Environmental
Geotechnical
Specialists



REPORT

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GEOTECHNICAL ENVIRONMENTAL

Environmental Geotechnical Specialists

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Report on a Geo-environmental Investigation

Location:	Open Market, Huddersfield, HD1 1RY
For:	Kirklees Council
Report No.	J3644/16/E
Report date:	November 2016

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

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Report Summary[1]

Item	Comments	Section
Development	Erection of a steel framed single-storey building.	1.
Geology	Superficial geology – Head Solid geology – Pennine Lower Coal Measures Formation.	5.
Strata Conditions	Variable thickness of made ground overlying head deposits.	6.
Groundwater	Water strike at 2.0m (perched water).	6.2
Foundation Design	Strip or spread foundations or piled solution.	10.
Effect of Sulphates	DC-2z concrete.	10.5
Contamination	Contaminants do not exceed screening values. No asbestos detected.	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.

1. Introduction

The site is proposed to be developed by the construction of a steel framed single storey building. 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 report also takes into consideration the risk of any contamination present. This report describes the work undertaken, presents the data obtained and discusses the ground conditions in relation to the proposed works.

2. Limitations

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

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

3. Desk Study

A Phase 1 Desk Study has been undertaken by Rogers Geotechnical Services (RGS) and the results were presented as report number J3644/16/EDS in September 2016. This report has been used extensively during the current intrusive investigation.

4. Fieldworks

The fieldworks were undertaken on the 5th October 2016 and included the following:

- Three windowless sample boreholes.
- Three dynamic probes.
- Three gas monitoring standpipes.
- One hand excavated trialpit.

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

4.1 Windowless Sample Boreholes

These boreholes were sunk using a drive-in windowless sampler. The cores were undertaken in 1m lengths and reduced in diameter from 90mm for the first 1m through 80mm, 70mm and 60mm 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 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.

Standard penetration tests (SPTs) were undertaken at regular depth increments within WS2 and the results are summarised on the borehole records. 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,

4.2 Dynamic Probes

Dynamic penetration tests were undertaken adjacent to the windowless sample boreholes in accordance with the procedure given in BS1377: 1990: Part 9, 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.

4.3 Hand Excavated Trialpits

A trialpit was excavated employing hand digging techniques immediately adjacent to the existing car park retaining wall in order to reveal the extent and type of foundations of the existing wall. The soils were logged on site in general accordance with BS5930: 2015 and full descriptions are given on the trial pit records which are presented in Appendix 4.

4.4 Gas Monitoring Standpipes

Gas monitoring standpipes were installed to 4.0m depth in all of the boreholes 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.

4.5 Comments

Unfortunately the foundations could not be reached employing hand excavated trialpits. Therefore, a dynamic probe was undertaken approximately 2m away from the retaining wall. It is understood that the building is to be constructed approximately 2m to 3m away from the retaining wall, therefore, the probe

was required to to confirm that the lateral extent of any foundations did not extend to the proposed footprint of the development. No obstructions were met.

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	Head	Coombe Deposits	Polymict deposit: comprises gravel, sand and clay depending on upslope source and distance from source. Poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hillwash and soil creep. Essentially comprises sand and gravel, locally with lenses of silt, clay or peat and organic material. [Generic description].
Solid Geology	Pennine Lower Coal Measures Formation	Lower Coal Measures Formation	Interbedded grey mudstone, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower part and more numerous thicker coal seams in the upper part.

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
1.00 - +1.50	MADE GROUND (Cohesive)	WS3, TP1	None
0.60 – 2.30	MADE GROUND (Granular)	WS2, WS3, WS1, TP1	None
+4.00	Silty gravelly CLAY	WS1, WS2, WS3	WS2 2.00m

'+' 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*]

6.1 General Strata

In general, the borehole records indicate that beneath a 1.0m to 2.3m capping of made ground, soft becoming firm silty gravelly clays were revealed to the termination depths of the windowless sample boreholes. With respect to the published geological data for the site, it is considered that these soils represent Head deposits, which are anticipated to be present below the site.

6.2 Groundwater

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. Notwithstanding this, groundwater was observed within WS2 at a depth of 2.0m. It is considered that this water strike is associated with perched water.

7. Insitu Testing

7.1 Dynamic Penetration Tests

Dynamic penetration tests were undertaken adjacent to the windowless sample borehole positions and one within the approximate centre of the site. A summary of the results is presented below:

Table 3: Summary of Dynamic Penetration Tests

Position	Blows/100mm			Refusal type	Comments
	0 - 2	3 - 10	10+		
	Depth to which blow count range was observed (m)				
DP1	2.0	0.4 0.8 2.3 8.3	0.2 0.7 9.1	Effective	Initial high results to 1.0m, followed by weak material to 1.9m. Gradual increase and higher results to 9.1m.
DP2	2.1	0.5 7.9	0.2 9.6	Effective	Initial high results to 1.0m, followed by weak material to 2.1m. Gradual increase and higher results to 9.6m.
DP3	1.5 2.2	0.8 1.8 8.0	0.2 9.4	Effective	Initial high results to 0.9m, followed by weak material to 2.0m. Gradual increase and higher results to 9.4m.

7.2 Standard Penetration Tests

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

Table 4: Summary of Standard Penetration Tests				
Strata	**Depth Range (m)**	**SPT 'N' (Blows/300mm)**		**Comments**
		Granular soils	**Cohesive soils**	
Superficial Deposits	1.0 – 4.5	-	20 – 23	Generally soft in-situ conditions within the upper levels and firm becoming stiff in-situ conditions at depth.

7.3 Gas and Water Level Monitoring

The standpipes were monitored between the 12th October and the 2nd November 2016. 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	Barometric Pressure (mb)	Water Level (m)	Standpipe Depth (m)
WS01	12.10.16	0.0	4.6	16.8	0.1	1013	0.93	3.7
	19.10.16	0.0	5.7	16.6	0.1	1012	0.90	
	26.10.16	0.0	6.7	17.6	0.1	1014	1.30	
	02.11.16	0.0	6.3	18.5	0.1	1014	1.32	
WS02	12.10.16	0.0	0.3	20.6	0.0	1014	1.95	3.8
	19.10.16	0.0	0.6	20.1	0.0	1013	1.15	
	26.10.16	0.0	0.4	20.1	0.0	1015	1.53	
	02.11.16	0.1	0.6	20.3	0.0	1015	1.54	
WS03	12.10.16	0.0	0.4	20.7	0.0	1014	1.65	3.9
	19.10.16	0.0	0.4	20.6	0.0	1013	1.70	
	26.10.16	0.0	0.4	20.4	0.0	1015	2.19	
	02.10.16	0.0	0.3	20.7	0.0	1015	2.50	

This work was undertaken using a Geotechnical Instruments (UK) Ltd. GA5000 (serial No G503524) which was last calibrated on the 23rd August 2016.

8. Laboratory Testing - Geotechnical

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

- Moisture content determinations — BS 1377: 1990: Pt2: 3.2
- Index properties (1 point) — BS 1377: 1990: Pt2: 4.4, 5.3 & 5.4
- Linear shrinkage — BS 1377: 1990: Pt2: 6.3
- Particle size distribution (Wet sieve) — BS 1377: 1990: Pt2: 9.2
- Sedimentation by pipette — BS 1377: 1990: Pt2: 9.4
- Soluble sulphate content — BS 1377: 1990: Pt3: 5
- pH value — BS 1377: 1990: Pt3: 9

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	5	16% to 50%		
Index Properties (1 Point)	5	LL PL PI LS	36 to 48 15 to 22 21 to 26 10 to 12	Brown gravelly CLAY. Clay of intermediate plasticity Consistency index -0.1 to 1.0 NHBC Class – low and medium
Particle size distribution (wet sieve) and sedimentation	1	Gravel Sand Silt Clay	35% 20% 31% 14%	Sandy GRAVEL.
Soluble sulphate & pH	1	SO_4 pH	<10 to 32 mg/l 5.7 to 8.6	DS-1, ACEC class AC-2z

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)	Low and Medium	Gravelly CLAY
Concrete classification	DC-2z	Brownfield 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

This testing was undertaken by Chemtest Ltd and the results of all of the chemical testing are presented in Appendix 6 of this report.

10. Discussion of Ground Conditions - Geotechnical

It is understood that the site is to be developed by the construction of a single storey steel framed building surrounded by hard-standing areas. It cannot be recommended that foundations be constructed directly within the made ground. Although competent near surface soils are present beneath some areas of the site, it should be appreciated that these soils are underlain by superficial deposits which are present in a weak and variable condition to depths of at least 2.3m bgl across the site, such that excessive total and or differential settlement could occur under moderately light surface loading.

It is considered that the underlying superficial deposits will provide a suitable bearing stratum, provided that the foundations are placed within soil generally described as being present in a firm insitu condition. It is considered that strip or spread foundations constructed within this material, at a minimum depth of say 2.4m, could be designed assuming an allowable increase in stress given in the following table:

Table 8: Allowable increase in stress

Foundation Type		**Strip Footings**			**Spread Footings**		
Foundation Breadth	B (m)	0.6	1.0	1.5	0.6	1.0	2.0
Foundation Depth	D (m)		2.4			2.4	
Allowable increase in stress	(kN/m²)	113	108	103	175	168	153

The allowable increase in stress given above assumes a factor of safety of 3 against general shear failure, with cohesion of 45kN/m^2 at the foundation depths. Settlements at the above loading intensities should remain within tolerable limits for the type of structure proposed provided that the underlying soils are carefully inspected immediately once final trimming has taken place. Should any soft or weak material be encountered they should be locally removed and replaced with lean-mix concrete or compacted granular soil.

Alternatively, consideration may be directed to the use of a mini-pile foundation to transfer the foundation loads through the weaker material to more competent soils at depth. For preliminary design purposes it is considered that driven mini-piles are likely to represent the most economical foundation solution. In order to formulate a suitable design it is recommended that the advice of specialist piling contractors be sought. However, with respect to the increase in dynamic penetration results around 9m depth, it is expected that piles will need to reach these depths to provide sufficient capacity.

Considering the competent materials at shallow depths, a ground floor slab may be utilised. However, the zone of weaker material at depths between 1.0m and 2.0m may cause distortion to the slab. Therefore, construction joints would be required within the building to allow for settlement.

10.1 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 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.

10.2 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[4], 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-2z.

In order to evaluate the design chemical (DC) class for the buried concrete at this site reference should be made to Table D1[5], 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-2z is required.

11. Discussion of Ground Conditions - Environmental

11.1 Discussion of Test Results

It is understood that a site is proposed to be developed by the erection of a steel framed single storey building which will be used for waste management. Consequently, the site may be classified as commercial.

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. These values have been derived in such a way as to adhere to the principles within the revised CLEA model

[4] Table C2, *Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations*
[5] 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.*

and include the most current release of the SGVs. A list of subscribers is provided within the website[6] 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 6. These results indicate the following:

Table 9: Summary of contaminated areas

Location	Contaminants found to be exceeding SSVs (Commercial)
WS1	PAHs [Pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ay)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene].
WS2	PAHs [Chrysene, benzo(b)fluoranthene, benzo(ay)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene].
WS3	PAHs [Pyrene, chrysene, benzo(b)fluoranthene, benzo(ay)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene].

Concentrations of chromium^{VI}, selenium, free cyanide, phenols (total) and total petroleum hydrocarbons (aliphatic C5 to C10 and aromatic C5 to C8) 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.

It should be appreciated that the soil screening values for the PAHs 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[7]. In view of this, the ATRISK soil SSVs notes that the users may wish to consider using a combined assessment criterion given by CLEA 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 CLEA criteria should be adopted for the PAHs at this site. The results of the contaminants found to exceed these screening values are tabulated below:

Table 10: Summary of areas contaminated by PAHs

Location	Contaminants found to be exceeding SGVs (Commercial)
WS1	None.
WS2	None.
WS3	None.

On the basis of all the information provided above, it is considered that the site can be classed as uncontaminated. Furthermore, no asbestos was detected.

[6] http://www.atrisksoil.co.uk/pages/general/subscribers.asp
[7] Ref: ATRISK soil, SSVs derived using CLEA v1.04 – v1.06 for 1% SOM, Commercial land use, 8.1.15.

11.1.2 Gas Concentrations

With respect to ground gas, the results of the monitoring visits indicated negligible levels of methane, with concentrations of carbon dioxide ranging between 0.3% and 6.7%, in association with oxygen levels of between 16.8% and 20.7%. 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 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 1012mb and 1015mb.

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 negligible (0.000) methane was recorded along with 6.7% (0.067) carbon dioxide, in association with a maximum flow rate of 0.1 l/hr. This results in a GSV of 0.000 l/hr for methane and a GSV of 0.0067 l/hr for carbon dioxide.

In accordance with Table 8.5, *Modified Wilson and Card classification* of the CIRIA report C665, *Assessing risks posed by ground gasses to building,* the site may be characterised as *Characteristic Situation Level 1*. However, as the level of carbon dioxide is over 5%, this should be upgraded to *Characteristic Situation Level 2.* It is therefore considered that there is a low risk of harm to end users and site operatives and some special precautionary measures are required in accordance to Table 8.6, *Typical scope of gas protection measures,* of CIRIA report C665.

It should be noted that the gas screening value threshold for the next level, Characteristic Situation level 3, is <3.5 l/hr. Assuming the flow rate remains constant at 0.1l/hr the gas concentration would need to exceed 3500% to move into the next risk band, which is not possible. Moreover, by keeping the concentration constant, the flow rate would need to increase to 52.2 l/hr to move into the next band, which is a five hundred fold increase. We consider that these increases are not feasible as the fill is not deleterious, thus the site is not a generating source.

With regard to the number of monitoring visits required reference is made to Tables 5.5a and 5.5b of CIRIA report C665 (2007)[8]. Accepting that the proposed development is of low sensitivity (commercial) and that the generation potential is very low to low, these tables suggest that 4 readings could 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.* In this case, a total of 4 monitoring visits were undertaken over a four week time period. In view of the above, it is considered that the site is fully characterised and some protection measures will be required.

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

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

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

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

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 11.

[9] 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'.
[10] 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.
[11] See 'Circular 2/2000 Contaminated Land: Implementation of Part II of The Environmental Protection Act 1990', appendix A.

Table 11: Conceptual Site Model and Site Specific Risk Assessment [Contamination: Lead and TPHs]

Conceptual Site Model			Site Specific Risk Assessment	
Pathways	**Receptor**	**Linkage Present?**	**Risk Rating**	**Notes**
Direct contact/dermal absorption/soil ingestion	Operative	No – no contaminants exceed trigger values for commercial development.	Low	Some elevated levels of contaminants present in the soils underlying the site. These do not exceed trigger values, however, precautionary measures will be required during the construction phase.
	End User	No – no contaminants exceed trigger values for commercial development.	Low	
	Neighbours	No – no contaminants exceed trigger values for commercial development.	Low	
Inhalation of Dust/Vapours	Operative	No – no contaminants exceed trigger values for commercial development.	Low	Some elevated levels of contaminants present in the soils underlying the site. These do not exceed trigger values, however, precautionary measures will be required during the construction phase.
	End User	No – no contaminants exceed trigger values for commercial development.	Low	
	Neighbours	No – no contaminants exceed trigger values for commercial development.	Low	
Ingestion of fruit/vegetables and/or waters	Operative	No – no edible plants or contained water sources in the area of the proposed new works.	N/A	
	End User	No – commercial end use and no contaminants exceed trigger values.	Low	
	Neighbours	No – site is within a non-residential and commercial area, predominantly buildings and hard standing are present.	N/A	
Migration of hazardous gases via permeable strata or shallow mining activity	Operative	Yes – elevated levels of carbon dioxide have been found to be present at the site.	High	Elevated levels of carbon dioxide are present and site is Characteristic Situation Level 2. Remediation will be required in order to protect the end user.
	End User		High	
	Neighbours	No – site is not considered to be a generating source of ground gasses.	N/A	

Spillage/loss/run off direct to receiving water	Controlled Waters	No – no contaminants exceed trigger values for commercial development.	Low	
Migration via permeable unsaturated strata	Controlled Waters	No – no contaminants exceed trigger values for commercial development.	Low	
Run off via drainage/sewers etc	Controlled Waters	No – no contaminants exceed trigger values for commercial development.	Low	
Direct contact with contaminated soils	Plants	No – commercial end use and no contaminants exceed trigger values.	Low	
Uptake via root system			Low	
Direct contact with contaminated soils	Building Materials	Yes – no contaminants exceed trigger values for commercial development. However, variable pH and sulphate concentrations.	High	Concrete classification DC-2z. Please see section 11.3.3 for information on good building practice.
Direct contact with contaminated groundwater				
Exposure to Radon	Operative	Yes – in a radon affected area.	Low	Less than 1% of properties are above the action level. No radon protection measures required.
	End User			

11.3 Remediation Strategy

In view of the site specific risk assessment it is considered that it will not be necessary to undertake any specific remediation at this site for chemical contamination. However, remediation will be required for the presence of elevated levels of carbon dioxide. Furthermore, it should be appreciated, that careful inspection of the subgrade should be made during the groundworks. Should areas of contamination be detected then further testing may become necessary.

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 and vapours.
- To protect site operatives and the end user from elevated levels of carbon dioxide.

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 a single storey steel frame building. For preliminary design and costing the following remediation proposals are offered.

11.3.3 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 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.
- Where vehicles are transferring soil to landfill site they should be covered to prevent any potential contamination of the surrounding area by dust.
- Any stockpiles of contaminated soil that maybe subsequently be found on site should be sheeted over to prevent excessive amounts of airborne dust and may require Waste Assessment Criteria (WAC) testing before transfer to an appropriate licensed landfill site.
- 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 any potential contamination to surrounding areas.
- Undertake risk assessments in relation to the presence of elevated levels of carbon dioxided within parts of site and ensure appropriate PPE is provided or protection measures undertaken where necessary, particularly if workers are to enter confined spaces and excavations during construction.

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.
- 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'.
- For buried concrete the results of the sulphate and pH testing indicate that the design sulphate class for the site should be DS-1.
- Due to the levels of CO_2 encountered on site and in according to Table 8.6, *Typical scope of gas protection measures,* of CIRIA report C665, two levels of protection are considered necessary and should include:
    - Reinforced concrete cast *in situ* floor slab (suspended, non-suspended or raft) with at least 1200g DPM and under floor venting.
    - Beam and block or pre-cast concrete slab and 2000g DPM / reinforced gas membrane and under floor venting.

  Note: All joints and penetrations must be sealed.

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, for the following.

- It is a suitable growing medium where 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 YAHPAC[12] 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 12: 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.

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 13: Fill screening values

Contaminant	Screening Value (Commercial) (mg/kg)	Reference
As	640	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
Cd	230	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
Cr^{VI}	330	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
Cu	109000	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
Hg	2.1	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
Ni	1800	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
Pb	6490	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter
V	7530	$Atrisk^{SOIL}$ SSVs, 6% soil organic matter

[12] Sampling & Testing Matrix of Yorkshire and Humberside Pollution Advisory Council, 2013, *YAHPAC Technical Guidance for Developers, Landowners and Consultants – Verification Requirements for Cover Systems v2.1*, Appendix 1a.

Zn	917000	Atrisk^{SOIL} SSVs, 6% soil organic matter
TPH CWG	See contamination analysis sheet	Atrisk^{SOIL} SSVs, 6% soil organic matter
PAH 16 USEPA	See contamination analysis sheet	Atrisk^{SOIL} SSVs, 6% soil organic matter

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 immediate 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. Recommendations for further work

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

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) (2016), BGS, Keyworth.
  - Geology of Britain Viewer: (*http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html)*
  - Lexicon of Named Rock Units:
  - (*http://www.bgs.ac.uk/lexicon/)*

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

- British Standards Institution (2015) BS5930: *Code of practice for site investigations,* B.S.I., London.

- British Standards Institution (2004) BS EN ISO 14688: *Geotechnical investigation and testing – Identification and classification of soil*, *incorporating corrigendum no.1 (2007)*, B.S.I., London.

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

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

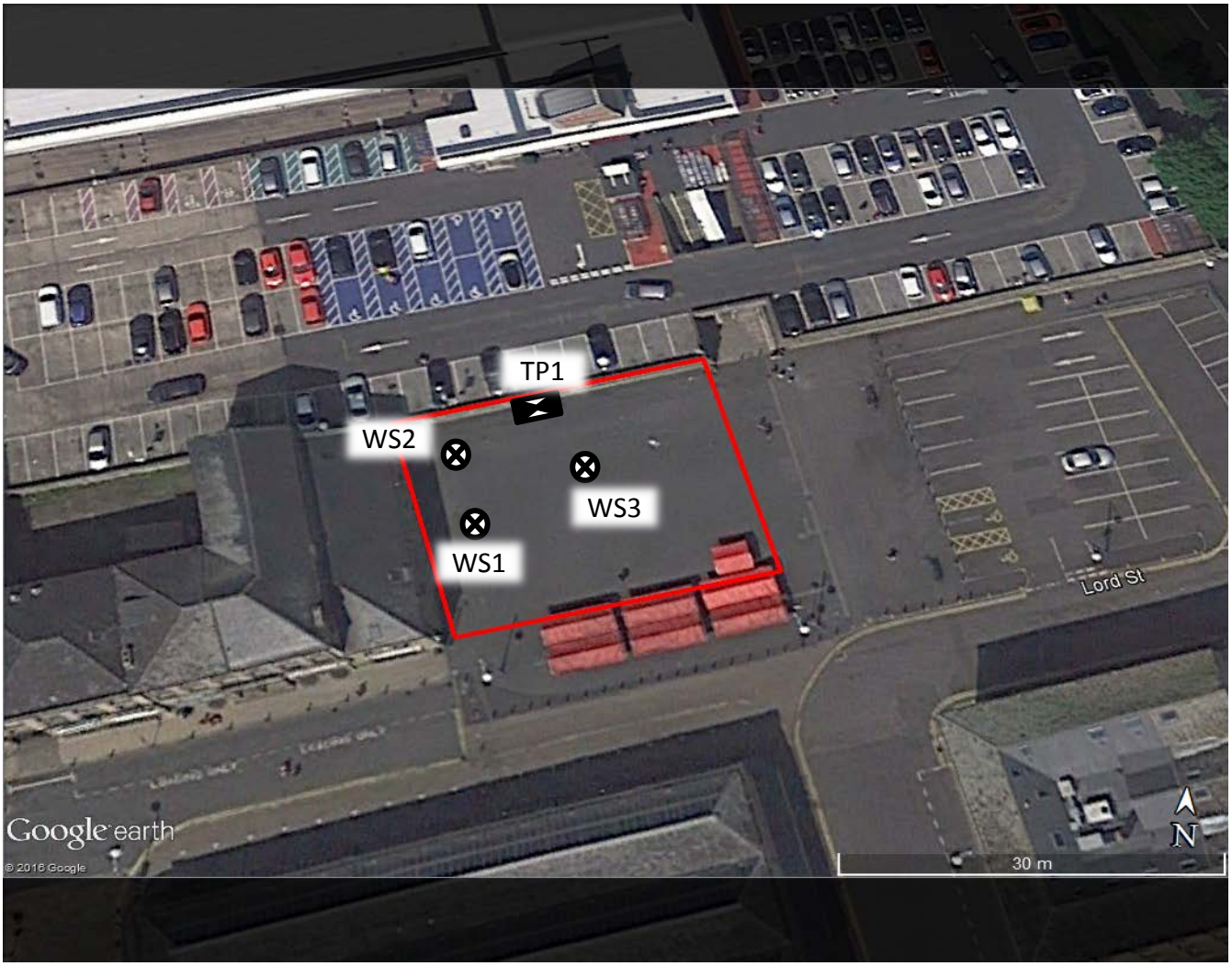
- Department for Environment, Food and Rural Affairs and the Environment Agency (2009) DEFRA Science Report – SC050021/SR3, *Updated technical background to the CLEA model*. Environment Agency, Bristol.

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

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

Appendix 1

Site Plan



Plan not to scale and investigation positions approximated from site operative's notes.

Title: **Investigation Location Plan**

Rogers Geotechnical Services Ltd	Site Name: The Open Market, **Huddersfield**	Job No: **J3644/16/E**

Appendix 2

Borehole Records

Borehole Log

Borehole No. **WS1**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type WLS
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By JDMI

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.55 0.60	ES ES	90	100		0.47			MADE GROUND. (Black sandy angular to sub-rounded fine to medium dolostone GRAVEL). (Unbound asphalt).
							1.06			MADE GROUND. (Light brownish white coarse gravelly SAND. Gravel is angular and sub-angular fine to medium limestone).
		1.60	D	80	100					MADE GROUND (Black mottled orange fine sandy angular and sub-rounded fine to coarse sandstone and brick GRAVEL. Sand is ash).
		2.20	D	70	100		2.30			Firm orange mottled grey gravelly CLAY. Gravel is angular to sub-rounded fine to coarse sandstone.
		3.45 3.50	ES ES	60	62		3.00			Stiff brown crypto-laminated silty gravelly CLAY. Gravel is angular to sub-angular fine to medium sandstone. *3.00m3.08m: Red clayey medium SAND.*
							4.00			End of Borehole at 4.00m

Remarks

Borehole Log

Borehole No. **WS2**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type WLS
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By JDMI

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.16			MADE GROUND. (Black sandy angular to sub-rounded fine to medium dolostone GRAVEL). (Unbound asphalt).
				90	100		0.50			MADE GROUND. (Light brownish white coarse gravelly SAND. Gravel is angular and sub-angular fine to medium limestone).
		0.76	ES							
		0.85	ES							
		1.00	SPT			N=1 (2,0/0,1,0,0)	1.00			MADE GROUND. (Black clayey sandy angular to sub-angular fine to coarse brick and sandstone GRAVEL. Sand is ash).
		1.40	D	80	86					Soft becoming firm orange mottled grey gravelly CLAY. Gravel is angular to sub-rounded fine to coarse sandstone.
		2.00								
		2.00	SPT			N=17 (1,2/3,3,5,6)				
		2.50 - 2.80	D	70	100					*2.3m: Becoming firm*
		2.95	ES							
		3.00	SPT			N=23 (3,2/3,3,10,7)				
		3.15	ES	60	90		3.40			Stiff brown crypto-laminated silty gravelly CLAY. Gravel is angular to sub-angular fine to medium sandstone.
		4.00	SPT			N=20 (3,3/4,5,4,7)	4.00			End of Borehole at 4.00m

Remarks

Borehole Log

Borehole No. **WS3**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type WLS
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By JDMI

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.05			ASPHALT. (Driller's note).
		0.56	ES	90	100		0.40			MADE GROUND. (Light brownish white coarse gravelly SAND. Gravel is angular and sub-angular fine to medium limestone).
		0.75	ES							MADE GROUND. (Firm becoming soft brown gravelly CLAY. Gravel is angular to sub-rounded fine to coarse sandstone).
				80	66		1.00			MADE GROUND. (Brownish white speckled black sandy angular and sub-angular fine to medium limestone and ash GRAVEL).
							1.59			MADE GROUND. (Light orange gravelly angular sandstone COBBLES. Gravel is angular fine to coarse sandstone.)
				70	100		1.89			Soft becoming firm brown gravelly CLAY. Gravel is angular and sub-angular fine to coarse sandstone.
										2.3m: Becoming firm.
		3.56	D	60	100		3.00			Stiff brown crypto-laminated slightly silty gravelly CLAY. Gravel is angular to sub-angular fine to medium sandstone.
		3.80	D							
							4.00			End of Borehole at 4.00m

Remarks

Appendix 3

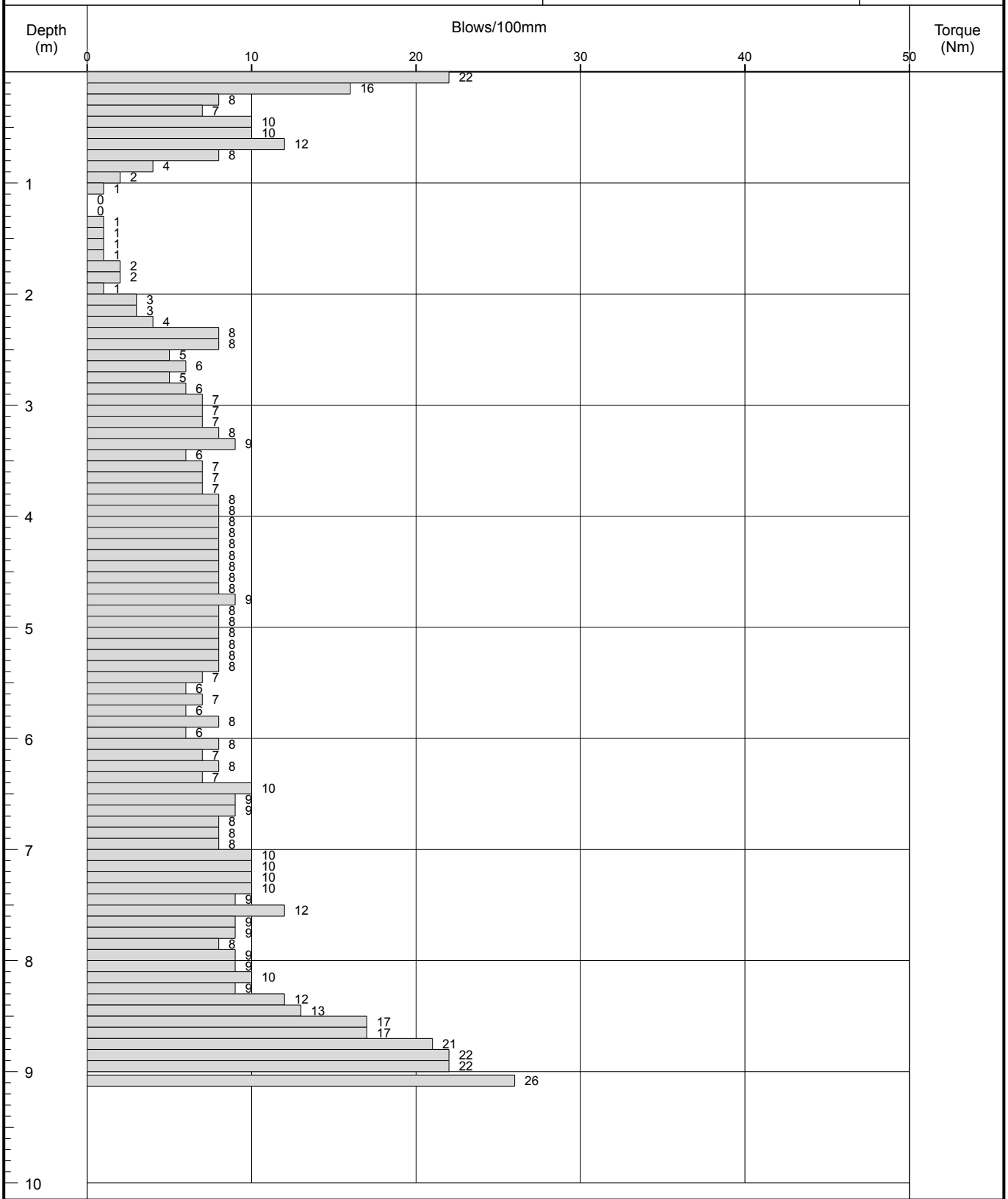
Dynamic Probing Records

Probe Log

Probe No. **DP1**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type DCP
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By



Remarks:

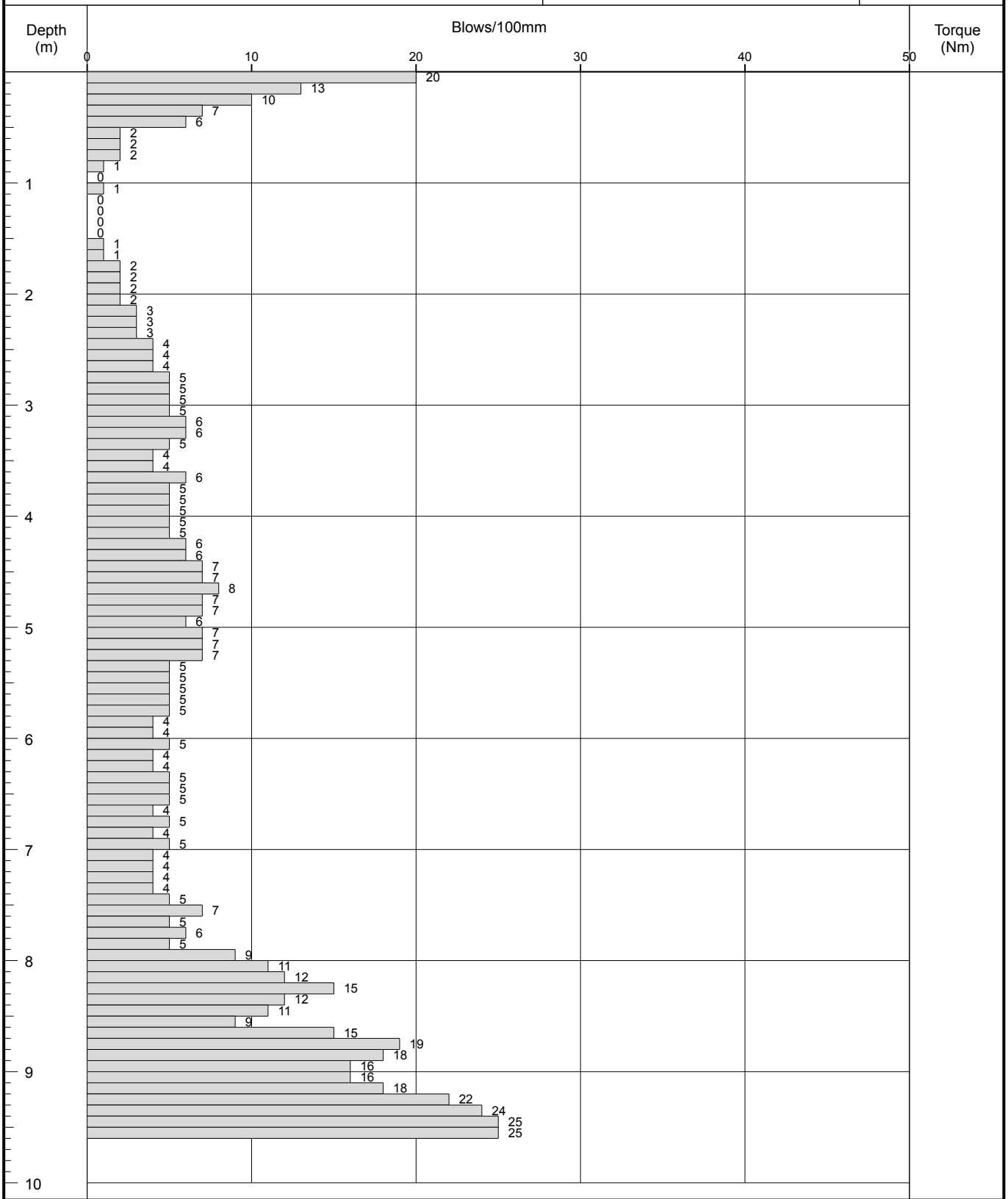
Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	9.03m
Probe Type	DPSH-B		

Probe Log

Probe No. **DP2**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type DCP
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By



Remarks:

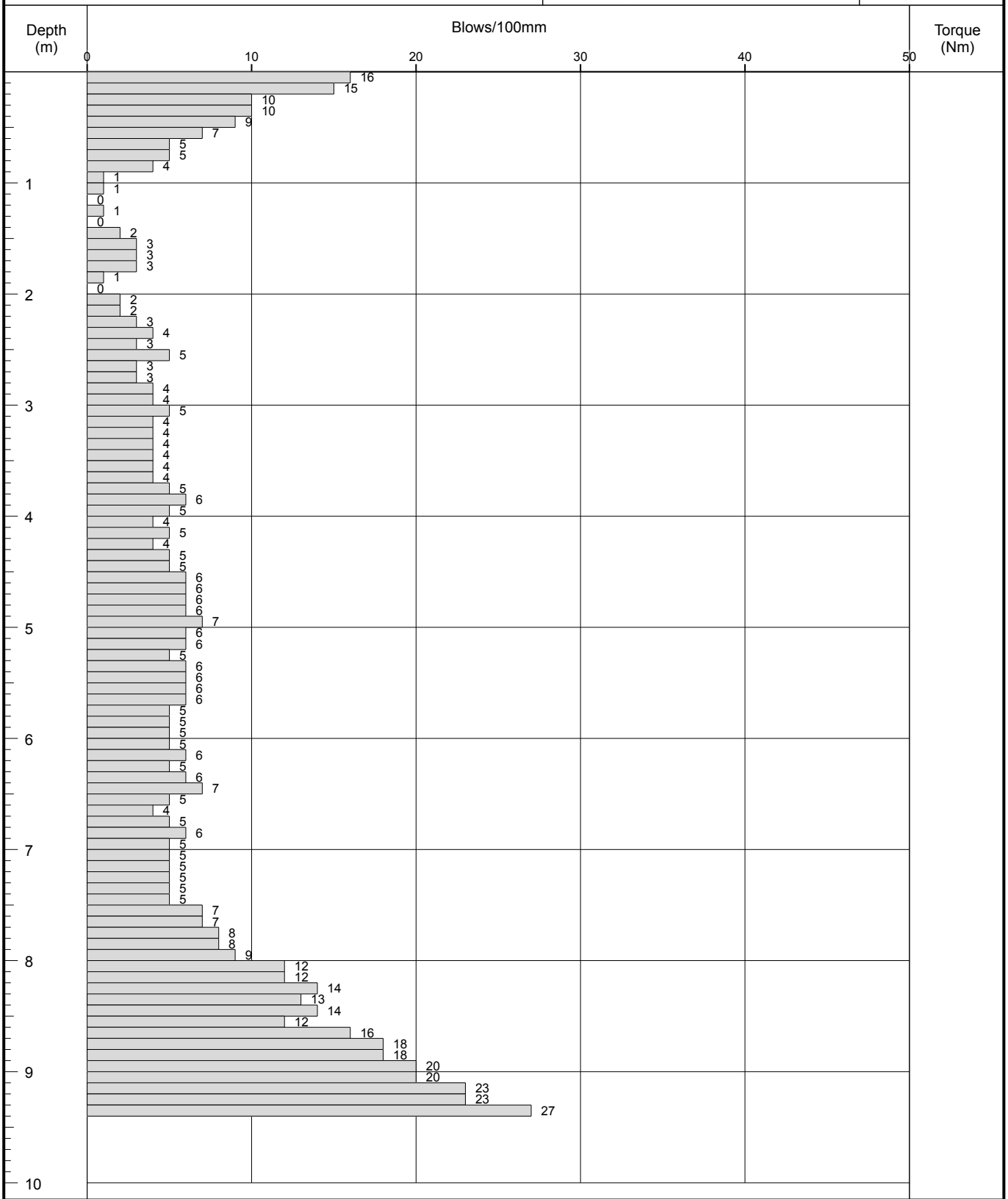
Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	9.5m
Probe Type	DPSH-B		

Probe Log

Probe No. **DP3**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type DCP
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By



Remarks:

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	9.4m
Probe Type	DPSH-B		

Appendix 4

Hand Excavated Trialpit Records

Borehole Log

Borehole No. **TP1**

Sheet 1 of 1

Project Name: Open Market	Project No. J3644/16/E	Co-ords:	Hole Type WLS
Location: Huddersfield, HD1 1RY		Level:	Scale 1:50
Client: Kirklees Council		Dates: 05/10/2016	Logged By JDMI

Well	Water Strikes	Samples and In Situ Testing					Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Dia. (mm)	TCR (%)	Results				
							0.15			ASPHALT. (Operative's note).
										MADE GROUND. (GRAVEL). (Operative's note).
		0.60 - 0.80	D				0.60			
		0.80 - 1.20	D				0.80			MADE GROUND. (Light greyish brown sandy gravelly CLAY. Gravel is angular to sub-rounded fine sandstone and concrete).
		1.20 - 1.50	D				1.20			MADE GROUND. (Brown mottled orange sandy gravelly CLAY. Gravel is angular to rounded fine brick sandstone and concrete).
							1.50			MADE GROUND. (Brown mottled orange and grey sandy gravelly CLAY. Gravel os angular to rounded fine of brick sandstone cement and ash).
										End of Borehole at 1.50m

Remarks

Hand dug foundation pit.

Appendix 5

Laboratory Testing - Geotechnical

Summary of Classification Test Results

Project No.: J3644/16/E

Project Name: Open Market

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Density bulk (Mg/m3)	Density dry (Mg/m3)	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
WS1	5	1.60		D	Orange mottled grey gravelly CLAY.			24.0	92	42 -1pt	21	21		
WS1	6	2.20		D	Orange mottled grey gravelly CLAY.			17.0	95	38 -1pt	16	22		
WS2	5	1.40		D	Dark brown gravelly CLAY.			50.0	86	48 -1pt	22	26		
WS3	3	2.25		D	Brown gravelly CLAY.			16.0	82	36 -1pt	15	21		
WS3	4	3.30		D	Brown gravelly CLAY.			17.0	76	43 -1pt	18	25		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test | Liquid Limit | Particle density

Linear measurement unless : | 4pt cone unless : | sp - small pyknometer

wd - water displacement | cas - Casagrande method | gj - gas jar

wi - immersion in water | 1pt - single point test

Date Printed: 26/10/2016

Approved By: Jude

Table 1

sheet 1

Linear Shrinkage - Summary of Results

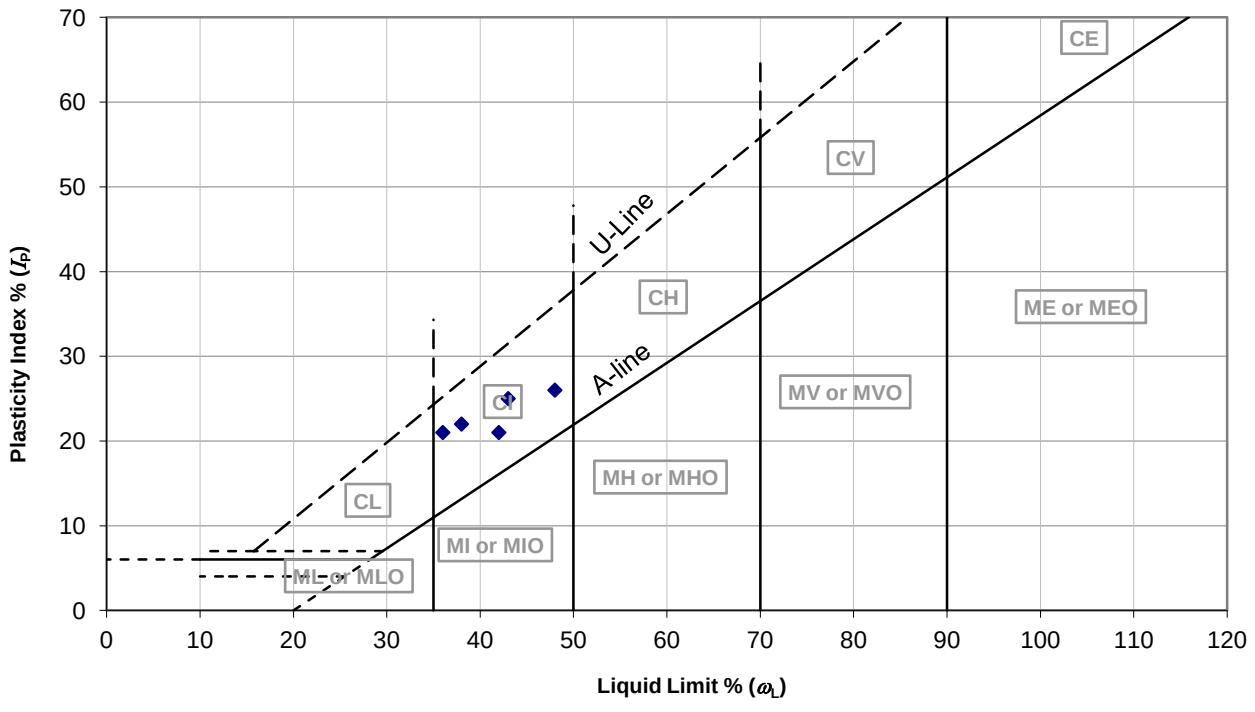
Project No.	Project Name
J3644/16/E	Open Market

Hole No.	Sample				Soil Description	Material <425µm %	Preparation	Linear Shrinkage %	Remarks
	Ref	Top	Base	Type					
WS1	5	1.60		D	Orange mottled grey gravelly CLAY.	92	Specimen prepared from natural material	12	
WS1	6	2.20		D	Orange mottled grey gravelly CLAY.	95	Specimen prepared from natural material	12	
WS2	5	1.40		D	Dark brown gravelly CLAY.	86	Specimen prepared from natural material	11	
WS3	3	2.25		D	Brown gravelly CLAY.	82	Specimen prepared from natural material	10	
WS3	4	3.30		D	Brown gravelly CLAY.	76	Specimen prepared from natural material	11	

Notes	Date Printed	Approved By	Table
Tests performed in accordance with BS 1377 : Part 2 : 1990, clause 6.5 unless annotated otherwise	26/10/2016	Jude	2 sheet 1

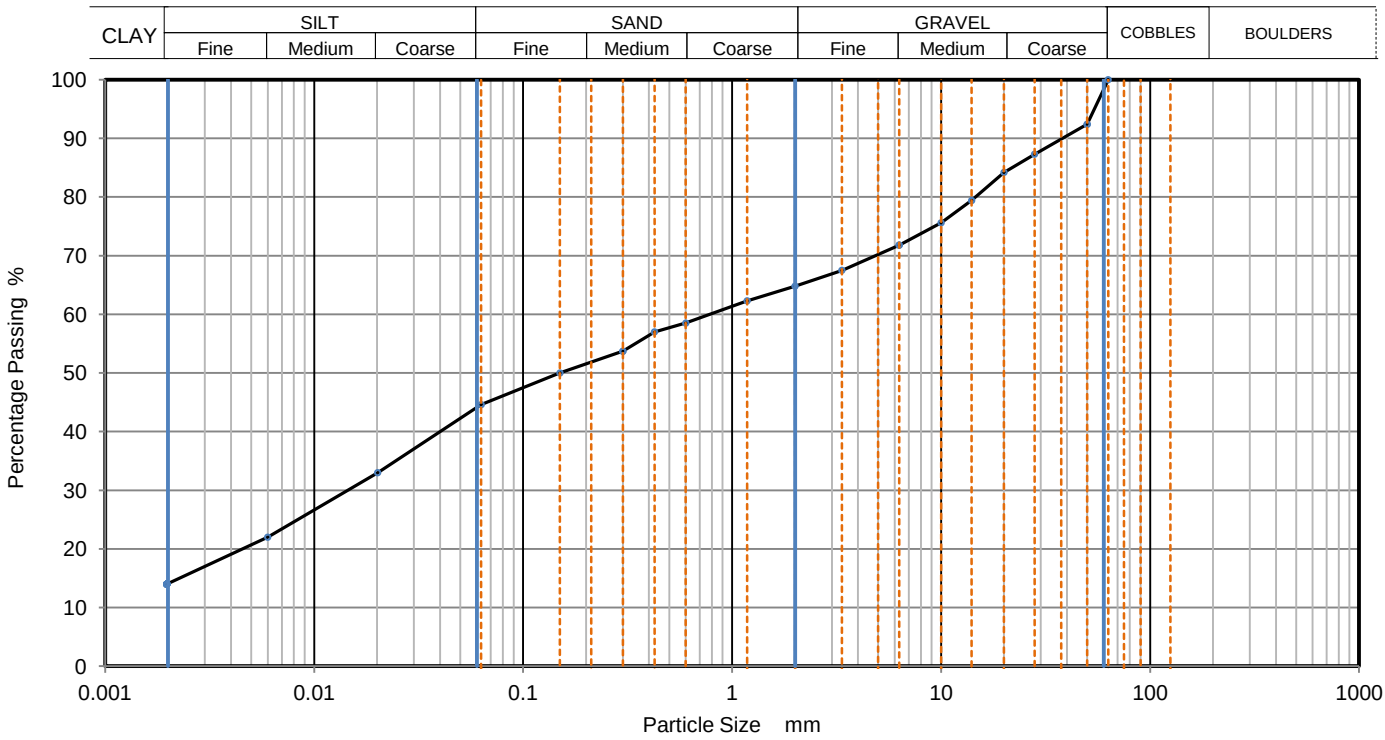
Rogers Geotechnical Services Ltd. Offices 1&2, Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU	**Interpretation of Moisture Content, Liquid and Plastic Limits**	**J3644/16/E**	
Project Name: Open Market	**B.S 1377: Part 2: 1990: 3.2, 4 and 5**	Fig. 3	Sheet. 1
Location: Open Market, Huddersfield		Input By: CJN Date: 26.10.16	
Client: Kirklees Council		Check By: CJN Date: 26.10.16	

Location	Depth (m)	Moisture Content (w) (%)	Liquid Limit (wL) (%)	Plastic Limit (wP) (%)	Plasticity Index (IP) (%)	Retained by 425mm (%)	Modified (w) (w') (%)	Modified (IP) (IP') (%)	Liquidity/ Consistency (IL) (%)	Liquidity/ Consistency (IC) (%)	Casagrande Class	N.H.B.C Class (%)
WS1	1.60	24	42	21	21	8	26	19	0.1	0.9	C I	LOW
WS1	2.20	17	38	16	22	5	18	21	0.0	1.0	C I	MEDIUM
WS2	1.40	50	48	22	26	14	58	22	1.1	-0.1	C I	MEDIUM
WS3	2.25	16	36	15	21	18	20	17	0.0	1.0	C I	LOW
WS3	3.30	17	43	18	25	24	22	19	0.0	1.0	C I	LOW



PARTICLE SIZE DISTRIBUTION

				Job Ref	**J3644/16/E**
				Borehole/Pit No.	WS2
Site Name	Open Market			Sample No.	6
Soil Description	Dark brown gravelly CLAY.			Depth, m	2.50
Specimen Reference		Specimen Depth	2.50-2.80 m	Sample Type	D
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.4			KeyLAB ID	RGS_201610143



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	33
		0.0060	22
		0.0020	14
63	100		
50	92		
28	87		
20	84		
14	79		
10	76		
6.3	72		
3.35	68		
2	65		
1.18	62		
0.6	59	Particle density	(assumed)
0.425	57	2.65	Mg/m3
0.3	54		
0.15	50		
0.063	45		

Dry Mass of sample, g: 1539

Sample Proportions	% dry mass
Very coarse	0
Gravel	35
Sand	20
Silt	31
Clay	14

Grading Analysis		
D100	mm	63
D60	mm	0.782
D30	mm	0.0142
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig 4
Jude	Jude	Jude	26/10/2016	Sheet 1

Appendix 6

Laboratory Testing - Environmental

Rogers Geotechnical Services Ltd.

SUMMARY OF CONTAMINATION ANALYSIS - including Atkins ATRISK SSVs

Client: Job Number:
Site: Date:

Tox Data Report No.	Compound	Range of Values Found (mg/kg)		Commercial/Industrial Development Values (mg/kg)		Reference
	Metals	*Min*	Max			
3	Cadmium	<0.1	0.19	230		A
4	Chromium (VI)	<0.5	<0.5	330		A
	Copper	28	200	109000		A
7	Mercury	<0.1	2.1	26		A
8	Nickel	24	37	1800		A
	Lead	21	410	6490		A
	Zinc	72	90	917000		A
	Vanadium	23	45	7530		A
	Semi and Non Metals					
1	Arsenic	8.6	42	640		A
10	Selenium	<0.2	<0.2	13000		A
	Free Cyanide	<0.5	<0.5	34		A
9	Phenols (total)	<0.3	<0.3	3200		A
	Poly Aromatic Hydrocarbons			ATRISK	CLEA	
20	Naphthalene	<0.1	3.9	432	22700	A
	Acenaphthene	<0.1	3.6	937	106000	A
	Fluorene	<0.1	3.4	746	72100	A
	Anthracene	<0.1	6.4	20.9	545000	A
	Fluoranthene	<0.1	33	113	72700	A
	Pyrene	<0.1	32	13.2	54500	A
	Benzo(a)anthracene	<0.1	15	10.3	142	A
2	Chrysene	<0.1	15	2.64	14300	A
2	Benzo(b)fluoranthene	<0.1	18	7.29	144	A
2	Benzo(k)fluoranthene	<0.1	7.1	4.12	1440	A
2	Benzo(a)pyrene	<0.1	14	5.46	14.4	A
2	Dibenz(a,h)anthracene	<0.1	1.2	0.0236	14.4	A
2	Indeno(1,2,3-cd)pyrene	<0.1	9.6	0.368	144	A
2	Benzo(g,h,i)perylene	<0.1	8.3	0.112	1450	A
	Petroleum Hydrocarbons					
	Aliphatic C5-C6	<1.0	<1.0	1100		A
	Aliphatic C6-C8	<1.0	<1.0	769		A
	Aliphatic C8-C10	<1.0	<1.0	476		A
	Aliphatic C10-C12	<1.0	2.7	297		A
	Aliphatic C12-C16	<1.0	8.8	126		A
	Aliphatic C16-C21	<1.0	15	28400		A
	Aliphatic C21-C35	<1.0	77	28400		A
	Aromatic C5-C7 (Benzene)	<1.0	<1.0	95		A*
	Aromatic C7-C8 (Toluene)	<1.0	<1.0	1780		A
	Aromatic C8-C10	<1.0	2	2700		A
	Aromatic C10-C12	<1.0	13	2190		A
	Aromatic C12-C16	<1.0	120	925		A
	Aromatic C16-C21	<1.0	940	28400		A
	Aromatic C21-C35	<1.0	3400	28400		A
	Others					
	pH	5.7	8.6	-		-
	Organic Content (%)	1.3	21	-		-
	Soluble Sulphate (mg/l)	<0.01	0.032	-		-
	Total Sulphate (%)	<0.01	0.13	-		-
A = WS ATKINS PLC, ATRISK SOIL SCREENING VALUES BASED ON 6% SOIL ORGANIC MATTER						
For PAHs ATRISK assumes free product is avalable whilst CLEA assumes no free product						

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Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
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Amended Report

Report No.:	16-24965-2		
Initial Date of Issue:	21-Oct-2016	**Date of Re-Issue:**	31-Oct-2016
Client	Rogers Geotechnical Services Ltd		
Client Address:	Unit 4, Barncliffe Business Park Near Bank Shelley Huddersfield West Yorkshire HD8 8LU		
Contact(s):	Rob Palmer		
Project	J3644/16/E - Huddersfield Open Market		
Quotation No.:		**Date Received:**	17-Oct-2016
Order No.:	1016-33	**Date Instructed:**	17-Oct-2016
No. of Samples:	12		
Turnaround (Wkdays):	11	**Results Due:**	31-Oct-2016
Date Approved:	31-Oct-2016		
Approved By:			
Details:	Keith Jones, Technical Manager		

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Results - Soil

Project: J3644/16/E - Huddersfield Open Market

Client: Rogers Geotechnical Services Ltd					**Chemtest Job No.:**	16-24965	16-24965	16-24965	16-24965	16-24965	16-24965	16-24965	16-24965
Quotation No.:					**Chemtest Sample ID.:**	365664	365665	365666	365667	365668	365669	365670	365671
Order No.: 1016-33					Client Sample Ref.:	WS1	WS1	WS1	WS1	WS2	WS2	WS2	WS2
					Client Sample ID.:	C1	C1	C4	C4	C1	C1	C3	C3
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.55	0.60	3.50	3.45	0.76	0.85	2.95	3.15
					Date Sampled:	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016
					Asbestos Lab:				COVENTRY		COVENTRY		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Cadmium	M	2450	mg/kg	0.10		0.16		< 0.10		< 0.10		0.15	
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50		< 0.50		< 0.50		< 0.50	
Copper	M	2450	mg/kg	0.50		200		36		36		28	
Mercury	M	2450	mg/kg	0.10		2.1		< 0.10		2.1		< 0.10	
Nickel	M	2450	mg/kg	0.50		37		36		26		32	
Lead	M	2450	mg/kg	0.50		410		33		220		37	
Zinc	M	2450	mg/kg	0.50		90		74		73		69	
Vanadium	U	2450	mg/kg	5.0		45		27		32		27	
Arsenic	M	2450	mg/kg	1.0		42		8.8		23		10	
Selenium	M	2450	mg/kg	0.20		< 0.20		< 0.20		< 0.20		< 0.20	
Cyanide (Free)	M	2300	mg/kg	0.50		< 0.50		< 0.50		< 0.50		< 0.50	
Total Phenols	M	2920	mg/kg	0.30		< 0.30		< 0.30		< 0.30		< 0.30	
Naphthalene	M	2700	mg/kg	0.10		3.9		< 0.10		1.1		0.75	
Acenaphthylene	M	2700	mg/kg	0.10		0.84		< 0.10		1.1		< 0.10	
Acenaphthene	M	2700	mg/kg	0.10		3.6		< 0.10		0.64		< 0.10	
Fluorene	M	2700	mg/kg	0.10		3.4		< 0.10		1.8		0.16	
Phenanthrene	M	2700	mg/kg	0.10		25		< 0.10		7.8		0.48	
Anthracene	M	2700	mg/kg	0.10		6.4		< 0.10		3.1		0.16	
Fluoranthene	M	2700	mg/kg	0.10		33		< 0.10		8.3		0.74	
Pyrene	M	2700	mg/kg	0.10		32		< 0.10		8.5		0.71	
Benzo[a]anthracene	M	2700	mg/kg	0.10		15		< 0.10		7.3		0.27	
Chrysene	M	2700	mg/kg	0.10		15		< 0.10		7.7		0.26	
Benzo[b]fluoranthene	M	2700	mg/kg	0.10		18		< 0.10		7.6		< 0.10	
Benzo[k]fluoranthene	M	2700	mg/kg	0.10		7.1		< 0.10		3.1		< 0.10	
Benzo[a]pyrene	M	2700	mg/kg	0.10		14		< 0.10		6.4		< 0.10	
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10		9.6		< 0.10		4.2		< 0.10	
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10		2.8		< 0.10		1.9		< 0.10	
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10		8.3		< 0.10		3.7		< 0.10	
Total Of 16 PAH's	M	2700	mg/kg	2.0		200		< 2.0		74		3.5	
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0		2.7		< 1.0		< 1.0		< 1.0	
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0		8.8		< 1.0		< 1.0		< 1.0	
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0		15		< 1.0		< 1.0		< 1.0	
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0		77		< 1.0		36		< 1.0	
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0		160		< 1.0		< 1.0		< 1.0	

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Results - Soil

Project: J3644/16/E - Huddersfield Open Market

Client: Rogers Geotechnical Services Ltd					**Chemtest Job No.:**	16-24965	16-24965	16-24965	16-24965	16-24965	16-24965	16-24965	16-24965
Quotation No.:					**Chemtest Sample ID.:**	365664	365665	365666	365667	365668	365669	365670	365671
Order No.: 1016-33					Client Sample Ref.:	WS1	WS1	WS1	WS1	WS2	WS2	WS2	WS2
					Client Sample ID.:	C1	C1	C4	C4	C1	C1	C3	C3
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.55	0.60	3.50	3.45	0.76	0.85	2.95	3.15
					Date Sampled:	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016
					Asbestos Lab:				COVENTRY		COVENTRY		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Total Aliphatic Hydrocarbons	M	2680	mg/kg	5.0		260		< 5.0		36		< 5.0	
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0		2.0		< 1.0		< 1.0		< 1.0	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0		13		< 1.0		< 1.0		< 1.0	
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0		120		< 1.0		< 1.0		< 1.0	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0		940		< 1.0		19		< 1.0	
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0		3400		< 1.0		180		< 1.0	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0		220		< 1.0		< 1.0		< 1.0	
Total Aromatic Hydrocarbons	M	2680	mg/kg	5.0		4700		< 5.0		200		< 5.0	
Total Petroleum Hydrocarbons	M	2680	mg/kg	10		5000		< 10		240		< 10	
pH	M	2010		N/A		8.5	8.6	7.3	7.0	7.9	8.1	7.6	5.7
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010		< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.032	< 0.010
ACM Type	U	2192		N/A			-		-		-		-
Asbestos Identification	U	2192	%	0.001			No Asbestos Detected		No Asbestos Detected		No Asbestos Detected		No Asbestos Detected
Moisture	N	2030	%	0.020		14	10	12	12	18	23	17	13
Soil Colour	N	2040		N/A		Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Other Material	N	2040		N/A		Stones, Brick	Stones	Stones	Stones	Stones	Stones	Stones	Stones
Soil Texture	N	2040		N/A		Sand	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Sulphate (Total)	M	2430	%	0.010		0.13		< 0.010		0.071		0.049	
Organic Matter	M	2625	%	0.40		21		1.5		13		1.9	

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Results - Soil

Project: J3644/16/E - Huddersfield Open Market

Client: Rogers Geotechnical Services Ltd			**Chemtest Job No.:**		16-24965	16-24965	16-24965	16-24965
Quotation No.:			**Chemtest Sample ID.:**		365672	365673	365674	365675
Order No.: 1016-33			Client Sample Ref.:		WS3	WS3	WS3	WS3
			Client Sample ID.:		C1	C1	C4	C4
			Sample Type:		SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.56	0.75	3.56	3.80
			Date Sampled:		13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016
			Asbestos Lab:			COVENTRY		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Cadmium	M	2450	mg/kg	0.10	0.19		0.10	
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50		< 0.50	
Copper	M	2450	mg/kg	0.50	38		28	
Mercury	M	2450	mg/kg	0.10	0.17		< 0.10	
Nickel	M	2450	mg/kg	0.50	24		28	
Lead	M	2450	mg/kg	0.50	37		21	
Zinc	M	2450	mg/kg	0.50	75		72	
Vanadium	U	2450	mg/kg	5.0	25		23	
Arsenic	M	2450	mg/kg	1.0	10		8.6	
Selenium	M	2450	mg/kg	0.20	< 0.20		< 0.20	
Cyanide (Free)	M	2300	mg/kg	0.50	< 0.50		< 0.50	
Total Phenols	M	2920	mg/kg	0.30	< 0.30		< 0.30	
Naphthalene	M	2700	mg/kg	0.10	2.9		< 0.10	
Acenaphthylene	M	2700	mg/kg	0.10	0.33		< 0.10	
Acenaphthene	M	2700	mg/kg	0.10	3.5		< 0.10	
Fluorene	M	2700	mg/kg	0.10	2.9		< 0.10	
Phenanthrene	M	2700	mg/kg	0.10	23		< 0.10	
Anthracene	M	2700	mg/kg	0.10	4.9		< 0.10	
Fluoranthene	M	2700	mg/kg	0.10	22		< 0.10	
Pyrene	M	2700	mg/kg	0.10	20		< 0.10	
Benzo[a]anthracene	M	2700	mg/kg	0.10	7.9		< 0.10	
Chrysene	M	2700	mg/kg	0.10	8.6		< 0.10	
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	9.4		< 0.10	
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	3.6		< 0.10	
Benzo[a]pyrene	M	2700	mg/kg	0.10	7.1		< 0.10	
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	4.4		< 0.10	
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	1.2		< 0.10	
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	4.2		< 0.10	
Total Of 16 PAH's	M	2700	mg/kg	2.0	130		< 2.0	
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0		< 1.0	

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Results - Soil

Project: J3644/16/E - Huddersfield Open Market

Client: Rogers Geotechnical Services Ltd		**Chemtest Job No.:**			16-24965	16-24965	16-24965	16-24965
Quotation No.:		**Chemtest Sample ID.:**			365672	365673	365674	365675
Order No.: 1016-33		Client Sample Ref.:			WS3	WS3	WS3	WS3
		Client Sample ID.:			C1	C1	C4	C4
		Sample Type:			SOIL	SOIL	SOIL	SOIL
		Top Depth (m):			0.56	0.75	3.56	3.80
		Date Sampled:			13-Oct-2016	13-Oct-2016	13-Oct-2016	13-Oct-2016
		Asbestos Lab:				COVENTRY		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Total Aliphatic Hydrocarbons	M	2680	mg/kg	5.0	< 5.0		< 5.0	
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Total Aromatic Hydrocarbons	M	2680	mg/kg	5.0	< 5.0		< 5.0	
Total Petroleum Hydrocarbons	M	2680	mg/kg	10	< 10		< 10	
pH	M	2010		N/A	8.6	8.6	7.4	6.1
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010	0.010	< 0.010	< 0.010
ACM Type	U	2192		N/A		-		-
Asbestos Identification	U	2192	%	0.001		No Asbestos Detected		No Asbestos Detected
Moisture	N	2030	%	0.020	17	20	12	14
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	Clay	Sand	Clay	Clay
Sulphate (Total)	M	2430	%	0.010	0.031		< 0.010	
Organic Matter	M	2625	%	0.40	2.2		1.3	

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Test Methods

SOP	Title	Accreditation	Parameters included	Method summary
2010	pH Value of Soils	UKAS accreditedMCERTS accredited	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	UKAS accreditedMCERTS accredited	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	UKAS Accredited	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	UKAS accreditedMCERTS accredited	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	UKAS accreditedMCERTS accredited*	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	UKAS accreditedMCERTS accredited	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	UKAS accreditedMCERTS accredited	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2680	TPH A/A Split	Normal Level TPH A/A Split is MCERTS accredited. Low Level TPH A/A Split is unaccredited	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	UKAS accreditedMCERTS accredited	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
2920	Phenols in Soils by HPLC	UKAS accreditedMCERTS accredited	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"

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

Sample Retention and Disposal

All soil samples will be retained for a period of 45 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.co.uk