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GEOTECHNICAL ENVIRONMENTAL

PHASE 2 GEO-ENVIRONMENTAL REPORT

job number	date
C1913/21/E/2940	12/08/2021

site address
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Report on a Phase 2 Geo-environmental Investigation

Location:	Westfield Farm, Barnsley Road, Flockton, Wakefield, West Yorkshire, WF4 4DW
For:	Paul Brown
Consultants:	-
Report No.	C1913/21/E/2940
Report date:	August 2021

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

Charlotte Campion MGeoSci FGS
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Report Summary[1]

Item	Comments	Section
Development	Erection of a residential properties with associated gardens.	1.
Geology	Superficial geology – None recorded. Solid geology – Pennine Lower Coal Measures Formation and Birstall Rock.	5.
Strata Conditions	Up to 0.3m of made ground over generally granular weathered Birstall Rock strata.	6.
Groundwater	None encountered during investigation.	6.2
Foundation Design	Shallow strip or spread.	10.1
Effect of Sulphates	DC-1 concrete.	10.5
Contamination	PAH contamination revealed in made ground.	11.

[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 Westfield Farm, Flockton, WF4 4DW is to be developed by the construction of residential properties and associated gardens and driveways. 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

A Phase 1 Desk Study has been undertaken by Met Consultancy Group and the results were presented as report number P18-00854 in July 2018. This report has been used during the current intrusive investigation.

4. Fieldworks

The fieldworks were undertaken on the 9th July 2021 and included the following:

- Five windowless sample boreholes.
    - WS2, WS4, WS5, involved breaking/coring of surface concrete prior to commencing drilling.
- Standard penetration tests within one borehole.
- Five dynamic probes.

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

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4.1 Windowless Sample Boreholes

These boreholes were sunk using a drive-in windowless sampler. The cores were undertaken in 1m lengths and reduced in diameter from 90mm for the first 1m through 80mm and 70mm for subsequent 1m increments. The recovered cores were sealed and returned to the laboratory for logging and subsequent testing. The soils were described in general accordance with BS5930: 2015 +A1: 2020 and full descriptions are given on the windowless sample records which are presented in Appendix 2. Also included on these records are the core diameters and percentages of core recovered.

4.2 Standard Penetration Tests

Standard penetration tests (SPT) were undertaken within windowless sample borehole WS03. 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 cone or split barrel sampler assembly into the ground and the recovered barrel samples were retained in air tight plastic containers.

4.3 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 3.

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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	Pennine Lower Coal Measures Formation	Grey Measures of Yorkshire and Nottingham Lower Coal Measures Formation Lower Coal Measures	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.
	Birstall Rock	Cropper Gate Rock	The Birstall Rock is a fine-grained, thickly bedded, cross bedded sandstone with common pebbles of ironstone, coal sandstone and mudstone, and common streaks of shaly coal.

It should be appreciated that the majority of the site is recorded to be underlain by undifferentiated strata of the Pennine Lower Coal Measures Formation strata, with the outcrop of the Birstall Rock recorded to be limited to the very northern boundary of the site.

6. Strata Conditions

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

Table 2: Generalised Strata Profile

Depth m below ground level to underside of layer	Strata Type	Positions Encountered	Groundwater Strikes m below ground level
0.10 – 0.20	MADE GROUND (Concrete).	WS02, WS04 & WS05	None
0.10 – 0.30	MADE GROUND (Granular).	WS01, WS02 & WS03	None
0.50 – 0.70	Soft brown slightly gravelly silty CLAY.	WS01, WS02 & WS05	None
0.80 – 1.65	Medium dense orangish brown clayey silty very sandy GRAVEL.	WS02 to WS05	None
1.85	Stiff light and orangish brown slightly gravelly silty CLAY.	WS05	None
+1.85 – +3.0	Medium dense orangish brown slightly cobbly silty sandy GRAVEL.	WS01, WS02, WS04 & WS05	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.

[2] Sources: British Geological Survey (NERC) Map Sheet 77; Huddersfield; 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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6.1 General Strata

Hardstanding cover comprising concrete was encountered to a maximum depth of 0.2m in three boreholes. This was underlain by made ground in WS02 and by natural strata in WS04 and WS05.

The made ground encountered below the concrete to a depth of 0.3m comprised sandstone gravel. The made ground encountered from surface in boreholes WS01 and WS03 to a maximum depth of 0.2m comprised dark brown silty sand with gravel of ash, sandstone and rare concrete. It should be noted that potentially reworked natural clay was encountered to a depth of 0.5m in WS05.

The natural strata, considered representative of the weathered Birstall Rock, was encountered to the base of the boreholes and generally comprised brown silty clay with gravel of sandstone overlying orangish brown and light brown silty sandy sandstone gravel with cobbles of sandstone. It should be noted that in WS05 at depths between 1.65m and 1.85m a band of clay was encountered within the granular strata. With reference to section 5 above, the strata conditions would suggest that the site is predominantly underlain by the Birstall Rock, as opposed to undifferentiated strata (i.e. mudstone/siltstone) of the Pennine Lower Coal Measures Formation.

6.2 Groundwater

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

7. Insitu Testing

7.1 Standard Penetration Tests

The standard penetration test carried out in WS03 is 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	
Clayey silty sandy GRAVEL	0.10m to 1.45m	66	-	SPT's indicate granular material is in a very dense in-situ condition, likely represents rock quality strata present at base of borehole.

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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)[4]	Comments
	0 - 2	3 - 10	10+		
	Depth to which blow count range was observed (m)				
DP01	1.4	3.12	-	Abrupt	Generally low blow counts recorded to 1.4m followed by moderate blow counts to the base of the borehole and abrupt refusal at 3.12m.
DP02	1.0	2.4	2.575	Abrupt	Generally low blow counts to 1.0m followed by moderate blow counts to 2.4m depth and high blow counts and abrupt refusal at the base of the borehole at 2.575m.
DP03	0.1	0.9	1.58	Effective	Low results recorded to 0.1m, followed by moderate blow counts to 0.9m with high blow counts below and effective refusal recorded at 1.58m.
DP04	0.2	1.6	1.88	Effective	Low results recorded to 0.2m, followed by moderate blow counts to 1.6m with high blow counts below and effective refusal recorded at 1.88m.
DP05	0.7	1.0 2.15	1.8	Abrupt	Low results recorded to 0.7m, followed by moderate blow counts to 1.0m with high blow counts below to 1.8m. Moderate blow counts were then recorded again to 2.15m. Abrupt refusal recorded at 2.15m.

[4] Abrupt refusal: obstruction or bedrock encountered. Effective refusal: +25 blows/100mm.

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8. Laboratory Testing - Geotechnical

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

- Determination of water content — BS EN ISO 17892-1:2014
- Determination of liquid and plastic limits — BS EN ISO 17892-12:2018
- Linear Shrinkage — BS 1377: 1990: Pt2: 6.5
- Determination of particle size distribution (Wet) — BS EN ISO 17892-4:2016: 5.2
- Sedimentation by pipette — BS EN ISO 17892-4:2016: 5.3 – 5.4
- Soluble sulphate content — BS 1377: 1990: Pt3: 5
- pH value — BS 1377: 1990: Pt3: 9

The test results are presented in Appendix 4 and are summarised below:

Table 5: Summary of Geotechnical Test Results

Test type	Number of tests	Range of results		Comments
Water content determinations	1	18%		Dry of plastic limit.
Index properties (1 Point)	1	LL PL PI LS	40% 23% 17% 07%	Clay of intermediate plasticity. Consistency index 1.3% Liquidity index -0.3% NHBC Class - Low
Particle size distribution (Wet sieve and sedimentation)	1	Gravel Sand Silt Clay	55% 23% 17% 05%	Slightly clayey silty very sandy GRAVEL. Uniformity coefficient 670 Curvature coefficient 0.069
Soluble sulphate & pH	3	SO_4 pH	<0.010 to 0.098g/l 7.2 to 8.2	DS-1, AC1.

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 plasticity index[5] of 17% suggests an f_1 value of 6.1 and a f_2 value of 0.6.

[5] See paragraph 6.2 'Index Property Tests'

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8.1 Geotechnical Properties

The idealised geotechnical properties employed in design are summarised below.

Table 6: Summary of Geotechnical Properties

Property		Range of values	Comments
Volume change potential (NHBC)		Low	Silty gravelly CLAY
Shear strength parameters (at 1.7m)	c_u	91kN/m^2	Stroud (1974) where $c_u = f_1N$.
Consolidation characteristics	m_v	0.11m^2/MN	Stroud (1974) where $m_v = 1/f_2N$.
Concrete classification		DC1	Natural ground locations (Mobile water).

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 4 of this report.

10. Discussion of Ground Conditions - Geotechnical

It is understood that the site is to be developed by the construction of residential properties and associated gardens and driveways. 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, soft cohesive strata or shallow loose granular strata revealed at this site, as foundations placed in these soils may be subject to excessive total and or differential settlement under moderately light surface loading. In broad terms, therefore, it is considered that the foundations could be placed on shallow strip or spread foundations placed within the granular weathered Birstall Rock strata.

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10.1 Strip and Spread Foundations

In view of the above, foundations could be designed assuming an allowable increase in stress given in the following table:

Table 4: Allowable Bearing Pressure

Foundation type		Strip Footings			Spread Footings		
Foundation Breadth	B (m)	0.6	0.9	1.2	0.5	1.0	2.0
Allowable Bearing Pressure*	(kN/m^2)	80	120	135	85	170	170

The allowable increase in stress given above assumes settlements of less than 25mm, with a conservative SPT 'N' value of 12 at the foundation depths and provided that the underlying soils are carefully inspected immediately final trimming has taken place.

Should any very loose, cohesive or weak material be encountered they should be locally removed and replaced with lean-mix concrete or compacted granular soil. In addition, if the excavations are required to stand open for any period of time then a blinding layer of lean-mix concrete should be placed in the excavation bases. This expedient will reduce loosening of the sub-grade due to the ingress of surface water.

Prior to placement of concrete the foundation level should comprise of a suitably compacted granular layer of thickness no greater than 150mm. Site won extremely weathered sandstone recovered as gravel should be suitable for placement of foundations.

10.2 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.

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.

10.3 Ground-floors

In light of the made ground and soft near surface cohesive soils, which were revealed to depths of up to 0.7m, 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.

Based on the ground conditions identified, it is likely that any of the shallow cohesive soils will be removed during the site strip and construction. However, if any cohesive strata are present within

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sub-floor void then, due to the volume change potential at the site and if trees and shrubs are present, an allowance for soil volume change should be included. Further guidance is available in the NHBC standards, however, soil volume change can typically be catered for by providing a suitable void or utilize proprietary materials beneath the floor slab.

10.4 Hard-standing Areas

It is considered that any hard-standing at the site could be constructed employing traditional pavement design. A design California Bearing Ratio (CBR) of >1% could be employed in the pavement design[6]. However, it is recommended that proof rolling of the sub-grade be undertaken to establish the suitability of the soils, to expose any soft or weak ground and to ensure the sub-grade is well compacted prior to construction. Any areas of soft or weak ground should be remediated by increasing the sub-base thickness. Alternatively, weak material could be locally removed and replaced with a compacted granular capping layer. If construction were to be undertaken during the winter or after periods of prolonged rainfall, it may be prudent to employ a geotextile and/or a geogrid between the sub-base and sub-grade.

10.5 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[7], which is provided in BRE Special Digest 1, *Concrete in aggressive ground*: Part C. On the basis of this table and considering the soluble sulphate contents recorded, it can be shown that well compacted buried concrete should be designed in accordance with Class DS-1 requirements. Assuming mobile groundwater, the table also indicates that the aggressive chemical environment for concrete (ACEC) classification is AC-1.

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

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

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11. Discussion of Ground Conditions - Environmental

11.1 Discussion of Test Results

It is understood that the site is to be developed by the construction of residential properties and associated gardens and driveways. Consequently, the site may be classified as residential with plant uptake.

11.1.1 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 0.5% and 12%. On this basis, it is considered that the screening values associated with 1% SOM should be adopted. These values have been derived in such a way as to adhere to the principles within the revised CLEA model and include the most current release of the SGVs. A list of subscribers is provided within the website[9] and these include many local authorities.

A comparison of the results of the testing, together with the data given above, can be found within Appendix 4. These results indicate the following:

Table 8: Summary of Contaminated Areas

Location	Depth (m)	Contaminants found to be exceeding SSVs (Residential with plant uptake)
WS02	0.3 – 0.4	None identified.
WS03	0.0 – 0.1	PAHs (naphthalene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene).
WS03	0.5 – 0.6	None identified.
WS05	0.1 – 0.2	None identified.

Concentrations of chromium^{VI}, free cyanide, phenols (total) and total petroleum hydrocarbons (aliphatic C5 to C12; aromatic C5 to C12) were below the detection limits for the tests. Detectable levels of all other contaminants were recorded, but these mostly fell below the associated Atrisk Soil Screening Values. In addition, no asbestos was detected within the soil samples tested.

It should be appreciated that the soil screening values for PAHs and TPHs (where appropriate) represents vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure, which is unlikely to significantly affect the combined assessment criterion[10]. In view of this, the ATRISK soil SSVs notes that the users may wish to consider using a combined assessment criterion if free product is not observed, the values for which are also provided on the summary of contamination analysis. It is therefore considered that the criteria for no free product

[9] http://www.atrisksoil.co.uk/pages/general/subscribers.asp
[10] Ref: ATRISK soil, SSVs derived using CLEA v1.071 for 1% SOM, Residential with home grown produce land use, 23.06.17.

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should be adopted for the PAHs and TPHs at this site. The results of the contaminants found to exceed these screening values are tabulated below:

Table 9: Summary of Areas Contaminated by PAHs & TPHs

Location	Depth (m)	Contaminants found to be exceeding SSVs (Residential with Plant Uptake)
WS02	0.3 – 0.4	None.
WS03	0.0 – 0.1	PAHs (naphthalene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene.
WS03	0.5 – 0.6	None.
WS05	0.1 – 0.2	None.

On the basis of the above information, the results of the investigation have concluded that the site is generally uncontaminated.

However, PAH contamination has been identified in the made ground tested in WS03, but encountered elsewhere. It should be noted that no contamination was identified in the sample of natural strata below at 0.5m to 0.6m in WS03, suggesting contamination has not migrated to the underlying natural soils. Due to the levels of PAHs identified a double ratio PAH analysis was undertaken, this suggests the PAHs are derived from tyre oil.

11.2 Site Specific Risk Assessment

11.2.1 Approach

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

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

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11.2.2 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 10. Sources of contamination include the following:

On-site – Made Ground (PAH contamination).

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

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

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

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Table 10: Conceptual Site Model and Site Specific Risk Assessment [Contamination: PAHs]

Conceptual Site Model			Site Specific Risk Assessment	
Pathways	**Receptor**	**Linkage Present?**	**Risk Rating**	**Notes**
Direct contact/dermal absorption/soil ingestion	Operative	Yes – contamination found to be present at the site and contact with soil likely during works.	High	Contamination has been identified in the made ground underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways. However, as the site is anticipated to be secured during the development phase, contamination is not anticipated to affect neighbours.
	End User	Yes – contamination found to be present at the site and site to be developed into residential properties with gardens areas.	High	
	Neighbours	Yes – contamination found to be present at the site and a populated residential area surrounds the site.	Low	
Inhalation of Dust/Vapours	Operative	Yes – dust may be derived from contaminated soils. Dust may be produced from breaking out of hardstanding.	High	Some contamination is present underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways. Dust may be produced during breaking out of hardstanding. Suppression during prolonged dry periods may be required.
	End User	Yes – dust may be derived from contaminated soils.	High	
	Neighbours	Yes – contamination found to be present at the site and residential properties located within 250m radius of the site and possible inhalation of dust during the works. Dust may be produced from breaking out of hardstanding.	High	
Ingestion of fruit/vegetables and/or waters	Operative	No – no ed ble plants or contained water sources in the area of the proposed new works.	N/A	Some contamination is present underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways. However, the contamination at the site is considered to be of limited mobility, therefore the l kelihood of contamination affecting neighbouring gardens is considered low risk.
	End User	Yes – contamination found to be present at the site and site to be developed with residential properties and associated gardens.	Moderate	
	Neighbours	Yes – contamination found to be present at the site and residential area adjoins the site.	Low	
Migration of hazardous gases via permeable strata or shallow mining activity	Operative	It is recommended a ground gas assessment is undertaken as part of any further drilling works, to encompass all potential ground gas sources.	-	It is recommended a ground gas assessment is carried out following any further drilling to encompass all potential sources.
	End User		-	
	Neighbours		-	

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Spillage/loss/run off direct to receiving water	Controlled Waters	Yes – known controlled waters within 250m. However, the mobilisation of PAH contamination is only anticipated during periods of inclement weather, whereby dilution is anticipated.	Low	Some contamination is present underlying the site. Remediation will be required to either remove the contamination or break pathways. Old services to be removed or capped.
Migration via permeable unsaturated strata	Controlled Waters	Yes – a Secondary A Aquifer is present beneath the site. However, the mobilisation of PAH contamination is only anticipated during periods of inclement weather, whereby dilution is anticipated. In addition, the chemical analysis of the shallow natural strata has not identified any elevated contamination levels.	Moderate	
Run off via drainage/sewers etc	Controlled Waters	Yes – old services may be present on site. However, the mobilisation of PAH contamination is only anticipated during periods of inclement weather, whereby dilution is anticipated.	Low	
Direct contact with contaminated soils	Plants	Yes – contamination present at the site which may affect plants.	Moderate	Some contamination is present underlying the site. Remediation will be required to either remove the contamination or break pathways.
Uptake via root system			Moderate	
Direct contact with contaminated soils	Building Materials	Yes – PAH contamination revealed at the site may represent a significant risk to building materials or plastic water pipes. Moreover, testing indicates that the aggressive chemical environment for concrete classification is AC-1.	Moderate (plastic services)	Please see section 11.3.3 for information on good building practice.
Direct contact with contaminated groundwater			Low (buried concrete)	
Exposure to Radon	Operative	Yes – Site is in a radon affected area.	Low	1 – 3 % of properties in the area are above the radon action level. No radon protection measures are required.
	End User			
UXO Risk	Operative	No – Zetica UXO risk map suggests low risk.	Low	No further action required.
	End User		Low	

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11.3 Indicative Remediation Strategy

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

11.3.1 Remediation Objectives

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

- To protect the site operatives during the construction process from the ingestion of soil or dust, dermal contact with the soil and inhalation of dust.
- To protect the end user from the ingestion of soil or dust, dermal contact with the soil and inhalation of dust.
- To protect neighbours from the inhalation and ingestion dust during the construction process.
- To protect operatives, end users and neighbours from the ingestion of contaminated fruit and vegetables.
- To protect plants from direct contact with contamination and prevent uptake via root system.
- To ensure that contamination cannot reach controlled waters via surface run-off or permeable strata.
- To ensure that contamination cannot enter the former services occupying the site which may return to controlled waters.
- To protect plastic services from being penetrated by, or degrading due to the presence of, contamination in the soil or groundwaters.

11.3.2 Development Requirements

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

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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 Health and Safety Plan and site specific Method Statements. These documents should include the following main elements.

- Site operatives at all levels should be made aware of the hazards of working with contaminated soils.
- 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 to ensure appropriate disposal. The classification of waste is purely to the discretion of the chosen waste contractor.
- Any stockpiles of contaminated soil on site should be sheeted over to prevent excessive amounts of airborne dust and cross contamination of imported fill.
- Where vehicles are transferring soil to the landfill site they should be covered to prevent contamination of the surrounding area by dust.
- Where work is undertaken in wet weather, vehicle and wheel washing facilities are required to ensure that the vehicles leaving the site do not transfer contamination to surrounding areas.
- Asbestos has been identified on farm buildings on site, a 'waching brief' should be employed during site works for any potentially Asbestos Containing Materials (ACMs). If ACMs are suspected work should cease until testing can be undertaken.

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

Construction

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

- Beneath buildings, pavements and hard-standings clean inert granular sub-base should be employed.

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

Landscaped Areas

It is understood that there is proposed to include garden areas, which may include trees and shrubs. In view of this and the potential contamination on site, it is considered that landscaped areas will require some remediation. This could include the provision of a clean cover system including a capping layer of say 500mm of inert material, which will put the contaminated ground out of the end users' dig range, this should include a 150mm thick capping of topsoil to act as a suitable growing medium. At the base of this layer, a granular capillary break of say 100mm of free draining granular soil should be placed in order to prevent mobile contamination rising upward. This expedient should also provide a suitable root barrier to isolate the plants from the underlying contaminated ground.

11.4 Fill Materials

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

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

- It is a suitable growing media if it is to be employed as such, including compliance with BS3882 (2015)
- It is free from obvious contamination i.e. visual or olfactory evidence
- It has not come from areas where Japanese Knotweed or other invasive or injurious plants are suspected to be growing
- It is not a statutory nuisance, such as being odorous
- It is free from unsuitable, deleterious, or frost susceptible 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[14] documentation and may be used as a

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

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

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

Table 12: Fill Screening Values

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

Please see summary sheet within Appendix 5 for full screening values including PAHs & TPHs.

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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.

11.5 Verification Report

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

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

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

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

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12. 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.
- Investigation and assessment of underground workings relating to coal mining.
- Ground gas monitoring and risk assessment.
- Discussions with ground work contractors in relation to the requirement for testing of materials to be disposed off-site (Waste Acceptance Criteria) and the suitability of imported materials.
- Discussions with service providers regarding suitable materials for pipe work given the nature of chemical determinands found within the soils on site.
- Produce a validation report to demonstrate that the geo-environmental risks discussed in this report have been mitigated.
- Detailed design of the sub-structure.

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

13. References

- British Geological Survey (NERC) (2021), BGS, Keyworth.
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  - Lexicon of Named Rock Units:
  - (*http://www.bgs.ac.uk/lexicon/)*

- British Standards Institution (1990) BS1377: *British standard methods of test for soils for civil engineering purposes,* B.S.I., London.

- British Standard Institution (2005 +A1: 2011) BS EN ISO 22476-2: *Geotechnical investigation and testing – Field testing, Part 2: Dynamic Probing,* B.S.I., London.

- British Standard Institution (2005 +A1: 2011) BS EN ISO 22476-3: *Geotechnical investigation and testing – Field testing, Part 3: Standard penetration test,* B.S.I., London.

- British Standards Institution (2015 +A1: 2020) BS 5930: *Code of practice for ground investigations,* B.S.I., London.

- British Standards Institution (2011), BS 10175: *Investigation of potentially contaminated sites – Code of Practice,* British Standards Institute.

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- Building Research Establishment (BRE) Special Digest 1 (2005), Third Edition: Concrete in aggressive ground, BRE Press, Garston.
    - Part C: *Assessing the aggressive chemical environment.*
    - Part D: *Specifying concrete for general cast-in-situ use.*

- Department for Environment, Food and Rural Affairs and the Environment Agency (2009) DEFRA Science Report – Final SC050021/SR2, *Human Health toxicological assessment of contaminants in soil*. Environment Agency, Bristol.

- Department for Environment, Food and Rural Affairs and the Environment Agency (2009) DEFRA Science Report – SC050021/SR3, *Updated technical background to the CLEA model*. Environment Agency, Bristol.

- Department for Environment, Food and Rural Affairs (2014) SP1010: *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document*.

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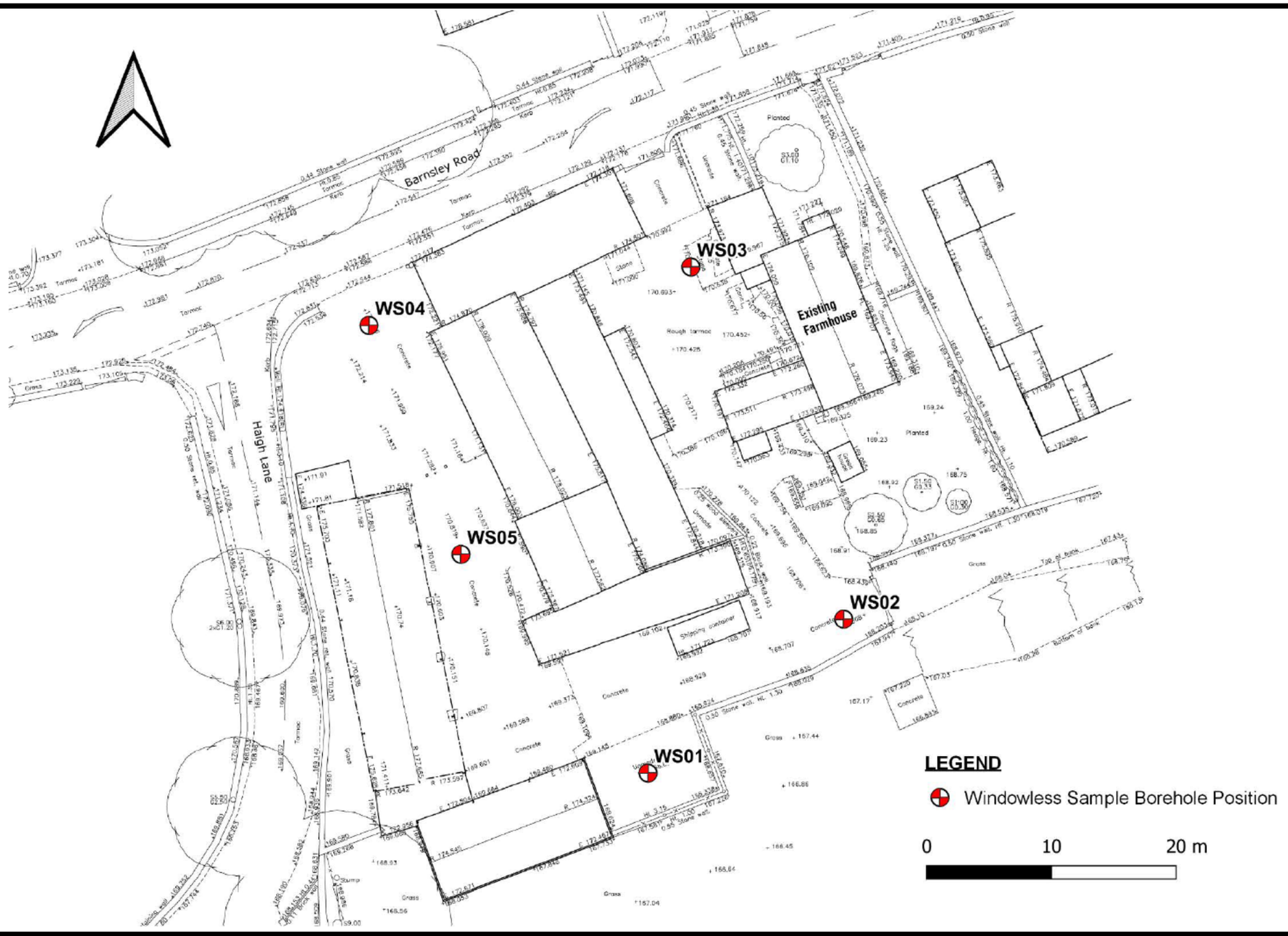
Appendix 1

Site Plan



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

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Scale: Not to scale – reference only

Client:
Paul Brown

Job Number:
C1913/21/E2940

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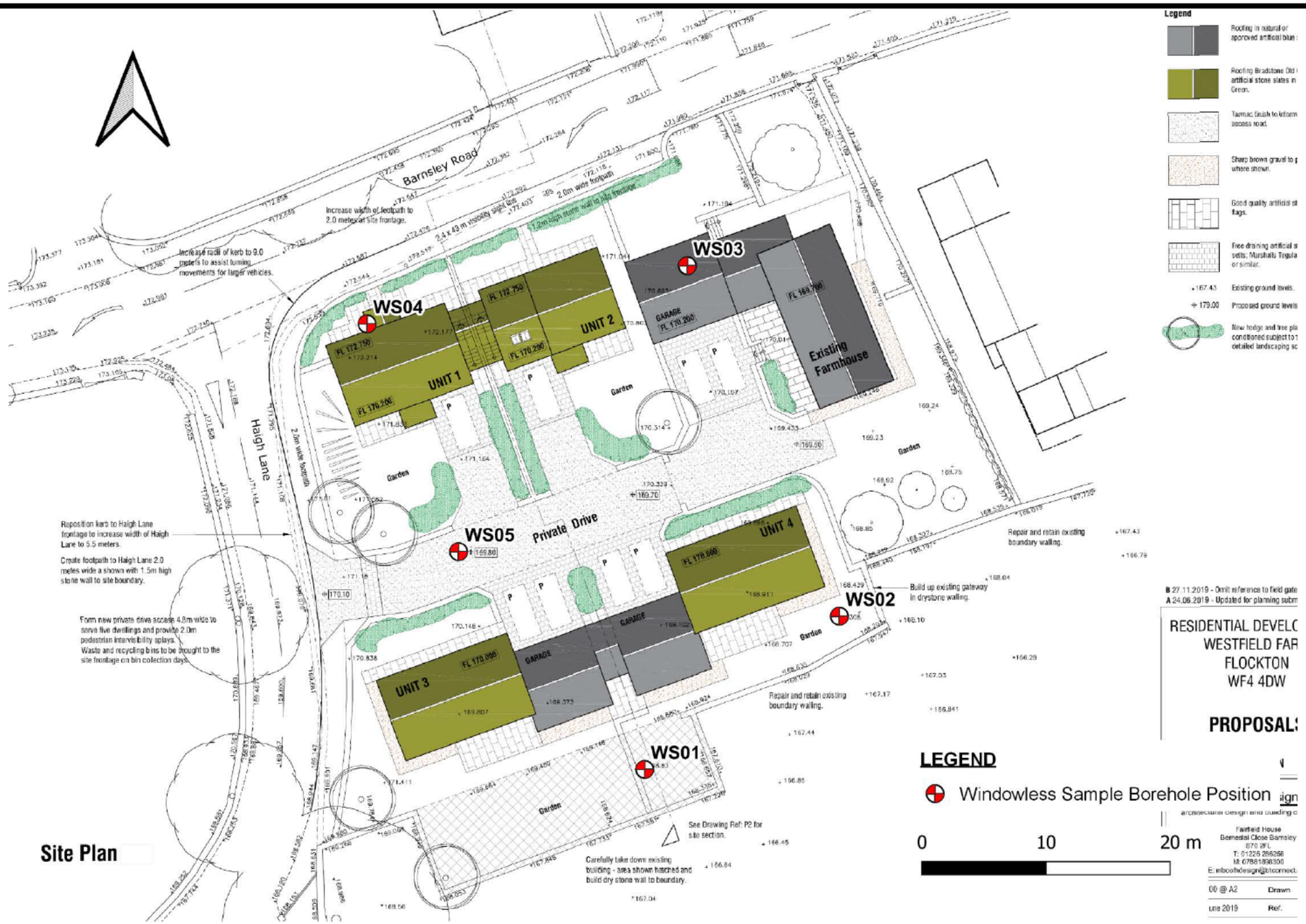
Project Details:
Westfield Farm, Flockton

Scale: Not to scale – reference only



Site Plan

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

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laboratory testing & gas monitoring | engineering consultancy
surveying & flood risk assessments | training, CPD & expert witness
... delivered using our own drilling rigs / crews / soils lab / engineers

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Investigation positions approximated from site operative's notes.

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Appendix 2

Borehole Records

Borehole Log

Borehole No. **WS01**

Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type WLS
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
				87	65		0.20			MADE GROUND (Dark brown silty gravelly fine to coarse SAND. Gravel is sub-angular fine and medium of ash, sandstone and rare concrete).
							0.55			Soft brown slightly gravelly silty CLAY. Gravel is sub-angular fine and medium of sandstone.
				77	70					Loose becoming medium dense orangish brown and light brown slightly cobbly silty very sandy sub-angular fine to coarse GRAVEL of sandstone. Cobbles are of sandstone.
										1.3m: Becoming medium dense.
				67	75		3.00			End of Borehole at 3.00m

Remarks

No groundwater encountered.

Borehole Log

Borehole No. **WS02**

Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type WLS
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.15			MADE GROUND (Concrete).
		0.30 - 0.40	ES	87	80		0.30			MADE GROUND (Sandstone cobbles).
							0.70			Soft brown slightly gravelly silty CLAY. Gravel is sub-angular fine and medium of sandstone.
				77	75		1.50			Medium dense orangish brown clayey silty very sandy sub-angular fine to coarse GRAVEL of sandstone.
				67	100		2.50			Medium dense orangish brown slightly cobbly silty very sandy sub-angular fine to coarse GRAVEL of sandstone. Cobbles are of sandstone.
										End of Borehole at 2.50m

Remarks

Concrete encountered at surface broken out utilising hydraulic breaker prior to drilling. No groundwater encountered.

Borehole Log

Borehole No. **WS03**

Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type WLS
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.10	ES				0.10			MADE GROUND (Dark brown silty gravelly fine to coarse SAND. Gravel is sub-angular fine and medium of ash, sandstone and rare concrete).
		0.50 - 0.60	ES	87	95					Medium dense orangish brown clayey silty very sandy sub-angular fine to coarse GRAVEL of sandstone.
		1.00	SPT			N=66 (5,9/13,14,19,20)				
							1.45			End of Borehole at 1.45m

Remarks

No groundwater encountered.

Borehole Log

Borehole No. **WS04**

Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type WLS
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.20			MADE GROUND (Concrete).
				87	95		0.80			Medium dense orangish brown clayey silty very sandy sub-angular fine to coarse GRAVEL of sandstone.
				67	100		1.85			Medium dense orangish brown slightly cobbly silty very sandy sub-angular fine to coarse GRAVEL of sandstone. Cobbles are of sandstone. *1.7m: Becomes thinly laminated.* End of Borehole at 1.85m

Remarks

Concrete encountered at surface broken out utilising hydraulic breaker prior to drilling. No groundwater encountered.

Borehole Log

Borehole No. **WS05**

Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type WLS
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.10 - 0.20	ES				0.10			MADE GROUND (Concrete).
		0.60 - 0.80	D	87	90		0.50			Soft brown slightly gravelly silty CLAY. Gravel is sub-angular fine and medium of sandstone (Possibly reworked).
										Medium dense orangish brown clayey silty very sandy sub-angular fine to coarse GRAVEL of sandstone.
		1.70	D	67	100		1.65			Stiff light and orangish brown slightly gravelly silty CLAY. Gravel is sub-angular fine sandstone.
							1.85			Medium dense orangish brown slightly cobbly silty very sandy sub-angular fine to coarse GRAVEL of sandstone. Cobbles are of sandstone.
							2.00			End of Borehole at 2.00m

Remarks

Concrete encountered at surface broken out utilising hydraulic breaker prior to drilling. No groundwater encountered.

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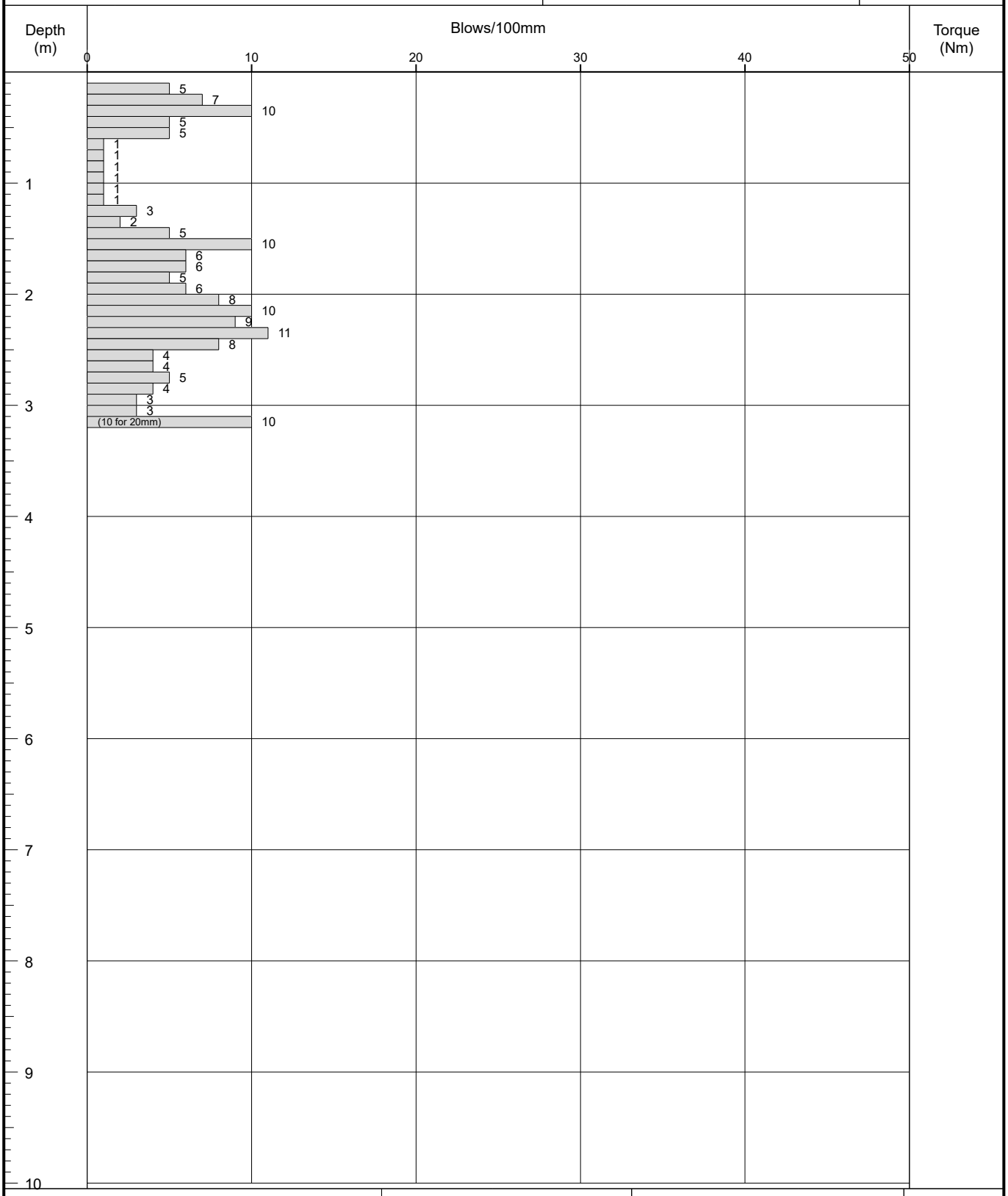
Appendix 3

Dynamic Probing Records

Probe Log

Probe No.
DP01
Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type DCP
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By AB



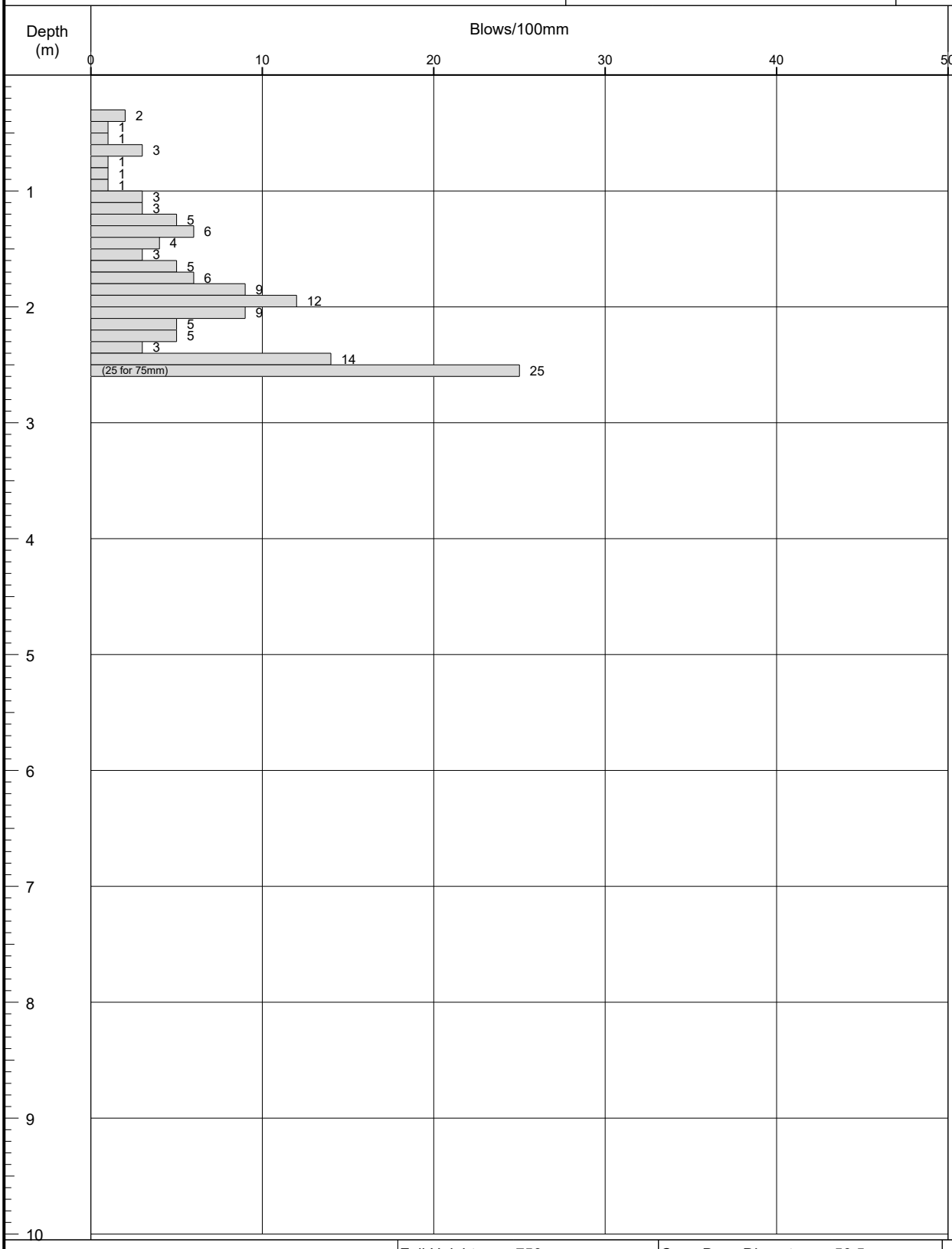
Remarks:
Abrupt refusal.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	3.12m
Probe Type	DPSH-B		

Probe Log

Probe No.
DP02
Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type DCP
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By AB



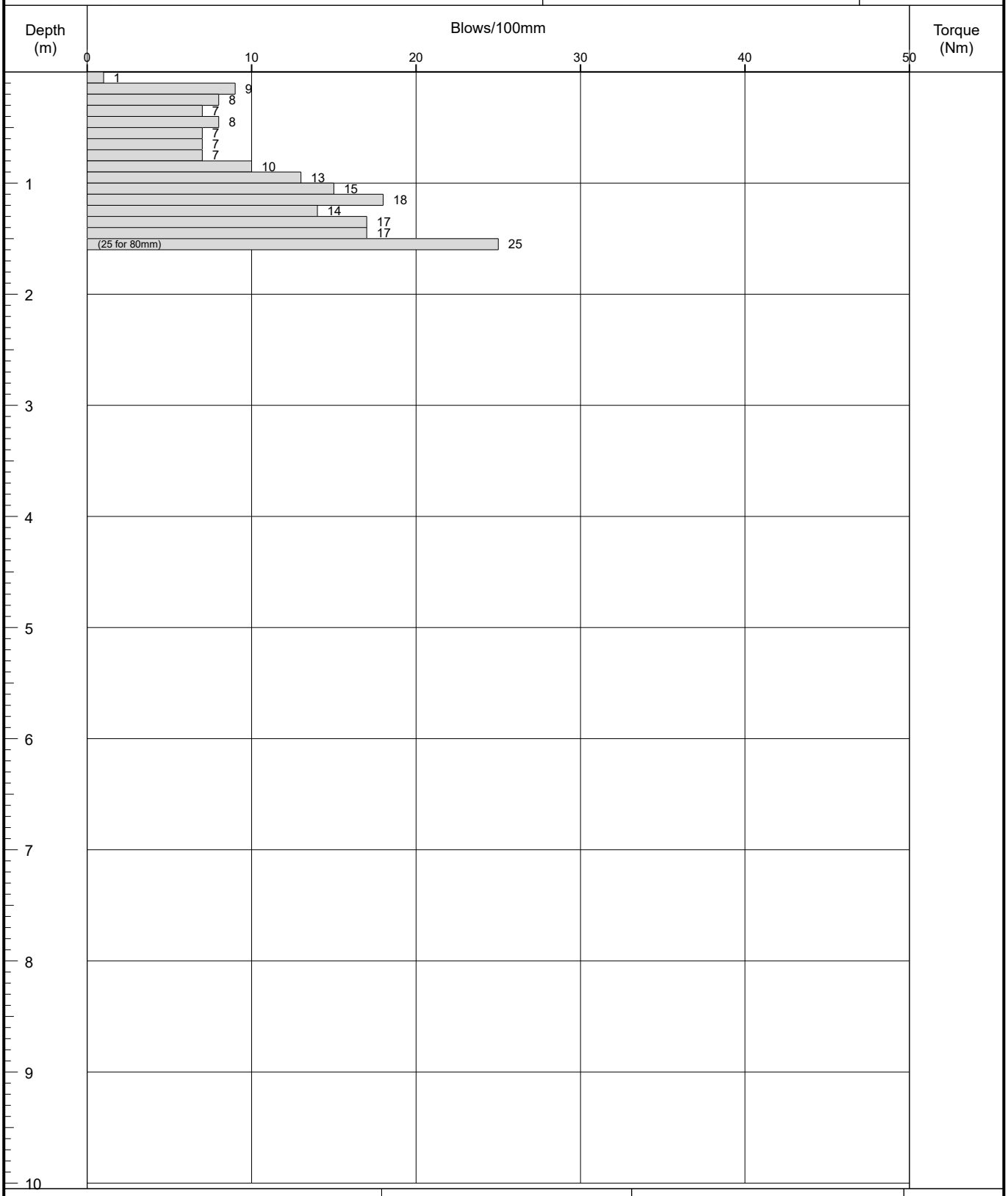
Remarks:
Effective refusal.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	2.575m
Probe Type	DPSH-B		

Probe Log

Probe No.
DP03
Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type DCP
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By AB



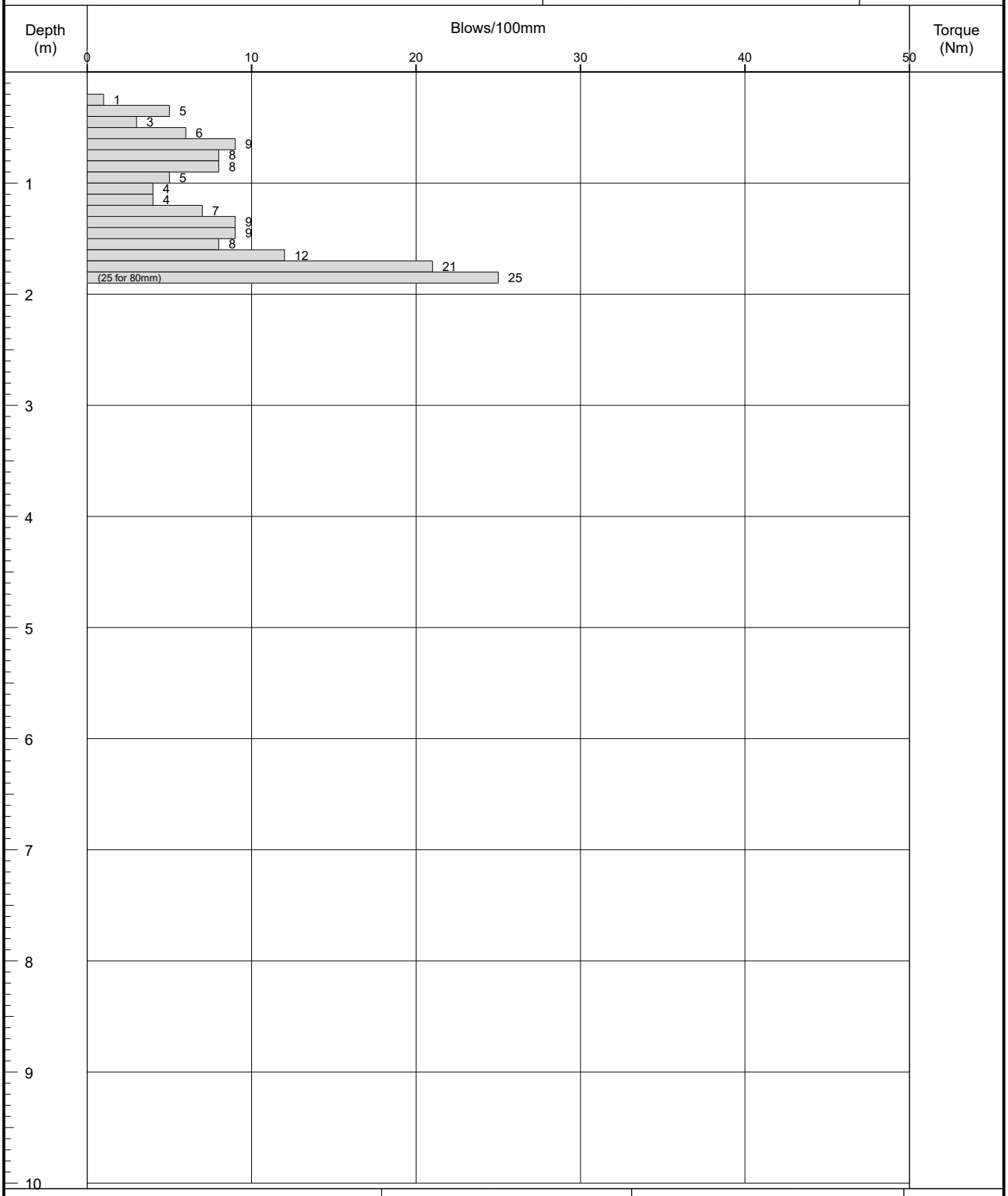
Remarks:
Effective refusal.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	1.58m
Probe Type	DPSH-B		

Probe Log

Probe No.
DP04
Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type DCP
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By AB



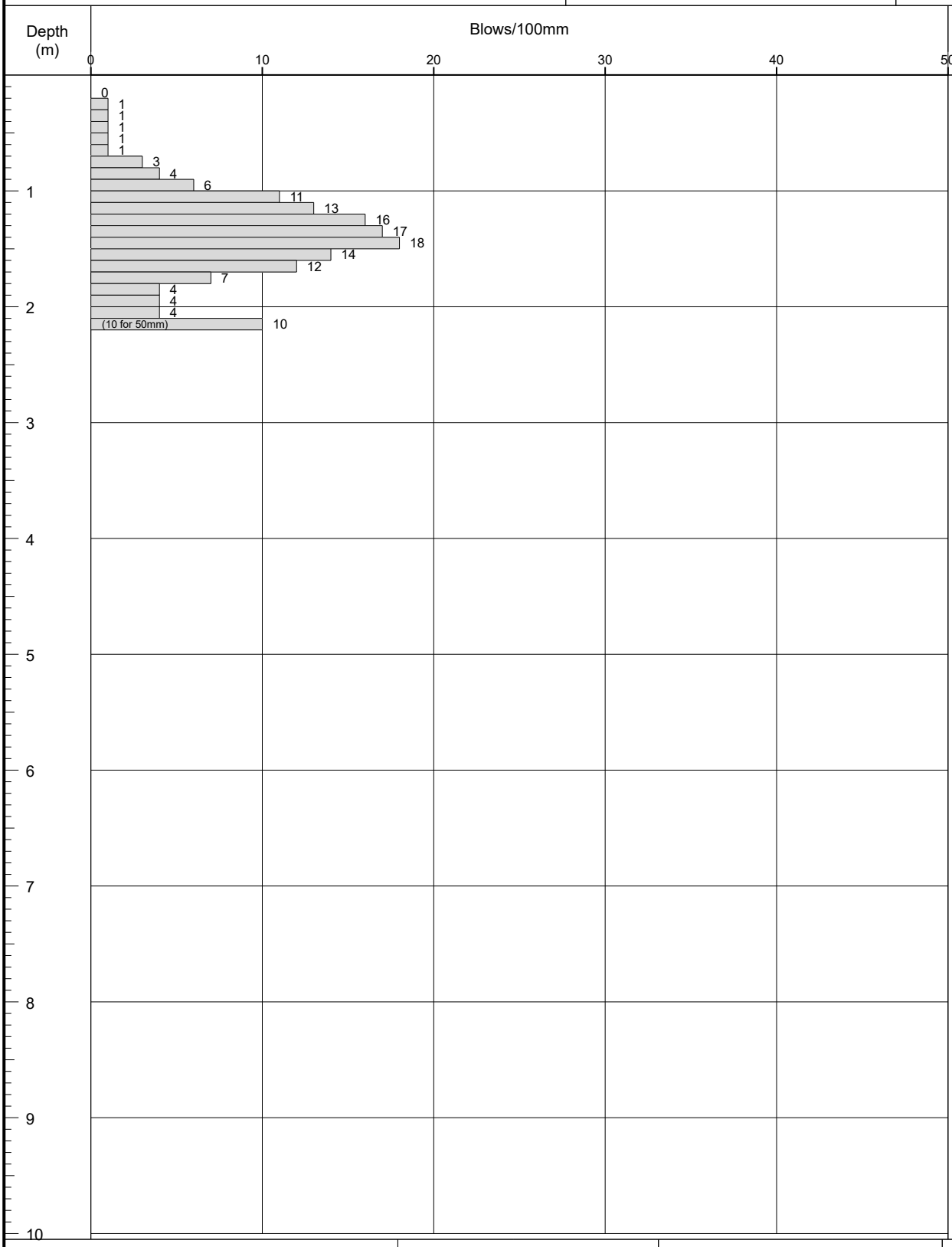
Remarks:
Effective refusal.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	1.88m
Probe Type	DPSH-B		

Probe Log

Probe No.
DP05
Sheet 1 of 1

Project Name: Westfield Farm	Project No. C1913/21/E/2940	Co-ords:	Hole Type DCP
Location: Flockton		Level:	Scale 1:50
Client: Paul Brown		Dates: 09/07/2021	Logged By AB



Remarks:
Abrupt refusal.

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	2.15m
Probe Type	DPSH-B		

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Appendix 4

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 C/1913/21/E/2940	client ref
site address Westfield Farm, Barnsley Road, Flockton, Wakefield, West Yorkshire, WF4 4DW	client address Paul Brown 9 Rock Road, Birchencliffe, Huddersfield, West Yorkshire, HD3 3BU
consultant	
date scheduled 15/07/2021	date issued 02/08/2021
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

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

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Fax 0843 51 599 30
Company No: 5130864

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Near Bank, Shelley, Huddersfield, HD8 8LU

Telephone 01484 607977
Company No: 5130864

Summary of Classification Test Results

Project No.	Project Name
C1913/21/E/2940	Westfield Farm

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												
WS05	2	1.70		D	Light brown and orangish brown slightly gravelly silty CLAY.			18.0	96	40 -1pt	23	17		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	21/07/2021		
wd - water displacement	cas - Casagrande method	gj - gas jar			sheet 1
wi - immersion in water	1pt - single point test			Harry	

Linear Shrinkage - Summary of Results

Project No.	Project Name
C1913/21/E/2940	Westfield Farm

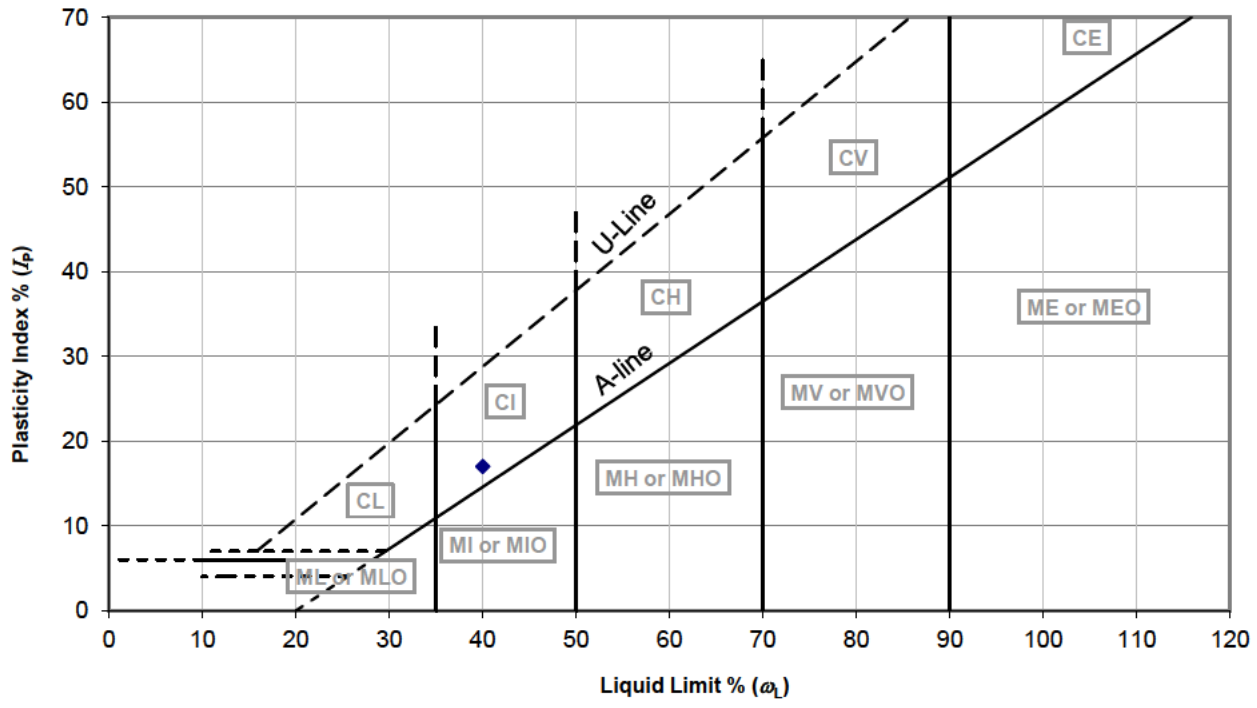
Hole No.	Sample				Soil Description	Material <425µm %	Preparation	Linear Shrinkage %	Date Tested
	Ref	Top	Base	Type					
WS05	2	1.70		D	Light brown and orangish brown slightly gravelly silty CLAY.	96	Specimen prepared from natural material	7	19/07/2021

Remarks:

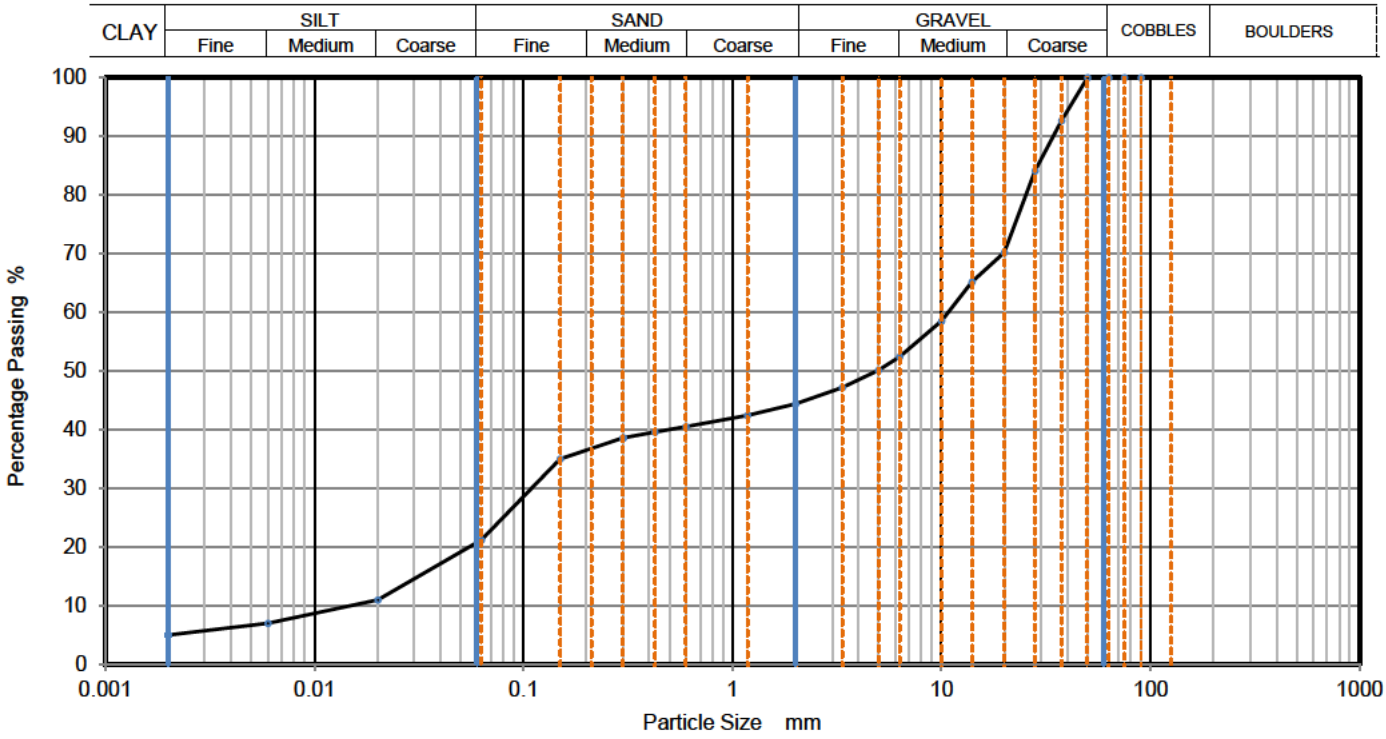
Notes	Date Printed	Approved By	Table
Tests performed in accordance with BS 1377 : Part 2 : 1990, clause 6.5 unless annotated otherwise	21/07/2021	Harry	2
			Sheet 1

Rogers Geotechnical Services Ltd. Offices 1&2, Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU	**Classification of Index Properties**	**C1913/21/E/2940**
Project Name: Westfield Farm	**BS EN ISO: 17892: Parts 1, 12**	Fig. 3 Sheet. 1
Location:		Input By: Harry
Client: Paul Brown		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 (%)
WS05	1.70	18	40	23	17	4	19	16	-0.3	1.3	C I	LOW



	PARTICLE SIZE DISTRIBUTION				Job Ref	C1913/21/E/2940
					Borehole/Pit No.	WS05
Site Name	Westfield Farm				Sample No.	1
Soil Description	Brown clayey, silty, very sandy, GRAVEL.				Depth, m	0.60
Specimen Reference	0.6	Specimen Depth	D1	m	Sample Type	D
Test Method	ISO 17892 -4, by sieving and pipette sedimentation				KeyLAB ID	RGS_202107161



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
	100	0.0201	11
90	100	0.0060	7
75	100	0.0020	5
63	100		
50	100		
37.5	93		
28	84		
20	70		
14	65		
10	59		
6.3	52		
5	50		
3.35	47		
2	44		
1.18	42		
0.6	41	Particle density (assumed)	
0.425	40	2.65	Mg/m3
0.3	39		
0.15	35		
0.063	21		

Dry Mass of sample, g: 2177

Sample Proportions	% dry mass
Very coarse	0
Gravel	55
Sand	23
Silt	17
Clay	5

Grading Analysis		
D100	mm	50
D60	mm	10.8
D30	mm	0.109
D10	mm	0.0161
Uniformity Coefficient		670
Curvature Coefficient		0.069

Remarks

Preparation and testing in accordance with BS EN ISO 17892 - 4, unless noted below

Operator	Checked	Approved	Sheet printed	Fig 4
Tobias	Harry	Harry	21/07/2021	Sheet 1

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Company No: 5130864

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

Final Report

Report No.:	21-24459-1
Initial Date of Issue:	30-Jul-2021
Client	Rogers Geotechnical Services Ltd
Client Address:	Offices 1&2, Barncliffe Business Park Near Bank Shelley Huddersfield West Yorkshire HD8 8LU
Contact(s):	Harry Letch
Project	C1913/21/E/2940 Westfield Farm, Flockton

Quotation No.:		**Date Received:**	16-Jul-2021
Order No.:	PO-1684	**Date Instructed:**	16-Jul-2021
No. of Samples:	4		
Turnaround (Wkdays):	11	**Results Due:**	30-Jul-2021
Date Approved:	30-Jul-2021		
Approved By:			

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: C1913/21/E/2940 Westfield Farm, Flockton

Client: Rogers Geotechnical Services Ltd		**Chemtest Job No.:**			21-24459	21-24459	21-24459	21-24459
Quotation No.:		**Chemtest Sample ID.:**			1241697	1241698	1241699	1241700
Order No.: PO-1684		Client Sample Ref.:			D	D	D	D
		Sample Location:			WS02	WS03	WS03	WS05
		Sample Type:			SOIL	SOIL	SOIL	SOIL
		Top Depth (m):			0.3	0	0.5	0.1
		Bottom Depth (m):			0.4	0.1	0.6	0.2
		Date Sampled:			14-Jul-2021	14-Jul-2021	14-Jul-2021	14-Jul-2021
		Asbestos Lab:			COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Cadmium	M	2450	mg/kg	0.10	< 0.10	0.24	< 0.10	< 0.10
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50
Copper	M	2450	mg/kg	0.50	9.7	12	14	7.0
Mercury	M	2450	mg/kg	0.10	< 0.10	0.44	< 0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	12	23	16	1.7
Lead	M	2450	mg/kg	0.50	8.5	32	11	13
Zinc	M	2450	mg/kg	0.50	35	27	32	24
Vanadium	U	2450	mg/kg	5.0	< 5.0	62	19	< 5.0
Arsenic	M	2450	mg/kg	1.0	2.3	2.8	8.9	1.9
Selenium	M	2450	mg/kg	0.20	0.21	< 0.20	0.38	< 0.20
Cyanide (Free)	M	2300	mg/kg	0.50	< 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	1.9	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10	2.3	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	< 0.10	0.75	< 0.10	< 0.10
Fluorene	M	2700	mg/kg	0.10	< 0.10	0.95	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	< 0.10	5.9	< 0.10	< 0.10
Anthracene	M	2700	mg/kg	0.10	< 0.10	4.8	< 0.10	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	< 0.10	27	0.87	< 0.10
Pyrene	M	2700	mg/kg	0.10	< 0.10	30	1.0	< 0.10
Benzo[a]anthracene	M	2700	mg/kg	0.10	< 0.10	20	< 0.10	< 0.10
Chrysene	M	2700	mg/kg	0.10	< 0.10	22	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	< 0.10	28	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	< 0.10	14	< 0.10	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.10	< 0.10	38	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	< 0.10	28	< 0.10	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	< 0.10	8.7	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	< 0.10	33	< 0.10	< 0.10
Total Of 16 PAH's	M	2700	mg/kg	2.0	< 2.0	270	< 2.0	< 2.0
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	< 1.0		< 1.0	< 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0		< 1.0	< 1.0

Results - Soil

Project: C1913/21/E/2940 Westfield Farm, Flockton

Client: Rogers Geotechnical Services Ltd		**Chemtest Job No.:**			21-24459	21-24459	21-24459	21-24459
Quotation No.:		**Chemtest Sample ID.:**			1241697	1241698	1241699	1241700
Order No.: PO-1684		Client Sample Ref.:			D	D	D	D
		Sample Location:			WS02	WS03	WS03	WS05
		Sample Type:			SOIL	SOIL	SOIL	SOIL
		Top Depth (m):			0.3	0	0.5	0.1
		Bottom Depth (m):			0.4	0.1	0.6	0.2
		Date Sampled:			14-Jul-2021	14-Jul-2021	14-Jul-2021	14-Jul-2021
		Asbestos Lab:			COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0		< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0		< 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	< 1.0		< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0		< 1.0	< 1.0
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0		< 1.0	< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0		< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0		< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10		< 10	< 10
pH	M	2010		4.0	8.2		7.2	8.0
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.041		0.098	< 0.010
ACM Type	U	2192		N/A	-	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	8.6	7.2	15	17
Soil Colour	N	2040		N/A	Brown	Brown	Brown	Brown
Other Material	N	2040		N/A	Stones	Stones	Stones	Stones
Soil Texture	N	2040		N/A	Sand	Sand	Sand	Clay
Sulphate (Total)	M	2430	%	0.010	0.21		0.27	0.017
Chromium	M	2450	mg/kg	1.0		330		
Organic Matter	M	2625	%	0.40	0.48	12	0.52	1.7

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	Al kaline 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

Rogers Geotechnical Services: Soil Screening Values Comparison Sheet

The Ground Investigation Specialists

Rogers Geotechnical Services Ltd		Soil Screening Value (SSV) Comparison Sheet
Job Number	C1913/21/E/2940	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
Job Name	Westfield Farm, Flockton	
Date	10/08/2021	
Client	Paul Brown	

KEY

- Exceeds SSV
- Exceeds 2017, Below 2015
- Below limit of detection (LOD)

Determinand	Units	Ref	LOD	Residential With Plant Uptake 1%		Sample Location	WS02	WS03	WS03	WS05		
				Atrisk 2015 (No Free Product	Atrisk 2017	Depth Top	0.3	0	0.5	0.1		
						Depth Base	0.4	0.1	0.6	0.2		
Cadmium	mg/kg	C	0.10		22.1		< 0.10	0.24	< 0.10	< 0.10		
Chromium (Hexavalent)	mg/kg	B/C	0.5	20.5	3.62		< 0.50	< 0.50	< 0.50	< 0.50		
Copper	mg/kg	A+	0.50		4730		10	12.0	14	7		
Mercury	mg/kg	A/D	0.10		8.81		< 0.10	0.44	< 0.10	< 0.10		
Nickel	mg/kg	A+	0.50		136		12	23.0	16	1.7		
Lead	mg/kg	C	0.50		200		9	32	11	13		
Zinc	mg/kg	A+	0.50		20000		35	27	32	24		
Vanadium	mg/kg	A+	5.0		136		< 5.0	62.0	19	< 5.0		
Arsenic	mg/kg	C	1.0		37		2	3	9	1.9		
Selenium	mg/kg	A	0.20		375		0.21	< 0.20	0.4	< 0.20		
Cyanide (Free)	mg/kg	A	0.50		34		< 0.50	< 0.50	< 0.50	< 0.50		
Total Phenols	mg/kg	A	0.1		267		< 0.10		< 0.10	< 0.10		
Naphthalene	mg/kg	A+	0.10	0	0.829		< 0.10	1.9	< 0.10	< 0.10		
Acenaphthylene	mg/kg		0.10				< 0.10	2.3	< 0.10	< 0.10		
Acenaphthene	mg/kg	A+	0.10	608	157		< 0.10	0.75	< 0.10	< 0.10		
Fluorene	mg/kg	A+	0.10	0	735		< 0.10	0.95	< 0.10	< 0.10		
Phenanthrene	mg/kg		0.10				< 0.10	5.9	< 0.10	< 0.10		
Anthracene	mg/kg	A+	0.10	0	10200		< 0.10	4.8	< 0.10	< 0.10		
Fluoranthene	mg/kg	A+	0.10		983		< 0.10	27	0.87	< 0.10		
Pyrene	mg/kg	A+	0.10		668		< 0.10	30	1	< 0.10		
Benzo[a]anthracene	mg/kg	A	0.10	4.52	1.71		< 0.10	20	< 0.10	< 0.10		
Chrysene	mg/kg	A	0.10	585	0.44		< 0.10	22	< 0.10	< 0.10		
Benzo[b]fluoranthene	mg/kg	A	0.10	7.72	1.22		< 0.10	28	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/kg	A	0.10	84.4	0.686		< 0.10	14	< 0.10	< 0.10		
Benzo[a]pyrene	mg/kg	B/C	0.10	4.95	1.51		< 0.10	38	< 0.10	< 0.10		
Indeno(1,2,3-c,d)Pyrene	mg/kg	A*	0.10	7.31	0.0614		< 0.10	28	< 0.10	< 0.10		
D benz(a,h)Anthracene	mg/kg	A	0.10	0.838	0.00393		< 0.10	8.7	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/kg	A	0.10	96.2	0.0187		< 0.10	33	< 0.10	< 0.10		
Total Of 16 PAH's	mg/kg		2.0				< 2.0	270	< 2.0	< 2.0		
Aliphatic TPH >C5-C6	mg/kg	A+	1.0	0	42.7		< 1.0		< 1.0	< 1.0		

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Job Name	Westfield Farm, Flockton	KEY Exceeds SSV Exceeds 2017, Below 2015 Below limit of detection (LOD)
Date	10/08/2021	
Client	Paul Brown	

Determinand	Units	Ref	LOD	Residential With Plant Uptake 1%		Sample Location	WS02	WS03	WS03	WS05		
						Depth Top	0.3	0	0.5	0.1		
						Depth Base	0.4	0.1	0.6	0.2		
Aliphatic TPH >C6-C8	mg/kg	A+	1.0	0	99.3		< 1.0		< 1.0	< 1.0		
Aliphatic TPH >C8-C10	mg/kg	A+	1.0	0	13.9		< 1.0		< 1.0	< 1.0		
Aliphatic TPH >C10-C12	mg/kg	A+	1.0	81.7	49.9		< 1.0		< 1.0	< 1.0		
Aliphatic TPH >C12-C16	mg/kg	A+	1.0	385	20.9		< 1.0		< 1.0	< 1.0		
Aliphatic TPH >C16-C21	mg/kg	A+	1.0		210000		< 1.0		< 1.0	< 1.0		
Aliphatic TPH >C21-C35	mg/kg	A+	1.0		210000		< 1.0		< 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				< 5.0		< 5.0	< 5.0		
Aromatic TPH >C5-C7	mg/kg	A+	1.0		0.137		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C7-C8	mg/kg	A+	1.0	0	113		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C8-C10	mg/kg	A+	1.0	0	20.5		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C10-C12	mg/kg	A+	1.0	0	70		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C12-C16	mg/kg	A+	1.0	165	155		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C16-C21	mg/kg	A+	1.0		319		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C21-C35	mg/kg	A+	1.0		1120		< 1.0		< 1.0	< 1.0		
Aromatic TPH >C35-C44	mg/kg		1.0				< 1.0		< 1.0	< 1.0		
Total Aromatic Hydrocarbons	mg/kg		5.0				< 5.0		< 5.0	< 5.0		
Total Petroleum Hydrocarbons	mg/kg		10.0				< 10		< 10	< 10		
pH			N/A				**8.2**		**7.2**	8		
Sulphate (2:1 Water Soluble) as SO4	g/l		0.010				**0.04**		**0.098**	< 0.010		
ACM Type			N/A									
Asbestos Identification	%		0.001				No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		
ACM Detection Stage			N/A									
Moisture	%		0.020				8.6	7.2	15	17		
Soil Colour			N/A				Brown	Brown	Brown	Brown		
Other Material			N/A				Stones	Stones	Stones	Stones		
Soil Texture			N/A				Sand	Sand	Sand	Clay		
Sulphate (Total)	%		0.010				0.21		0.270	0.017		
Organic Matter	%		0.40				**0.5**	**12.0**	0.5	1.7		

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Appendix 5

Fill Screening Values

Rogers Geotechnical Services Ltd.

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

Tox Data Report No.	Compound	Residential with Homegrown Produce Landuse (mg/kg)				Reference
	Metals	**SOM: 1%**		**SOM: 6%**		
3	Cadmium	22.1		22.1		C
4	Chromium VI	3.62	20.5	3.62	20.5	B/C
	Copper	4730		4790		A+
7	Mercury	8.81		15.80		A/D
8	Nickel	136		136		A+
	Lead	200		200		C
	Zinc	20000		20300		A+
	Vanadium	136		138		A+
	Semi and Non Metals					
1	Arsenic	37		37		C
10	Selenium	375		375		A
	Free Cyanide	34		34		A
9	Phenols (total)	267		1200		A
	Poly Aromatic Hydrocarbons	Free product	No free product	Free product	No free product	
20	Napthalene	0.829		12.2		A+
	Acenaphthene	157	608	2760		A+
	Fluorene	735		2610		A+
	Anthracene	10200		26200		A+
	Fluoranthene	983		2980		A+
	Pyrene	668		2120		A+
	Benzo(a)anthracene	1.71	4.52	8.54		A
2	Chrysene	0.44	585	2.64	927	A
2	Benzo(b)fluoranthene	1.22	7.72	7.29	9.86	A
2	Benzo(k)fluoran hene	0.686	84.4	4.12	100	A
2	Benzo(a)pyrene	1.51	4.95	0.998	5	B/C
2	Dibenzo(a,h)anthracene	0.00393	0.838	2.05	4.95	A*
2	Indeno(1,2,3-cd)pyrene	0.0614	7.31	0.368	9.75	A
2	Benzo(g,h,i)perylene	0.0187	96.2	0.112	103	A
	Petroleum Hydrocarbons					
	Aliphatic C5-C6	42.7		369		A+
	Aliphatic C6-C8	99.3		768	1240	A+
	Aliphatic C8-C10	13.9		204		A+
	Aliphatic C10-C12	49.9	81.7	297	1180	A+
	Aliphatic C12-C16	20.9	385	125	4130	A+
	Aliphatic C16-C21	210000		210100		A+
	Aliphatic C21-C35	210000		210100		A+
	Aromatic C5-C7 (Benzene)	0.137		0.871		A+
	Aromatic C7-C8 (Toluene)	113		780		A+
	Aromatic C8-C10	20.5		232		A+
	Aromatic C10-C12	70		468		A+
	Aromatic C12-C16	155	165	830		A+
	Aromatic C16-C21	319		1040		A+
	Aromatic C21-C35	1120		1710		A+

A+ = Values update June 2017.

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

B = Health Criterion Values (available from toxicological reviews published in the C4SL project methodology report).

C = Catergory 4 Screening Levels (C4SLs).

D = SSV provided is for Methyl Mercury.