and a single element should not be used because there would be no redundancy to allow for defects in the component.

In order to achieve this score, the following should be undertaken.

Table 10: Combination of protection elements (BS8485: 2015) for CS2

Reference	Protection Element	Score
Table 5	Reinforced cast in situ suspended floor slab with minimal penetrations. Note 1.	1 or 1.5
Table 6	Pressure relief Pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building). Note 2.	0.5
	Total Score	**Min: 1.5 Max: 2**

Note 1:
A reinforced cast in situ suspended floor slab with minimal penetrations should be utilised. To achieve a score of 1.5 the suspended slab should be well reinforced to control cracking and have minimal penetrations cast in. The details of the system to be adopted shall be included on the technical drawings provided by the engineer/architect.

Note 2:
If the pressure relief pathway layer has low permeability and/or is not terminated in a venting trench (or similar), then the score is zero. gas resistant membrane shall meet the following criteria:

In addition to the above, the following points shall be considered.

- Technical drawings of the incorporation of the gas protection measures into the sub-structure will be provided by a suitably qualified engineer/architect and produced in accordance with the guidance given in BRE 414.
- The sequence of construction indicating when the gas protection system will be installed will be included with the remediation statement.

Verification of the installation of the gas protection system should be carried out for the structure, unless agreed with any statutory authorities prior to construction.

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12.4 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 BS3883 (2007)
- 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[13] 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 11: Validation Sampling and Testing

Fill Type	Frequency	Minimum Determinands
Virgin Quarried Material	1 or 2 depending on the type of stone (to confirm the inert nature of the material)	Standard metals/metalloids (As, Cd, Cr, Cr^{VI}, Cu, Hg, Ni, Pb, Se, Zn)
Crushed Hardcore, Stone, Brick	Minimum 1 per 1000m³	Standard metals/metalloids as above plus PAH (16 USEPA) and Asbestos
Greenfield/ Manufactured Soils	The greater of a minimum of 3 or 1 per 250m³	Standard metals/metalloids as above plus PAH (16 USEPA) and Asbestos
Brownfield/ Screened Soils	The greater of a minimum of 6 or 1 per 100m³	Standard metals/metalloids as above plus PAH (16 USEPA), TPH (CWG banded) and Asbestos. Any additional analysis dependant on the history of the donor site.

[13] *YALPAG Technical Guidance for Developers, Landowners and Consultants – Verification Requirements for Cover Systems V3.3* Appendix 1a, October 2016.

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

Table 12: Fill Screening Values

Contaminant	Screening Value (Commercial) (mg/kg)		Reference
	1% SOM	6% SOM	
As	635	635	Atrisk^{SOIL} SSVs
Cd	410	410	Atrisk^{SOIL} SSVs
Cr(VI)	49.1	49.1	Atrisk^{SOIL} SSVs
Cu	106000	106000	Atrisk^{SOIL} SSVs
Hg	350	405	Atrisk^{SOIL} SSVs
Ni	1770	1770	Atrisk^{SOIL} SSVs
Pb	2310	2310	Atrisk^{SOIL} SSVs
V	7490	7490	Atrisk^{SOIL} SSVs
Zn	1100000	1100000	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.

12.5 Verification Report

In order to demonstrate that the remedial works to protect end users from harmful ground gases have been sufficiently carried out, it will be necessary to produce a verification report for submission to any statutory authorities. It will be necessary for this report to include evidence that suitable gas protection measures have been implemented. The verification should be undertaken by a suitably qualified specialist. 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.

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13. 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. In particular, the Coal Authority should be made aware of the apparent grouting at the site.
- Discussions with piling contractors regarding their method for installing piles and the necessity for further borehole information.
- 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.
- Discussions with contractors in relation to the suitability of materials and installation methods for gas protection measures.
- 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.

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14. References

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- Wilson S, Oliver S, Mallet H, Hutchings H, Card G, *Assessing risks posed by ground gasses to buildings,* CIRIA Report C665.

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Appendix 1

Site Plan

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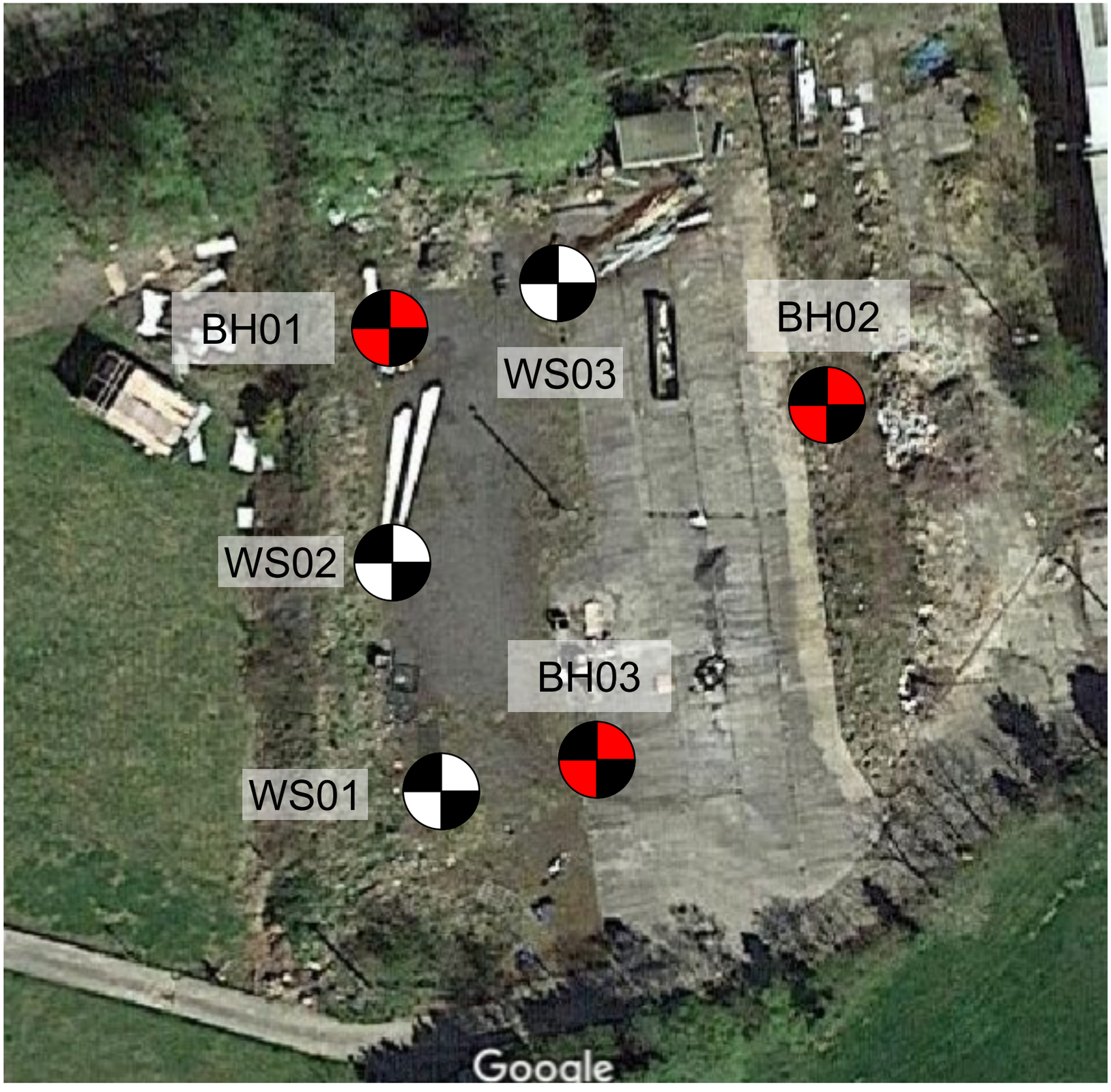

Notes:
Investigation positions approximated from site operative's notes.

Environmental Geotechnical Specialists

RGS

Rogers Geotechnical Services Ltd

Offices 1 & 2, Barncliffe Business Park,
Near Bank,
Shelley,
Huddersfield,
HD8 8LU

Telephone:0843506687
www.rogersgeotech.co.uk

Client:
To Your Home Ltd

Job Number:
C1675/21/E/2596

Project Details:
Century Works, Manchester Road, Millhouse Green, Barnsley, S36 9LQ

Scale:	Not to scale – reference only

Notes:
Investigation positions approximated from site operative's notes.

Environmental Geotechnical Specialists

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Offices 1 & 2, Barncliffe Business Park,
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Scale:	Not to scale – reference only

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Appendix 2

Coal Authority Permit

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The Coal Authority

Permit to Enter or Disturb Coal Authority Interests

Permit 22114

Name and Address of Permit Holder:

To Your Home Ltd
Century Works
Manchester Road
Millhouse Green
Barnsley
S36 9LQ

Site Location:

Land at
Century Works
Manchester Road
Millhouse Green
Barnsley
S36 9LQ

This certificate hereby grants the above named Permit Holder a Permit to carry out:-

A Ground Investigation comprising three boreholes to 30m within the Authority's interests at the identified site location above as shown on the Grant Permit Boundary (overleaf) for the period of 12 months from the granted date shown below. *The granting of this Permit does not constitute advice given by the Authority in relation to the proposed operations. It is the Permit Holder's responsibility to obtain appropriate health, safety, environmental, technical and legal advice.*

Conditions:

- *Water flush*
- *Gas Monitoring CO, CH_4, CO_2, O_2, H_2S at borehole and rig*
- *Operators undertaking the work must be in possession of this certificate and the Permit boundary plan at the time of works*
- *Appropriate borehole sealing without delay and to withstand site level changes*

Signed: Michael Amirtash Granted Date: ***16th June 2021***

For and on behalf of The Coal Authority

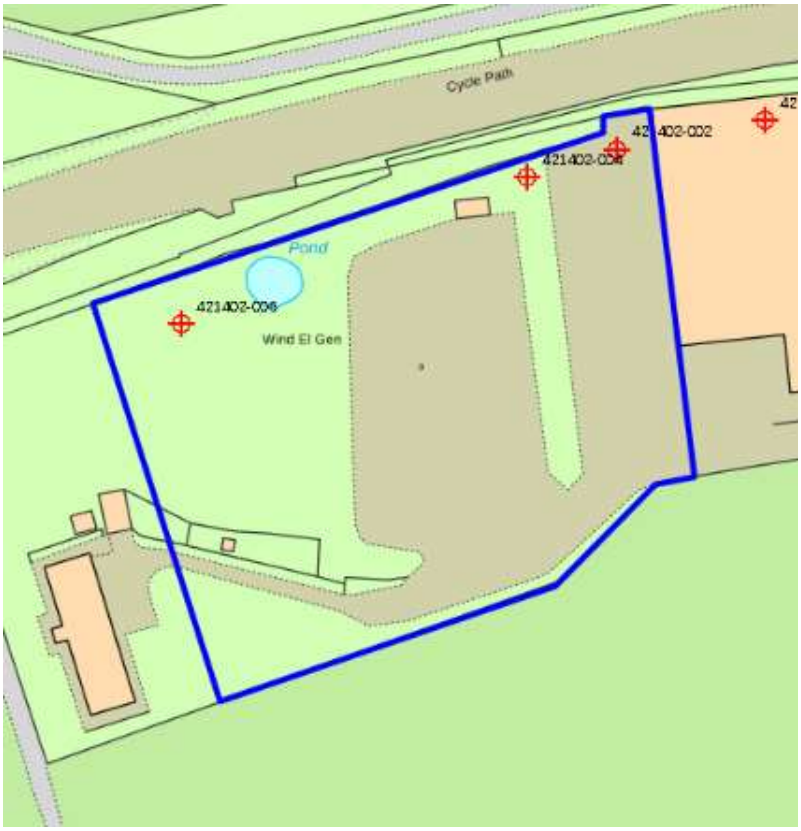
Nominated Representative: Michael Amirtash, Permitting Manager;
The Coal Authority, Permitting Office, 200 Lichfield Lane, Mansfield, Notts, NG18 4RG
Tel: 01623 637450; E-Mail: permissions@coal.gov.uk

The Coal Authority

Granted Permit Boundary

Permit Ref: 22114

Permit Boundary:



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Appendix 3

Borehole Records

Rogers Geotechnical Services Ltd Telephone 0843 50 666 87 Fax 0843 51 599 30
Email enquiries@rogersgeotech.co.uk www.rogersgeotech.co.uk

Borehole Log

Borehole No. **WS01**

Sheet 1 of 1

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type WLS
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By CRC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	ES				0.60			MADE GROUND (dark grey slightly clayey sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse angular of brick, concrete, glass, slag and limestone).
	▼	1.30					0.90			MADE GROUND (firm light brownish grey mottled black and orangish brown slightly cobbly gravelly SILT. Gravel is fine to coarse angular of sandstone and coal. Cobbles are angular of sandstone).
		2.00	SPT			N=23 (4,5/6,9,5,3)	1.50			MADE GROUND (dark grey to black slightly clayey fine to coarse angular mudstone, coal, ironstone and timber fragments GRAVEL).
							1.80			MADE GROUND (firm dark grey mottle black and dark orangish brown slightly gravelly SILT. Gravel is fine to coarse angular of coal fragments and ironstone).
							2.45			MADE GROUND (soft orangish brown slightly cobbly silty CLAY. Cobbles are angular of sandstone).
										End of Borehole at 2.45m

Remarks

Groundwater encountered at 1.3m, standing at 1.15m.

Borehole Log

Borehole No. **WS02**

Sheet 1 of 1

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type WLS
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By HH

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.30			MADE GROUND. (Dark grey, slightly clayey, sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse angular of brick, concrete, glass, slag and limestone).
							0.60			MADE GROUND. (Firm, light brownish grey mottled black and orangish brown, slightly cobbly gravelly SILT. Gravel is fine to coarse angular of sandstone and coal. Cobbles are angular of sandstone).
		1.20	ES				1.40			
							1.50			MADE GROUND. (Dark grey, clayey silty sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse of mudstone, sandstone and wood).
		1.90 - 2.00	D	87	100		1.60			
							1.80			
							2.20			MADE GROUND. (Loose, dark orangish brown mottled dark brown, slightly clayey, slightly gravelly, silty SAND. Sand is fine to coarse. Gravel is sub-angular to angular and fine to medium of sandstone, coal and mudstone).
		2.80 - 2.90	D	87	100		2.90			
							3.00			MADE GROUND. (Loose, reddish brown, silty gravelly SAND. Sand is fine to coarse. Gravel is sub-angular to angular and fine to medium of slag, glass and sandstone).
										MADE GROUND. (Soft, dark brown mottled light brown and orangish brown, silty sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-rounded to sub-angular and fine to coarse of light brown sandstone and coal). Slight organic odour.
										Soft, yellowish brown mottled light grey, slightly gravelly, sandy CLAY. Sand is fine to medium. Gravel is fine to coarse of sandstone.
										Firm, becoming stiff, yellowish brown mottled light grey, slightly gravelly, sandy CLAY. Sand is fine to medium. Gravel is fine to coarse of sandstone.
										Sub-angular cobble of light grey sandstone.
										Medium dense, yellowish brown mottled light brown, clayey sandy, sub-rounded to sub-angular, fine to coarse GRAVEL of sandstone.
										End of Borehole at 3.00m

Remarks

No groundwater encountered.

Borehole Log

Borehole No. **WS03**

Sheet 1 of 1

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type WLS
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By HH

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.80	ES				0.30			MADE GROUND. (Loose, dark brown to dark grey, slightly clayey, silty sandy cobbly GRAVEL. Sand is fine to coarse. Gravel is rounded to sub-angular and fine to coarse of sandstone, brick, quartzite, concrete and wood. Cobbles of brick).
							1.00			MADE GROUND. (Soft, dark brown mottled white and red, silty sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-rounded to sub-angular and fine to coarse of sandstone, brick and rare coal).
							1.20			MADE GROUND. (Loose, dark grey, silty sandy sub-rounded to angular, fine to coarse GRAVEL of sandstone).
										End of Borehole at 1.40m

Remarks

No groundwater encountered.

Borehole Log

Borehole No. **BH01**

Sheet 1 of 2

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type RO
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By DG

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
								MADE GROUND (black chippings onto possible colliery fill [driller's description]).
					2.00			MADE GROUND (timber [driller's description]).
					3.00			yellow SANDSTONE [driller's description].
					3.50			Grey CLAY [driller's description].
					4.50			yellow SANDSTONE [driller's description].
					6.00			MADE GROUND (Hard white lense. Very slow drilling [driller's description]. [Possible concrete]).
					7.00			Grey MUDSTONE [driller's description].
					9.00			Dark grey MUDSTONE [driller's description].
								Continued on Next Sheet

Remarks

No groundwater encountered.

Borehole Log

Borehole No. **BH01**

Sheet 2 of 2

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type RO
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By DG

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					11.00			light grey MUDSTONE / SILTSTONE [driller's description].
					13.30			Medium grey MUDSTONE / SILTSTONE [driller's description].
					15.00			End of Borehole at 15.00m

Remarks

No groundwater encountered.

Borehole Log

Borehole No. **BH02**

Sheet 1 of 2

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type RO
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 08/06/2021	Logged By DG

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.20			MADE GROUND (Concrete).
								MADE GROUND (fill [driller's description]).
					1.00			MADE GROUND (fill of soil, brick and coal. colliery fill [driller's description]).
					3.00			Grey CLAY [driller's description].
	▼	4.50						
					6.00			MADE GROUND (Hard white lense [driller's description]. [Possible concrete]).
					7.00			Interbedded grey SILTSTONE / MUDSTONE and yellow SANDSTONE [driller's description].
								Continued on Next Sheet

Remarks

Groundwater encountered at 4.5m, standing at 4m depth.

Borehole Log

Borehole No. **BH02**

Sheet 2 of 2

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type RO
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 08/06/2021	Logged By DG

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					11.50			Dark grey MUDSTONE / SILTSTONE [driller's description].
					14.00			Medium grey MUDSTONE / SILTSTONE [driller's description].
					16.50			End of Borehole at 16.50m

11 12 13 14 15 16 17 18 19 20

Remarks

Groundwater encountered at 4.5m, standing at 4m depth.

Borehole Log

Borehole No. **BH03**

Sheet 1 of 2

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type RO
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 08/06/2021 - 09/06/2021	Logged By DG

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
								MADE GROUND (fill [driller's description]).
					1.00			MADE GROUND (colliery fill of coal fragments and soil [driller's description]).
					3.00			Grey clayey soil [driller's description].
	▼	4.50			4.50			Yellow CLAY [driller's description].
					5.00			MADE GROUND (Very hard white possible concrete [driller's description]).
					7.00			Interbedded yellow SANDSTONE and grey SILTSTONE / MUDSTONE [driller's description].
								Continued on Next Sheet

1 2 3 4 5 6 7 8 9 10

Remarks

Groundwater encountered at 4.5m, standing at 3.5m depth.

Borehole Log

Borehole No. **BH03**

Sheet 2 of 2

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type RO
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 08/06/2021 - 09/06/2021	Logged By DG

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					16.00			End of Borehole at 16.00m

Remarks

Groundwater encountered at 4.5m, standing at 3.5m depth.

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Appendix 4

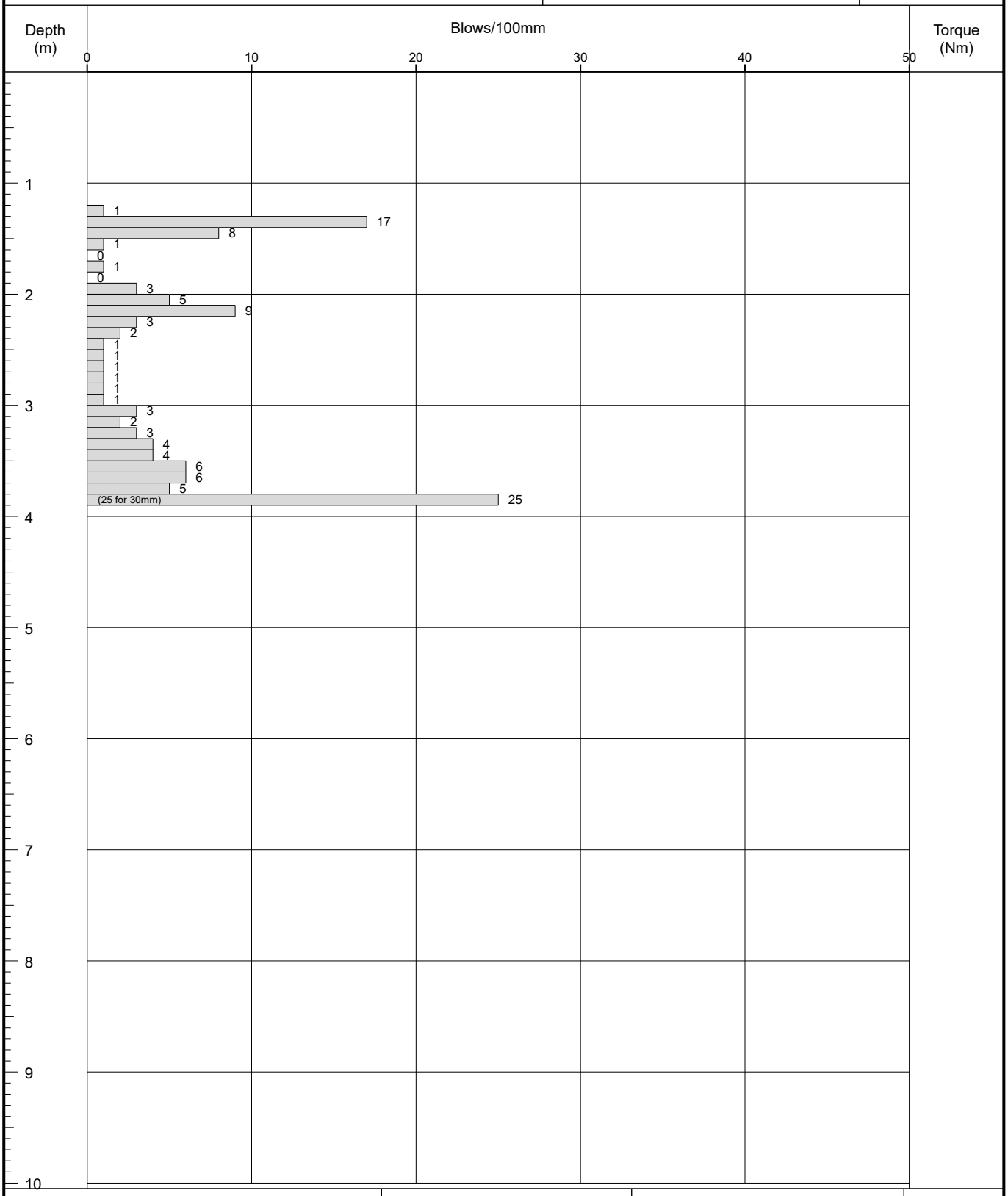
Dynamic Probing Records

Rogers Geotechnical Services Ltd Telephone 0843 50 666 87 Fax 0843 51 599 30
Email enquiries@rogersgeotech.co.uk www.rogersgeotech.co.uk

Probe Log

Probe No.
DP01
Sheet 1 of 1

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type DP
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By Rae



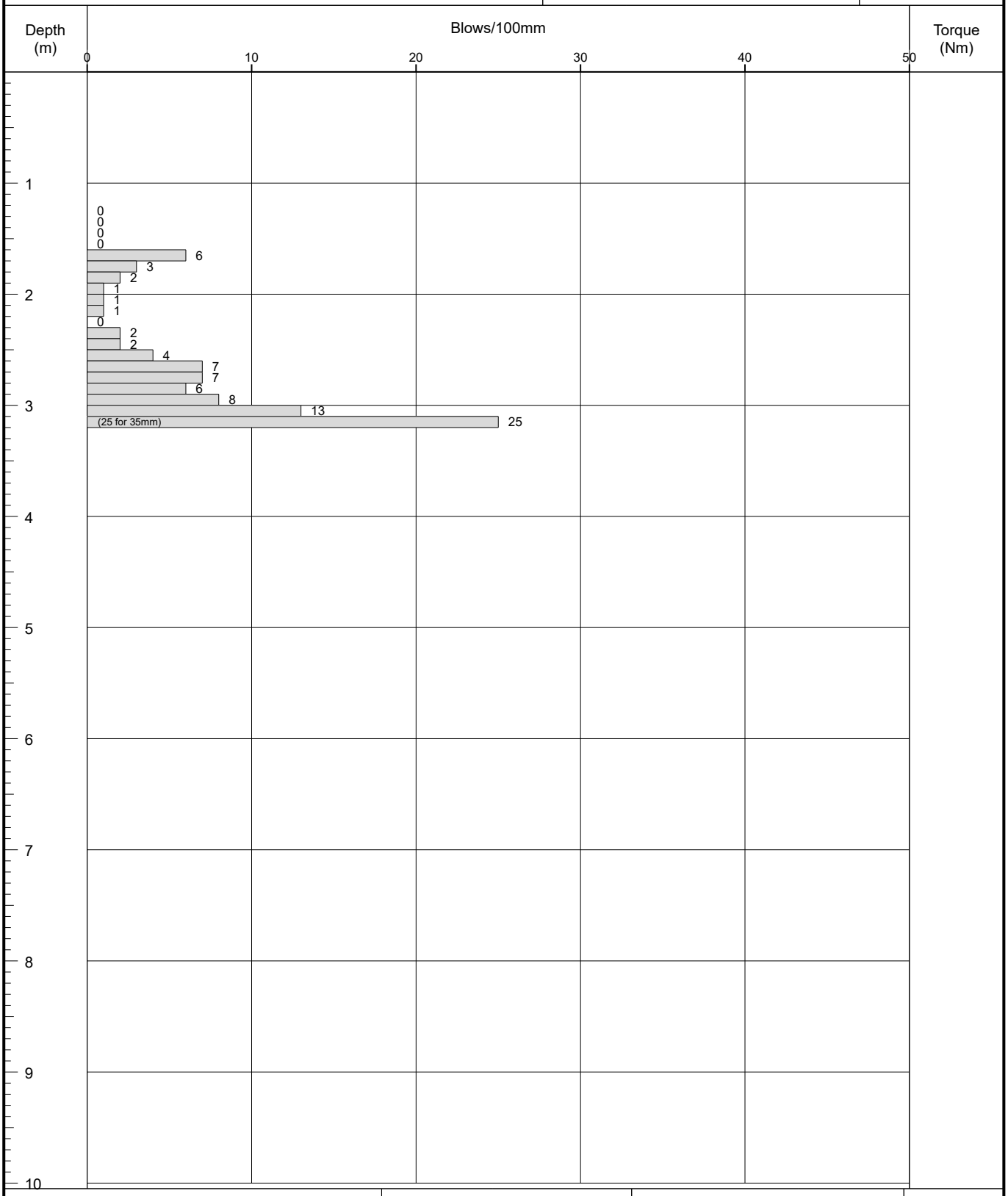
Remarks:
DP started at 1.2m due to HDSP. Abrupt refusal at 3.83m.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	3.83m
Probe Type	DPSH-B		

Probe Log

Probe No.
DP02
Sheet 1 of 1

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type DP
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By Rae



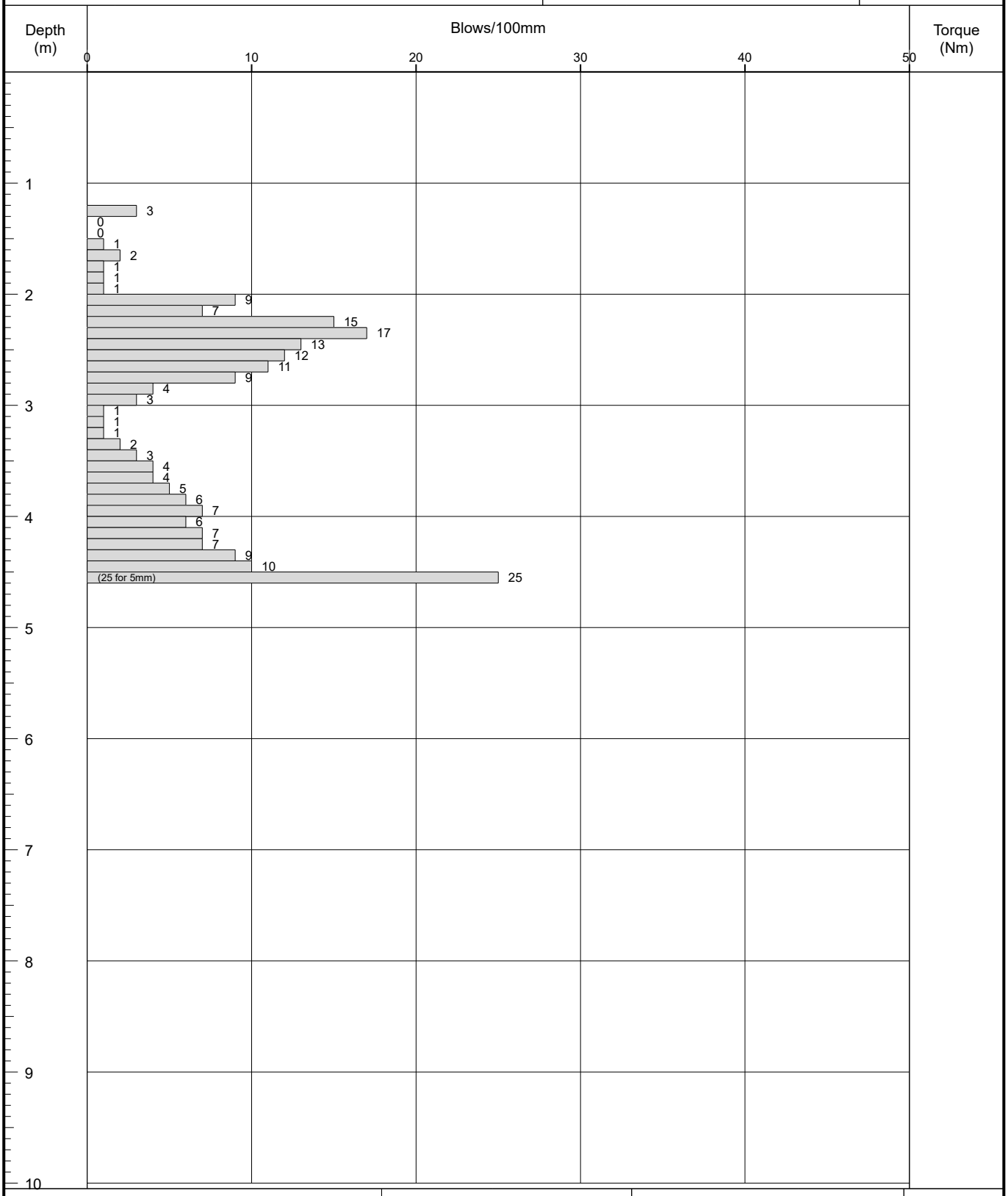
Remarks:
DP started at 1.2m due to HDSP. Refusal at 3.135m.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	3.135m
Probe Type	DPSH-B		

Probe Log

Probe No.
DP03
Sheet 1 of 1

Project Name:	Century Works, Manchester Road, Millhouse Green	Project No. C1675/21/E/2596	Co-ords:	Hole Type DP
Location:	Century Works, Manchester Road, Millhouse Green, Barnsely, S36 9LQ		Level:	Scale 1:50
Client:	To Your Home Ltd		Dates: 07/06/2021	Logged By Rae



Remarks:
DP started at 1.2m due to HDSP. Refusal at 4.505m.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	4.505m
Probe Type	DPSH-B		

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Appendix 5

Laboratory Testing

Rogers Geotechnical Services Ltd Telephone 0843 50 666 87 Fax 0843 51 599 30
Email enquiries@rogersgeotech.co.uk www.rogersgeotech.co.uk

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LABORATORY REPORT

job number C1675/21/E/2596	client ref

site address Century Works, Manchester Road, Millhouse Green, S36 9LQ	client address To Your Home Ltd Century Works, Manchester Road, Millhouse Green, S36 9LQ

consultant

date scheduled 17/06/2021	date issued 28/06/2021
issued by H J Letch	job title Asst. Lab Manager

Rogers Geotechnical Services Ltd **Telephone 01484 607 977**
Email jude.norcliffe@rogersgeotech.co.uk www.rogersgeotech.co.uk
Unit 4, Barncliffe Business Park, Near Bank, Shelley,
Huddersfield, West Yorkshire HD8 8LU.

GEOTECHNICAL ENVIRONMENTAL

Schedule of UKAS Accredited Laboratory Tests

1. CLASSIFICATION OF SOIL	BS 1377-2:1990	BS EN 150 17892	Accredited (A)	Unaccredited (U)
1.1 Moisture / Water content determination				
i. Oven drying	Pt 2 : 3.2	Pt 1 : 2014	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	Pt 12 : 2018 : 5.3 / 5.5	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			U
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			U
- CBR mould	Pt 4 : 3			U
ii. 4.5kg rammer – 1 litre mould	Pt 4 : 3			U
- CBR mould	Pt 4 : 3			U
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			U
ii. Recompacted sample	Pt 5 : 7			U
iii. Soaked, inc measurement of swell	Pt 5 : 7			U
4. COMPRESSIBILITY OF SOIL	**BS 1377-5:1990**			
i. One dimensional consolidation	Pt 5 : 3			U
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			U
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

GEOTECHNICAL ENVIRONMENTAL

Rogers Geotechnical Services Ltd
Office 1 & 2 Barncliffe Business Park,
Near Bank, Shelley, Huddersfield, HD8 8LU

Telephone 0843 50 666 87
Fax 0843 51 599 30
Company No: 5130864

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GEOTECHNICAL LAB RESULTS

GEOTECHNICAL
ENVIRONMENTAL

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Rogers Geotechnical Services Ltd
Office 1 & 2 Barncliffe Business Park,
Near Bank, Shelley, Huddersfield, HD8 8LU

Telephone 01484 607977
Company No: 5130864

Summary of Classification Test Results

Project No.	Project Name
C1675/21/E/2596	Century Works, Manchester Road, Millhouse Green

Hole No.	Sample				Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Cone 80g/30° 60g/60°	Water Increase Decrease	Remarks
	Ref	Top	Base	Type												
WS02	1	1.90	2.00	D	Soft, yellowish brown slightly gravelly, sandy CLAY.			26.0	100	46 -1pt	23	23		80g/30deg	Increacing	
WS02	2	2.80	2.90	D	Firm, yellowish brown slightly gravelly, sandy CLAY.			14.0	87	33 -1pt	13	20		80g/30deg	Increacing	

All tests performed in accordance with BS EN ISO 17892 unless specified otherwise

Key			Date Printed	Approved By	Table
Density test	Liquid Limit	Particle density			1
Linear measurement unless :	4pt cone unless :	sp - small pyknometer	23/06/2021		
wd - water displacement	cas - Casagrande method	gj - gas jar			sheet
wi - immersion in water	1pt - single point test			Harry	1

Linear Shrinkage - Summary of Results

Project No.	Project Name
C1675/21/E/2596	Century Works, Manchester Road, Millhouse Green

Hole No.	Sample				Soil Description	Material <425µm %	Preparation	Linear Shrinkage %	Date Tested
	Ref	Top	Base	Type					
WS02	1	1.90	2.00	D	Soft, yellowish brown slightly gravelly, sandy CLAY.	100	Specimen prepared from natural material	11	19/06/2021
WS02	2	2.80	2.90	D	Firm, yellowish brown slightly gravelly, sandy CLAY.	87	Specimen prepared from natural material	8	19/06/2021

Remarks:

Notes	Date Printed	Approved By	Table
Tests performed in accordance with BS 1377 : Part 2 : 1990, clause 6.5 unless annotated otherwise	23/06/2021	Harry	2
			Sheet 1

Rogers Geotechnical Services Ltd.
Offices 1&2,
Barncliffe Business Park,
Near Bank, Shelley,
Huddersfield,
HD8 8LU

Classification of Index Properties

C1675/21/E/2596

Project Name: Century Works, Manchester Roa

BS EN ISO: 17892: Parts 1, 12

Fig. 3 | Sheet. 1

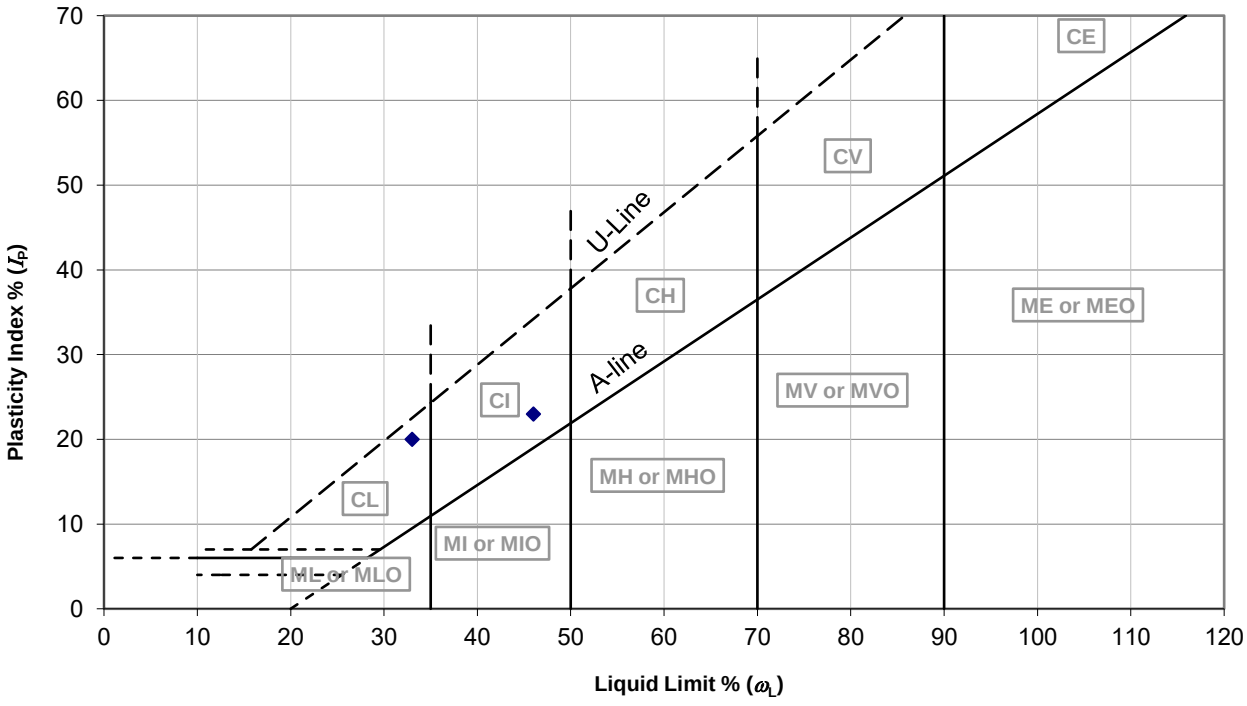
Location:

Input By: Harry

Client: To Your Home Ltd

Check By: Harry

Location	Depth (m)	Moisture Content (w) (%)	Liquid Limit (wL) (%)	Plastic Limit (wP) (%)	Plasticity Index (IP) (%)	Retained by 0.425mm (%)	Modified (w) (w') (%)	Modified (IP) (IP') (%)	Liquidity/ Consistency (IL) (%)	Liquidity/ Consistency (IC) (%)	Casagrande Class	N.H.B.C Class (%)
WS02	1.90	26.4	46	23	23	0	26	23	0.1	0.9	C I	MEDIUM
WS02	2.80	14.1	33	13	20	13	16	17	0.1	0.9	C L	LOW



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Rogers Geotechnical Services Ltd
Office 1 & 2 Barncliffe Business Park,
Near Bank, Shelley, Huddersfield, HD8 8LU

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Company No: 5130864

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Office 1 & 2 Barncliffe Business Park,
Near Bank, Shelley, Huddersfield, HD8 8LU

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Company No: 5130864

Rogers Geotechnical Services: Soil Screening Values Comparison Sheet

Rogers Geotechnical Services Ltd				Soil Screening Value (SSV) Comparison Sheet						
Job Number				A = WS Atkins PLC, Atrisk Soil Screening Values. A+ = Values updated June 2017. A* = Atrisk's SSV is lower than Chemtest's detectable limit for this compound. B = health criterion values, which are available from toxicological reviews published in the C4SL project methodology report. C = Category 4 Screening Levels (C4SLs) based on 6% soil organic matter. D = Value provided is based on Methyl Mercury. Should elemental mercury be observed or a source be known then a				KEY Exceeds SSV Exceeds 2017, Below 2015 Below limit of detection (LOD)		
Job Name										
Date				**Sample Location**		WS01	WS02	WS03			
Client				Depth Top		0.5	1.2	0.8			
				Depth Base							
Determinand	**Units**	**Ref**	**LOD**	**Commercial 6%**							
				Atrisk 2015 (No Free Product	Atrisk 2017						
Cadmium	mg/kg	C	0.10		410	0.26	0.20	< 0.10			
Chromium (Hexavalent)	mg/kg	B/C	0.5	49.1	19.7	< 0.50	< 0.50	< 0.50			
Copper	mg/kg	A+	0.50		106000	44	33.0	11			
Mercury	mg/kg	A/D	0.10		405	0.13	0.22	0.14			
Nickel	mg/kg	A+	0.50		1770	27	35.0	3			
Lead	mg/kg	C	0.50		2310	61	23	23			
Zinc	mg/kg	A+	0.50		1100000	290	15	8			
Vanadium	mg/kg	A+	5.0		7490	33	9.9	< 5.0			
Arsenic	mg/kg	C	1.0		635	11	27	3			
Selenium	mg/kg	A	0.20		13000	0.55	2.8	0.3			
Cyanide (Free)	mg/kg	A	0.50		373	< 0.50	< 0.50	< 0.50			
Total Phenols	mg/kg	A	0.1		3170	< 0.10	< 0.10	< 0.10			
Naphthalene	mg/kg	A+	0.10	1050	432	< 0.10	< 0.10	< 0.10			
Acenaphthylene	mg/kg		0.10			< 0.10	< 0.10	< 0.10			
Acenaphthene	mg/kg	A+	0.10	0	106000	< 0.10	< 0.10	< 0.10			
Fluorene	mg/kg	A+	0.10	0	72000	< 0.10	< 0.10	< 0.10			
Phenanthrene	mg/kg		0.10			< 0.10	< 0.10	< 0.10			
Anthracene	mg/kg	A+	0.10	0	544000	< 0.10	< 0.10	< 0.10			
Fluoranthene	mg/kg	A+	0.10		72600	0.85	1.6	1.4			
Pyrene	mg/kg	A+	0.10		54400	0.95	2.1	0.69			
Benzo[a]anthracene	mg/kg	A	0.10	142	10.3	< 0.10	< 0.10	< 0.10			
Chrysene	mg/kg	A	0.10	14300	2.64	< 0.10	< 0.10	< 0.10			
Benzo[b]fluoranthene	mg/kg	A	0.10	144	7.29	< 0.10	< 0.10	< 0.10			
Benzo[k]fluoranthene	mg/kg	A	0.10	1440	4.12	< 0.10	< 0.10	< 0.10			
Benzo[a]pyrene	mg/kg	B/C	0.10	76.3	26.2	< 0.10	< 0.10	< 0.10			
Indeno(1,2,3-c,d)Pyrene	mg/kg	A*	0.10	144	0.368	< 0.10	< 0.10	< 0.10			
Dibenz(a,h)Anthracene	mg/kg	A	0.10	14.4	0.0236	< 0.10	< 0.10	< 0.10			
Benzo[g,h,i]perylene	mg/kg	A	0.10	1450	0.112	< 0.10	< 0.10	< 0.10			
Total Of 16 PAH's	mg/kg		2.0			< 2.0	3.7	2.1			
Aliphatic TPH >C5-C6	mg/kg	A+	1.0	29400	1100	< 1.0	< 1.0	< 1.0			
Aliphatic TPH >C6-C8	mg/kg	A+	1.0	98200	769	< 1.0	< 1.0	< 1.0			
Aliphatic TPH >C8-C10	mg/kg	A+	1.0	14800	476	< 1.0	< 1.0	< 1.0			
Aliphatic TPH >C10-C12	mg/kg	A+	1.0	69500	297	< 1.0	< 1.0	< 1.0			

Rogers Geotechnical Services: Soil Screening Values Comparison Sheet

The Ground Investigation Specialists

Rogers Geotechnical Services Ltd				Soil Screening Value (SSV) Comparison Sheet							
Job Number				A = WS Atkins PLC, Atrisk Soil Screening Values. A+ = Values updated June 2017. A* = Atrisk's SSV is lower than Chemtest's detectable limit for this compound. B = health criterion values, which are available from toxicological reviews published in the C4SL project methodology report. C = Category 4 Screening Levels (C4SLs) based on 6% soil organic matter. D = Value provided is based on Methyl Mercury. Should elemental mercury be observed or a source be known then a							KEY Exceeds SSV Exceeds 2017, Below 2015 Below limit of detection (LOD)
Job Name											
Date				**Sample Location**		WS01	WS02	WS03			
Client				Depth Top		0.5	1.2	0.8			
				Depth Base							
Determinand	**Units**	**Ref**	**LOD**	**Commercial 6%**							
Aliphatic TPH >C12-C16	mg/kg	A+	1.0	139000	126	< 1.0	< 1.0	< 1.0			
Aliphatic TPH >C16-C21	mg/kg	A+	1.0		3620000	30	< 1.0	< 1.0			
Aliphatic TPH >C21-C35	mg/kg	A+	1.0		3620000	160	< 1.0	< 1.0			
Aliphatic TPH >C35-C44	mg/kg		1.0			< 1.0	< 1.0	< 1.0			
Total Aliphatic Hydrocarbons	mg/kg		5.0			190	< 5.0	< 5.0			
Aromatic TPH >C5-C7	mg/kg	A+	1.0		98	< 1.0	< 1.0	< 1.0			
Aromatic TPH >C7-C8	mg/kg	A+	1.0	183000	4360	< 1.0	< 1.0	< 1.0			
Aromatic TPH >C8-C10	mg/kg	A+	1.0	20800	3600	< 1.0	< 1.0	< 1.0			
Aromatic TPH >C10-C12	mg/kg	A+	1.0	53800	2190	< 1.0	< 1.0	< 1.0			
Aromatic TPH >C12-C16	mg/kg	A+	1.0	65400	65400	75	< 1.0	< 1.0			
Aromatic TPH >C16-C21	mg/kg	A+	1.0		28400	420	< 1.0	< 1.0			
Aromatic TPH >C21-C35	mg/kg	A+	1.0		28400	1700	< 1.0	< 1.0			
Aromatic TPH >C35-C44	mg/kg		1.0			120	< 1.0	< 1.0			
Total Aromatic Hydrocarbons	mg/kg		5.0			2300	< 5.0	< 5.0			
Total Petroleum Hydrocarbons	mg/kg		10.0			2500	< 10	< 10			
pH			N/A			**8.9**	**5.9**	7.0			
Sulphate (2:1 Water Soluble) as SO4	g/l		0.010			**0.10**	**0.71**	0.180			
ACM Type			N/A								
Asbestos Identification	%		0.001			No Asbestos Detected	No Asbestos Detected	No Asbestos Detected			
ACM Detection Stage			N/A								
Moisture	%		0.020			9	13.0	8			
Soil Colour			N/A			Brown	Black	Brown			
Other Material			N/A			Stones	Stones	Stones			
Soil Texture			N/A			Sand	Sand	Sand			
Sulphate (Total)	%		0.010			0.20	1.900	0.620			
Organic Matter	%		0.40			7.4	**69.0**	**6.0**			

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	21-20856-1
Initial Date of Issue:	25-Jun-2021
Client	Rogers Geotechnical Services Ltd
Client Address:	Unit 4, Barncliffe Business Park Near Bank Shelley Huddersfield West Yorkshire HD8 8LU
Contact(s):	Harry Letch
Project	C1675/21/E Century Works, Manchester Road

Quotation No.:		**Date Received:**	18-Jun-2021
Order No.:	PO-1613	**Date Instructed:**	18-Jun-2021
No. of Samples:	3		
Turnaround (Wkdays):	5	**Results Due:**	24-Jun-2021
Date Approved:	25-Jun-2021		

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: C1675/21/E Century Works, Manchester Road

Client: Rogers Geotechnical Services Ltd		**Chemtest Job No.:**			21-20856	21-20856	21-20856
Quotation No.:		**Chemtest Sample ID.:**			1224173	1224174	1224175
Order No.: PO-1613		Client Sample Ref.:			ES	ES	ES
		Client Sample ID.:			0.5	1.2	0.8
		Sample Location:			WS01	WS02	WS03
		Sample Type:			SOIL	SOIL	SOIL
		Date Sampled:			15-Jun-2021	15-Jun-2021	15-Jun-2021
		Asbestos Lab:			COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Cadmium	M	2450	mg/kg	0.10	0.26	0.20	< 0.10
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Copper	M	2450	mg/kg	0.50	44	33	11
Mercury	M	2450	mg/kg	0.10	0.13	0.22	0.14
Nickel	M	2450	mg/kg	0.50	27	35	3.2
Lead	M	2450	mg/kg	0.50	61	23	23
Zinc	M	2450	mg/kg	0.50	290	15	8.1
Vanadium	U	2450	mg/kg	5.0	33	9.9	< 5.0
Arsenic	M	2450	mg/kg	1.0	11	27	3.3
Selenium	M	2450	mg/kg	0.20	0.55	2.8	0.30
Cyanide (Free)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Total Phenols	M	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Naphthalene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Fluorene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Anthracene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	0.85	1.6	1.4
Pyrene	M	2700	mg/kg	0.10	0.95	2.1	0.69
Benzo[a]anthracene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Chrysene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	M	2700	mg/kg	2.0	< 2.0	3.7	2.1
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	30	< 1.0	< 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	160	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0

Results - Soil

Project: C1675/21/E Century Works, Manchester Road

Client: Rogers Geotechnical Services Ltd		**Chemtest Job No.:**			21-20856	21-20856	21-20856
Quotation No.:		**Chemtest Sample ID.:**			1224173	1224174	1224175
Order No.: PO-1613		Client Sample Ref.:			ES	ES	ES
		Client Sample ID.:			0.5	1.2	0.8
		Sample Location:			WS01	WS02	WS03
		Sample Type:			SOIL	SOIL	SOIL
		Date Sampled:			15-Jun-2021	15-Jun-2021	15-Jun-2021
		Asbestos Lab:			COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	190	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	75	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	420	< 1.0	< 1.0
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	1700	< 1.0	< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	120	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	2300	< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	2500	< 10	< 10
pH	M	2010		4.0	8.9	5.9	7.0
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.097	0.71	0.18
ACM Type	U	2192		N/A	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	9.4	13	7.5
Soil Colour	N	2040		N/A	Brown	Black	Brown
Other Material	N	2040		N/A	Stones	Stones	Stones
Soil Texture	N	2040		N/A	Sand	Sand	Sand
Sulphate (Total)	M	2430	%	0.010	0.20	1.9	0.62
Organic Matter	M	2625	%	0.40	7.4	69	6.0

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

End of Report

Rogers Geotechnical Services Ltd
Office 1 & 2 Barncliffe Business Park,
Near Bank, Shelley, Huddersfield, HD8 8LU

Telephone 01484 607977
Company No: 5130864

Environmental
Geotechnical
Specialists

Appendix 6

Fill Screening Values

Rogers Geotechnical Services Ltd Telephone 0843 50 666 87 Fax 0843 51 599 30
Email enquiries@rogersgeotech.co.uk www.rogersgeotech.co.uk

Rogers Geotechnical Services Ltd.

Atkins ATRISK Soil Screening Values (SSVs) - Commercial Landuse

Tox Data Report No.	Compound	Commercial (mg/kg)				Reference
	Metals	1% SOM		6% SOM		
3	Cadmium	410		410		C
4	Chromium VI	19.7	49.1	19.7	49.1	B/C
	Copper	106000		106000		A+
7	Mercury	350.00		405.00		A/D
8	Nickel	1770		1770		A+
	Lead	2310		2310		C
	Zinc	1100000		1100000		A+
	Vanadium	7490		7490		A+
	Semi and Non Metals					
1	Arsenic	635		635		C
10	Selenium	13000		13000		A
	Free Cyanide	373		373		A
9	Phenols (total)	685		3170		A
	Poly Aromatic Hydrocarbons	Free product	No free produc	Free product	No free product	
20	Naphthalene	75	90.1	432	1050	A+
	Acenaphthene	156.8	83600	106000		A+
	Fluorene	66500		72000		A+
	Anthracene	535000		544000		A+
	Fluoranthene	72200		72600		A+
	Pyrene	54100		54400		A+
	Benzo(a)anthracene	1.71	131	10.3	142	A
2	Chrysene	0.44	14000	2.64	14300	A
2	Benzo(b)fluoranthene	1.22	142	7.29	144	A
2	Benzo(k)fluoranthene	0.686	1430	4.12	1440	A
2	Benzo(a)pyrene	26.1	76.3	26.2	76.3	B/C
2	Dibenz(a,h)anthracene	0.00393	14.3	0.0236	14.4	A*
2	Indeno(1,2,3-cd)pyrene	0.0614	142	0.368	144	A*
2	Benzo(g,h,i)perylene	0.0187	1440	0.112	1450	A*
	Petroleum Hydrocarbons					
	Aliphatic C5-C6	327	4490	1100	29400	A+
	Aliphatic C6-C8	157	10400	769	98200	A+
	Aliphatic C8-C10	82.4	1370	476	14800	A+
	Aliphatic C10-C12	49.9	7900	297	69500	A+
	Aliphatic C12-C16	20.9	34000	126	139000	A+
	Aliphatic C16-C21	3620000		3620000		A+
	Aliphatic C21-C35	3620000		3620000		A+
	Aromatic C5-C7 (Benzene)	12.5		98		A+
	Aromatic C7-C8 (Toluene)	834	27900	4360	183000	A+
	Aromatic C8-C10	613	2210	3600	20800	A+
	Aromatic C10-C12	369	12300	2190	53800	A+
	Aromatic C12-C16	155	41300	65400		A+
	Aromatic C16-C21	28400		28400		A+
	Aromatic C21-C35	28400		28400		A+
	Others					
	pH	-		-		-
	Organic Content (%)	-		-		-
	Soluble Sulphate (mg/l)	-		-		-
	Total Sulphate (%)	-		-		-
	Asbestos	-		-		-

A = WS ATKINS PLC, ATRISK SOIL SCREENING VALUES BASED ON 1% SOIL ORGANIC MATTER

A+ = Values updated June 2017.

A* Atrisk's SSV is lower than Chemtest's detectable limit for this compound.

B = health criterion values, which are available from toxicological reviews published in the C4SL project methodology report.

C = Category 4 Screening Levels (C4SLs) based on 1% soil organic matter.

D - Value provided is based on Methyl Mercury. Should elemental mercury be observed or a source be known then a limit of 7.95 should be used.