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PHASE 2

GEO-ENVIRONMENTAL REPORT

job number	C3875/23/E/5885
date	04/12/23
site address	Crows Nest Farm, Crawshaw Lane Flockton, Huddersfield West Yorkshire WF4 4BY
written by	J.Finch
checked by	S.Alexander
issued by	J.Finch

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Report on a Phase 2 Geo-environmental Investigation

Location:	Crows Nest Farm Crawshaw Lane, Flockton, Huddersfield, WF4 4BY
For:	Mr & Mrs Ellis
Consultants:	Highstone Housing Services Ltd
Report No.	C3875/23/E/5885 Report date: December 2023

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

James Finch BSc FGS
Graduate Engineer

Scott Alexander BSc FGS
Geo-environmental Engineer

Report Summary[1]

Item	Comments	Section
Development	Erection of a new detached residential dwelling with car parking and garden areas.	1.
Geology	Superficial geology – None. Solid geology – Sandstone mudstone and ironstone of the Birstall Rock.	5.
Strata Conditions	0.5m to 0.6m capping of cohesive made ground over gravels and clay weathered from the sandstone of the Birstall Rock.	6.
Groundwater	None encountered during investigation.	6.2
Foundation Design	Shallow strip foundation solution, based at 0.8m.	10.1
Effect of Sulphates	DS Class: DS-1 ACEC Class: AC-3z DC Class: DC-3z	10.4
Contamination	Slightly elevated PAHs, below SSVs.	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

It is understood that the land at Crows Nest Farm, Crawshaw Lane, Flockton, Huddersfield, WF4 4BY is to be developed by the construction of a new detached residential dwelling with car parking and garden areas. 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 Rogers Geotechnical Services (RGS) and the results were presented as report number C3875/23/E/5885 in October 2023. This report has been used extensively during the current intrusive investigation.

4. Fieldworks

The fieldworks were undertaken on the 6th November 2023 and included the following:

- Three windowless sample boreholes.
- Standard penetration tests within each borehole.
- Three gas monitoring standpipes.
- One hand dug trial pit.

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 87mm for the first 1m increment through 77mm for the second 1m increment. 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 at regular depth increments within each windowless sample borehole. 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 Gas Monitoring Standpipes

Gas monitoring standpipes were installed between 1.85m and 2.0m 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 above, and the installation was capped with a stop box cover in a concrete surround.

4.4 Hand Dug Trial Pit

One trial pit was excavated using hand-held digging equipment near to the diesel tank identified onsite in order to assess if its presence had resulted in contamination of the surrounding soils. The soils were logged on site in general accordance with BS5930: 2015+A1: 2020, and full descriptions are given on the trial pit records which are presented in Appendix 3. Samples were taken from the trial pits for environmental testing.

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]
Artificial Geology	Made Ground/Fill	N/A	Not indicated on site although infilled ground, presumably associated with coal workings, are shown to be present 10m south of the site.
Superficial Geology	N/A	N/A	Not indicated to underlie the site.
Solid Geology	Birstall Rock	Cropper Gate Rock Park 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.

A dip marker located within the same faulted block 1.1km to the northwest of the site indicates that the dip of the solid geology in the general area is 1-2 ° to the southeast.

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
0.5 – 0.6	MADE GROUND (Cohesive)	ALL	None
1.3 – 1.5	Clayey sandy GRAVEL	WS01 & WS03	None
1.6	Sandy gravelly silty CLAY	WS01	None
1.85	Silty sandy GRAVEL	WS02	None
2.3	Sandy cobbly GRAVEL	WS01 & WS03	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*]

6.1 General Strata

In general, the borehole records indicate that a 0.50m to 0.60m capping of cohesive made ground was present in each position, in WS01 and WS03 this was followed by a clayey sandy gravel to depths of 1.30m to 1.50m. This gravel was underlain by sandy gravelly silty clay to a depth of 1.60m in WS01. WS01 and WS03 were terminated at 2.30m bgl in sandy cobbly gravel. The entirety of natural deposits encountered within WS02 comprised medium dense becoming very dense silty sandy gravel.

It is considered that the strata encountered represented residual soils transitioning to the upper weathered fraction of the Birstall Rock which is recorded on the published geological records to underlie the site.

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 tests carried out in in each borehole are summarised in the following table:

Table 3: Summary of Standard Penetration Tests

Strata	Depth Range (m)	SPT 'N' (Blows/300mm)		Comments
		Granular soils	Cohesive soils	
Clayey sandy GRAVEL	1.00	22	–	SPT's indicate granular material is in a medium dense in-situ condition
Silty sandy GRAVEL	1.00 1.60	28 – 50	–	SPT's indicate granular material is in a medium dense to very dense in-situ condition
Sandy cobbly GRAVEL	2.00	60 – 110	–	SPT's indicate granular material is in a very dense in-situ condition. Typical of weathered rock.

8. Laboratory Testing - Geotechnical

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

- Determination of particle density — BS EN ISO 17892-3:2015
- Determination of particle size distribution (Dry) — BS EN ISO 17892-4:2016: 5.2
- Soluble sulphate content — BS 1377-3:2018+A1:2021: Pt3: 7.3
- pH value — BS 1377-3:2018+A1:2021: Pt3: 12
- California Bearing Ratio — BS 1377-4:1990: Pt4: 7

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

Table 4: Summary of Geotechnical Test Results

Test type	Number of tests	Range of results		Comments
Standard Proctor Compaction	1	Optimum Dry Density	1.95Mg/m3	95% compaction target 1.85Mg/m^3
		Optimum Moisture Content	13%	
California Bearing Ratio	1	Average CBR	30%	Moisture contents significantly below optimum.
		Moisture Content	9.35%	
Particle size distribution (Dry sieve)	2	Gravel Sand Silt/Clay	54 - 67% 31 - 37% 2 - 9%	Slightly clayey to clayey very sandy fine to coarse subangular and angular GRAVEL. Uniformity coefficient 51.3 – 89.7 Curvature coefficient 0.244 - 1.82
Soluble sulphate & pH	1	SO_4 pH	0.04g/l 4.88	DS Class: DS-1 ACEC Class: AC-3z DC Class: DC-3z

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 i2 Analytical 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 a new detached residential dwelling with car parking and garden areas. At the time of writing this report the precise method of construction is not known, thus the discussion below is of a generalised nature.

10.1 Foundations

It cannot be recommended that foundations be constructed directly within the made ground encountered during this investigation.

Competent near surface soils weathered from sandstone of the Birstall Rock are present throughout the footprint of the proposed house, it is considered that these will provide a suitable bearing stratum, provided that the foundations are placed 200mm into soil generally described as being present in at least a medium dense insitu condition. Within this investigation, suitable soils have been revealed from depths of 0.6m.

It is considered that strip or spread foundations constructed within this material, at a minimum depth of say 0.8m, could be designed assuming an allowable increase in stress given in the following table:

Table 5: Allowable Increase in Stress

Foundation Type		Strip Footings			Spread/Pad Footings		
Foundation Breadth	B (m)	0.6	0.9	1.2	0.5	1.0	2.0
Foundation Depth	D (m)	0.8			0.8		
Allowable Increase in Stress	(kN/m²)	110	165	185	115	230	230

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. 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 softening or loosening of the sub-grade due to the ingress of surface water.

No groundwater was recorded during the investigation however, should seepages of groundwater be encountered it is considered that they 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.

The stability of the 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.

10.2 Ground-floors

In light of the shallow made ground, which was revealed to depths of up to 0.6m, it is considered that ground bearing ground floor slabs could be employed. In this instance it would be necessary to remove the made ground and either place the floor slab on the competent soils beneath or build up to the required level with suitable engineered fill.

10.3 Hard-standing Areas

It is considered that any hard-standing at the site could be constructed employing traditional pavement design. A design California Bearing Ratio (CBR) of >20% could be employed in the pavement design[4]. 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.

10.4 Effect of Sulphates

In view of the nature of the underlying soils it is considered that the design sulphate class be assessed with reference to Table C2[5], which is provided in BRE Special Digest 1, *Concrete in aggressive ground*: Part C. On the basis of this table and considering the soluble sulphate contents recorded, it can be shown that well compacted buried concrete should be designed in accordance with Class DS-1 requirements. Assuming static groundwater, the table also indicates that the aggressive chemical environment for concrete (ACEC) classification is AC-3z.

In order to evaluate the design chemical (DC) class for the buried concrete at this site reference should be made to Table D1[6], 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-3z is required.

11. Discussion of Ground Conditions - Environmental

11.1 Discussion of Test Results

It is understood that the site is to be developed by the erection of a new detached residential dwelling with car parking and garden areas. Consequently, the site may be classified as residential with plant uptake.

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

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 1.6% and 2.4%. 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[7] 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 6: Summary of Contaminated Areas

Location	Depth (m)	Contaminants found to be exceeding SSVs (Residential with plant uptake)
WS01	0.5	Benzo[g,h,i]perylene
WS03	0.5	Chrysene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Divenz(a,h)Anthracene, Benzo[g,h,i]perylene
TP01	0.5	None

Concentrations of Selenium, Cyanide (Free), Total Phenols, Naphthalene, Acenaphthylene, (aliphatic C5 to C12; aromatic C5 to C21) were below the detection limits for the tests. Detectable levels of all other contaminants were recorded in at least one position, but these fell below the associated Atrisk Soil Screening Values. In addition, no asbestos was detected within the soils samples tested.

It should be appreciated that the soil screening values for PAHs and TPHs (where appropriate) represents vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure, which is unlikely to significantly affect the combined assessment criterion[8]. In view of this, the ATRISK soil SSVs notes that the users may wish to consider using a combined assessment criterion if free product is not observed, the values for which are also provided on the summary of contamination analysis. It is therefore considered that the criteria for no free product should be adopted for the PAHs and TPHs at this site. The results of the contaminants found to exceed these screening values are tabulated below:

Table 7: Summary of Areas Contaminated by PAHs & TPHs

Location	Depth (m)	Contaminants found to be exceeding SSVs (Residential with Plant Uptake)
WS01	0.5	None
WS03	0.5	None
TP01	0.5	None

On the basis of the above information it is reasoned that the site can be classified as low risk with respect to the proposed residential with plant uptake end use.

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

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 8. Sources of contamination include the following:

On-site – None.

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 8.

[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 8: Conceptual Site Model and Site-Specific Risk Assessment [Contamination: None]				
Conceptual Site Model			**Site Specific Risk Assessment**	
Pathways	**Receptor**	**Linkage Present?**	**Risk Rating**	**Notes**
Direct contact/dermal absorption/soil ingestion	Operative	Yes – contact with soils likely during works. Soil samples below SSVs.	Moderate	Some minor contamination potentially present within the made ground, however, soil samples below SSVs. Precautionary measures will be required during the construction phase. However, as the site is anticipated to be secured during the development phase, contamination is not anticipated to affect neighbours.
	End User	Yes – soil samples below SSVs and site to be developed into a residential dwelling with garden areas.	Low	
	Neighbours	Yes – soil samples below SSVs, a residential dwelling neighbours the site.	Low	
Inhalation of Dust/Vapours	Operative	Yes – dust may be derived from any contaminated soils, however soil samples below SSVs.	Moderate	Some contamination potentially present underlying the site. Precautionary measures will be required during the construction phase to prevent offsite migration of dust.
	End User	Yes – dust may be derived from contaminated soils, however soil samples below SSVs.	Low	
	Neighbours	Yes – soil samples below SSVs, residential property neighbours the site and possible inhalation of dust during the works.	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	Some minor contamination potentially present within the made ground, however, soil samples below SSVs. However, any contamination at the site is considered to be of limited mobility, therefore the likelihood of contamination affecting neighbouring gardens is considered low risk.
	End User	Yes – soil samples below SSVs and site to be developed into a residential dwelling with garden areas.	Low	
	Neighbours	Yes – soil samples below SSVs and residential dwelling adjoins the site.	Low	
Migration of hazardous gases via permeable strata or shallow mining activity	Operative	Yes – mine workings known within 250m. Yes - ground gas monitoring is ongoing and the results will be provided within an addendum report. Yes - Neighbouring residential properties. No immediately adjoining structures.	Moderate	Presence of mine workings beneath the site, precautionary measures may be required during construction. Gas protections such as a membrane may be necessary. Gas monitoring program to be completed and updated risk assessment to be provided in addendum report.
	End User		Moderate	
	Neighbours		Low	
Spillage/loss/run off direct to receiving water	Controlled Waters	Yes – known controlled waters within 250m. Any contamination is not anticipated to be significantly mobile.	Low	Contamination potentially present underlying the site. Old services to be removed or capped.

Migration via permeable unsaturated strata	Controlled Waters	Yes – secondary A aquifer is present beneath the site. Site underlain by predominantly granular strata which may promote downward migration from the surface.	Moderate	
Run off via drainage/sewers etc	Controlled Waters	Yes – old services may be present on site, soil samples below SSVs.	Low	
Direct contact with contaminated soils	Plants	Yes - minor contamination present at the site which may affect plants, however, soil samples below SSVs.	Low	Soil samples below SSVs. Suitable growing medium for garden areas required.
Uptake via root system			Low	
Direct contact with contaminated soils	Building Materials	Yes – minor 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-3z. pH <5 risk to wrapped ductile iron and copper pipes. TPH contamination >C10-C20 precludes use of PE pipe.	Moderate (plastic services) Moderate (buried concrete)	Concrete mix of FND3z required in trench fill foundation. Please see section 11.3 for information on good building practice.
Direct contact with contaminated groundwater				
Exposure to Radon	Operative	No – Not in a radon affected area.	N/A	Less than 1% of properties are above the action level. No radon protection measures required.
	End User			
UXO Risk	Operative	Yes – the Zetica[12] online maps indicate that the site is at low risk from UXO.	Low	Unlikely to be affected by UXO.
	End User			

[12] Pre-desk study assessment [*online resource from www.zeticauxo.com*].

11.3 Indicative Remediation Strategy

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

11.3.1 General Approach to Construction

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 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 at all times.
- 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 soil should be sheeted over to prevent excessive amounts of airborne dust.
- 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.
- 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.

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

Construction

During the construction phase of the development the following items are required to protect the structure from the potential contaminants revealed at this site.

- Beneath, pavements and hard-standings clean inert granular sub-base should be employed.
- For buried concrete the results of the sulphate and pH testing indicate that the design sulphate class for the site should be DS-1. The ACEC Class is AC-3z and the DC Class is DC-3z. Therefore, a concrete mix of FND3z is required.

- 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.

Landscaped Areas

It is understood that there is proposed to include garden areas. In view of the lack of topsoil recorded on site a suitable growing medium will need to be imported to site to form garden areas. This will need to comprise a minimum of 150mm of suitably screened and tested topsoil overlying a minimum of 300mm of suitably screened and tested subsoil. Should shrubs or trees be required then thickness shall be increased in accordance with the guidance outlined in *BS 3882*.

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 material i.e. whole bricks, brick ties, timber or glass.

It should also be appreciated that any fill should be subjected to validation testing to assess its suitability. The following table has been taken from YALPAG[13] documentation and may be used as a guide. Depending on the origin and nature of the material, not all fill will require the sampling frequency and testing indicated, although this should be in agreement with any regulatory bodies (such as the Local Authority).

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

Table 9: Validation Sampling and Testing		
Fill Type	**Frequency**	**Minimum Determinands**
Virgin Quarried Material	1 or 2 depending on the type of stone utilised, to confirm the inert nature of the material.	Standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn)
Crushed Hardcore, Stone, Brick	Minimum 1 per 500m³	Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, total TPH. Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).
Greenfield/ Manufactured Soils	Minimum 3 Dependent on source and receptor, between 1 per 50m^3 and 1 per 250m^3	Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, pH and soil organic matter (SOM) (or calculated from total organic carbon (TOC)).
Brownfield/ Screened Soils	Minimum 6 Dependent on source and receptor, between 1 per 50m^3 and 1 per 100m^3	Standard metals/ metalloids (as above), PAH (16 USEPA speciation), TPH (CWG banded), asbestos, pH and SOM (or calculated from TOC). Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE)..

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

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

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

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

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

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

11.5 Verification Report

It is not anticipated that it will be necessary to produce a verification report for submission to any statutory authorities. However, should any fill be imported to site it may be necessary to produce a report characterising the suitability of the clean material. Such a report would in 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.

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.

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.
- Completion and reporting of ongoing gas monitoring.
- Discussions with foundation contractors regarding their method for installing strip footings.
- Discussions with ground work contractors in relation to the requirement for testing of materials to be disposed off-site (Waste Acceptance Criteria) and the suitability of imported materials.
- Discussions with service providers regarding suitable materials for pipe work given the nature of chemical determinands found within the soils on site.
- Discussions with contractors in relation to the suitability of materials and installation methods for vapour barriers, if required.
- 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) (2023), 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.
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  - 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

Notes:

Investigation positions approximated from site operative's notes.

RGS Environmental Geotechnical Specialists

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HD8 8LU

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

Client:

Mr & Mrs Ellis

Job Number:

C3875/23/E/5885

Project Details:

Crows Nest Farm, Crawshaw Lane, Flockton

Scale: Not to scale - reference only

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

Appendix 2

Borehole Records

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **WS01**

Sheet 1 of 1

Project Name:	Crows Nest Farm, Crawshaw Lane, Flockton	Project No. C3875/23/E/5885	Co-ords:	Hole Type WLS
Location:	Crow Nest Farm, Crawshaw Lane, Flockton, Huddersfield, West Yorkshire, WF4 4BY		Level:	Scale 1:25
Client:	Mr & Mrs Ellis		Dates: 06/11/2023	Logged By JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.50								MADE GROUND (Dark brown slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is macadam and sandstone).
							0.50			
				87	100					Medium dense grey and brown clayey slightly sandy fine to coarse subangular and angular GRAVEL of sandstone with low cobble content. Sand is fine to coarse. Cobbles are of subangular sandstone.
		1.00	SPT			N=22 (4,3/4,4,6,8)				RESIDUAL SOILS OF THE BIRSTALL ROCK
							1.30			Stiff grey and brown slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is fine to medium subangular sandstone.
		1.40		77	90					
							1.60			RESIDUAL SOILS OF THE BIRSTALL ROCK
		2.00	SPT			110 (30,45/110 for 150mm)				Very dense grey and brown slightly sandy fine to coarse subangular and angular GRAVEL of sandstone with low cobble content. Sand is fine to coarse. Cobbles are of subangular sandstone.
							2.30			WEATHERED BIRSTALL ROCK
										End of Borehole at 2.30m

1 2 3 4 5

Remarks

No groundwater encountered.

Refusal at 2.3m.

AGS

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **WS02**

Sheet 1 of 1

Project Name:	Crows Nest Farm, Crawshaw Lane, Flockton	Project No. C3875/23/E/5885	Co-ords:	Hole Type WLS
Location:	Crow Nest Farm, Crawshaw Lane, Flockton, Huddersfield, West Yorkshire, WF4 4BY		Level:	Scale 1:25
Client:	Mr & Mrs Ellis		Dates: 06/11/2023	Logged By JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.55			MADE GROUND (Dark brown slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is macadam and sandstone).
		1.00	SPT	87	100	N=28 (5,5/7,7,7,7)				Medium dense becoming very dense grey and brown slightly silty slightly sandy fine to coarse subangular and angular GRAVEL of sandstone with low cobble content. Sand is fine to coarse. Cobbles are of subangular sandstone. RESIDUAL SOILS OF THE BIRSTALL ROCK
		1.10 - 1.30								
		1.60	SPT	77	100	50 (16,30/50 for 75mm)	1.85			End of Borehole at 1.85m

Remarks

No groundwater encountered.

Refusal at 1.85m.

AGS

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **WS03**

Sheet 1 of 1

Project Name:	Crows Nest Farm, Crawshaw Lane, Flockton	Project No. C3875/23/E/5885	Co-ords:	Hole Type WLS
Location:	Crow Nest Farm, Crawshaw Lane, Flockton, Huddersfield, West Yorkshire, WF4 4BY		Level:	Scale 1:25
Client:	Mr & Mrs Ellis		Dates: 06/11/2023	Logged By JF

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.50								MADE GROUND (Dark brown slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is macadam and sandstone).
				87	100		0.60			Medium dense grey and brown clayey very sandy fine to coarse subangular and angular GRAVEL of sandstone with low cobble content. Sand is fine to coarse. Cobbles are of subangular sandstone.
		1.00	SPT			N=28 (20,15/14,6,4,4)				RESIDUAL SOILS OF THE BIRSTALL ROCK
		1.30 - 1.50		77	75		1.50			Very dense grey and brown slightly sandy fine to coarse subangular and angular GRAVEL of sandstone with low cobble content. Sand is fine to coarse. Cobbles are of subangular sandstone.
		2.00	SPT			60 (30,20/60 for 150mm)				WEATHERED BIRSTALL ROCK
							2.30			End of Borehole at 2.30m

1 2 3 4 5

Remarks

No groundwater encountered.

Refusal at 2.3m.

AGS

Appendix 3

Trial Pit Records

Trial Pit Log

Trialpit No **TP01**

Sheet 1 of 1

Project Name:	Crows Nest Farm, Crawshaw Lane, Flockton	Project No. C3875/23/E/5885	Co-ords: - Level:	Date 06/11/2023
Location:	Crow Nest Farm, Crawshaw Lane, Flockton, Huddersfield, West Yorkshire, WF4 4BY	Dimensions (m): Depth 0.50	0.5 / 0.5	Scale 1:25
Client:	Mr & Mrs Ellis			Logged AB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.00 - 0.50			0.50			MADE GROUND (Dark brown slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is macadam and sandstone).
							Trial pit abandoned due to reaching natural ground. End of pit at 0.50 m

1 2 3 4 5

Remarks: No groundwater encountered.

Trial pit abandoned due to reaching natural ground 0.5m.

Stability: Stable

Appendix 4

Laboratory Testing

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LABORATORY REPORT

job number	C3875/23/E/5885
date	04/12/23
site address	Crows Nest Farm, Crawshaw Lane Flockton, Huddersfield West Yorkshire WF4 4BY
date scheduled	J.Finch
date issued	S.Alexander
issued by	J.Finch

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8948

Schedule of UKAS Accredited Laboratory Tests

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

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Disclaimer

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

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GEOTECHNICAL TESTING RESULTS

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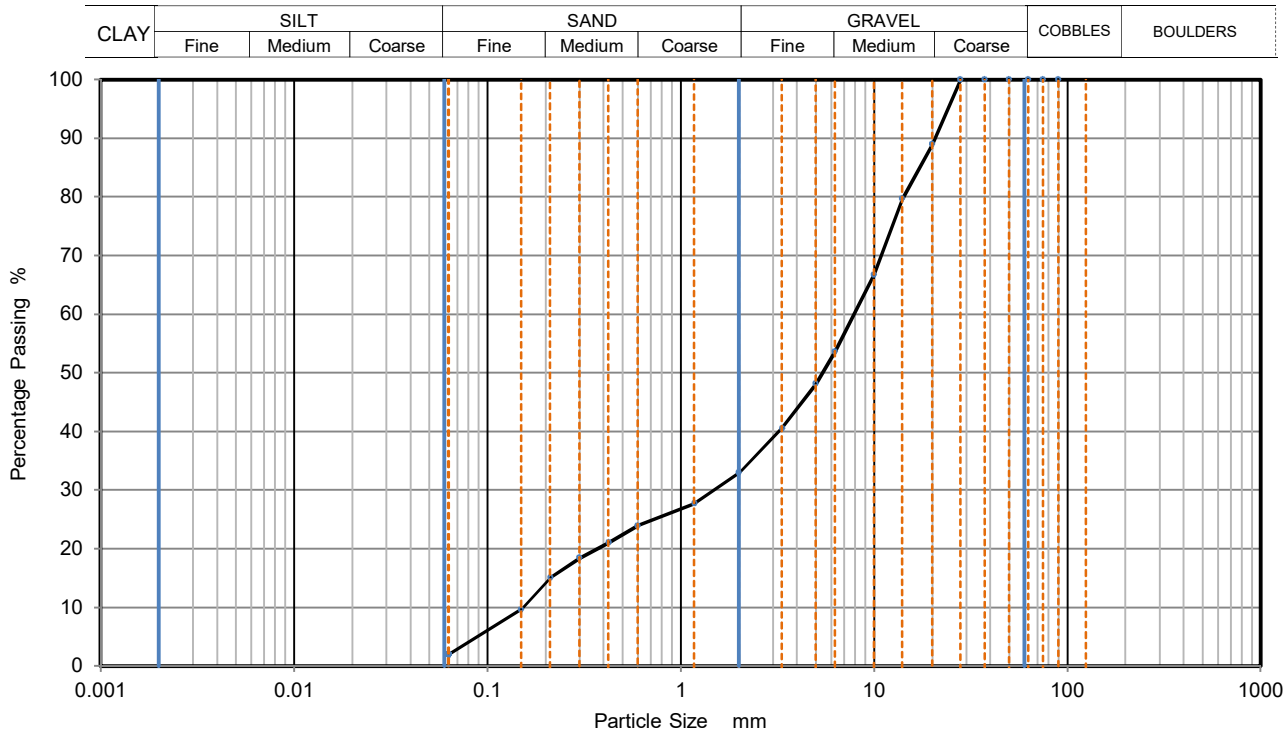
PARTICLE SIZE DISTRIBUTION

				Job Ref	C3875/23/E/5885
				Borehole/Pit No.	WS02
Site Name	Crows Nest Farm, Crawshaw Lane, Flockton			Sample No.	3
Soil Description	Slightly grey and brown silty slightly sandy fine to coarse subangular and angular GRAVEL.			Depth, m	1.10
Specimen Reference	3	Specimen Depth	1.1 m	Sample Type	
Test Method	ISO 17892 -4, by sieving on pre-dried or dry sample			KeyLAB ID	3



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	89		
14	80		
10	67		
6.3	54		
5	48		
3.35	41		
2	33		
1.18	28		
0.6	24		
0.425	21		
0.3	18		
0.212	15		
0.15	10		
0.063	2		

Dry Mass of sample, g	1172

Sample Proportions	% dry mass
Very coarse	0
Gravel	67
Sand	31
Fines <0.063mm	2

Grading Analysis		
D100	mm	28
D60	mm	7.9
D30	mm	1.49
D10	mm	0.154

Remarks

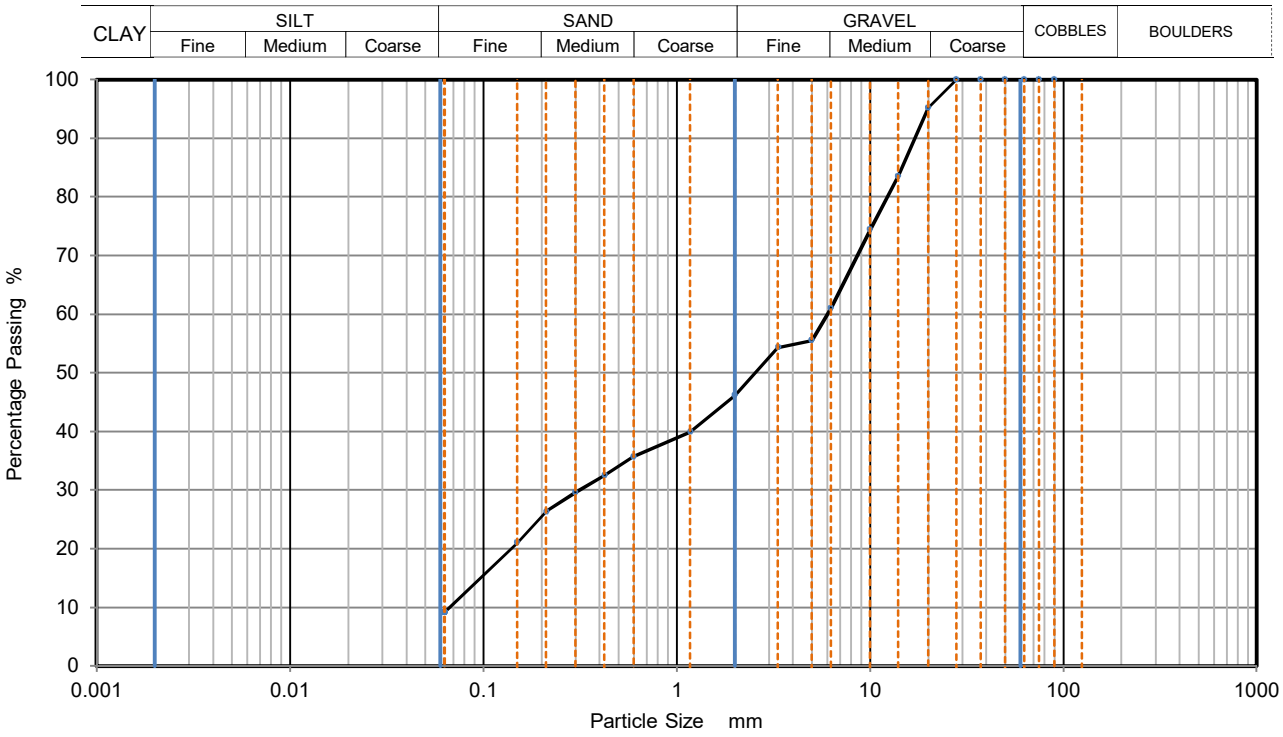
Preparation and testing in accordance with BS EN ISO 17892 - 4, unless noted below

Test performance date: 07/11/2023

Operator	Checked	Approved	Sheet printed	Fig 1
MT	Harry	Harry	20/11/2023	Sheet 1

PARTICLE SIZE DISTRIBUTION

				Job Ref	C3875/23/E/5885
				Borehole/Pit No.	WS03
Site Name	Crows Nest Farm, Crawshaw Lane, Flockton			Sample No.	5
Soil Description	Slightly clayey slightly sandy fine to coarse subangular and angular GRAVEL.			Depth, m	1.30
Specimen Reference	2	Specimen Depth	1.3 m	Sample Type	
Test Method	ISO 17892 -4, by sieving on pre-dried or dry sample			KeyLAB ID	5



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	84		
10	74		
6.3	61		
5	56		
3.35	54		
2	46		
1.18	40		
0.6	36		
0.425	33		
0.3	30		
0.212	26		
0.15	21		
0.063	9		

Dry Mass of sample, g	934

Sample Proportions	% dry mass
Very coarse	0
Gravel	54
Sand	37
Fines <0.063mm	9

Grading Analysis		
D100	mm	28
D60	mm	6.04
D30	mm	0.315
D10	mm	0.0673

Remarks

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

Test performance date: 07/11/2023

Operator	Checked	Approved	Sheet printed	Fig 1
MT	Harry	Harry	20/11/2023	Sheet 2

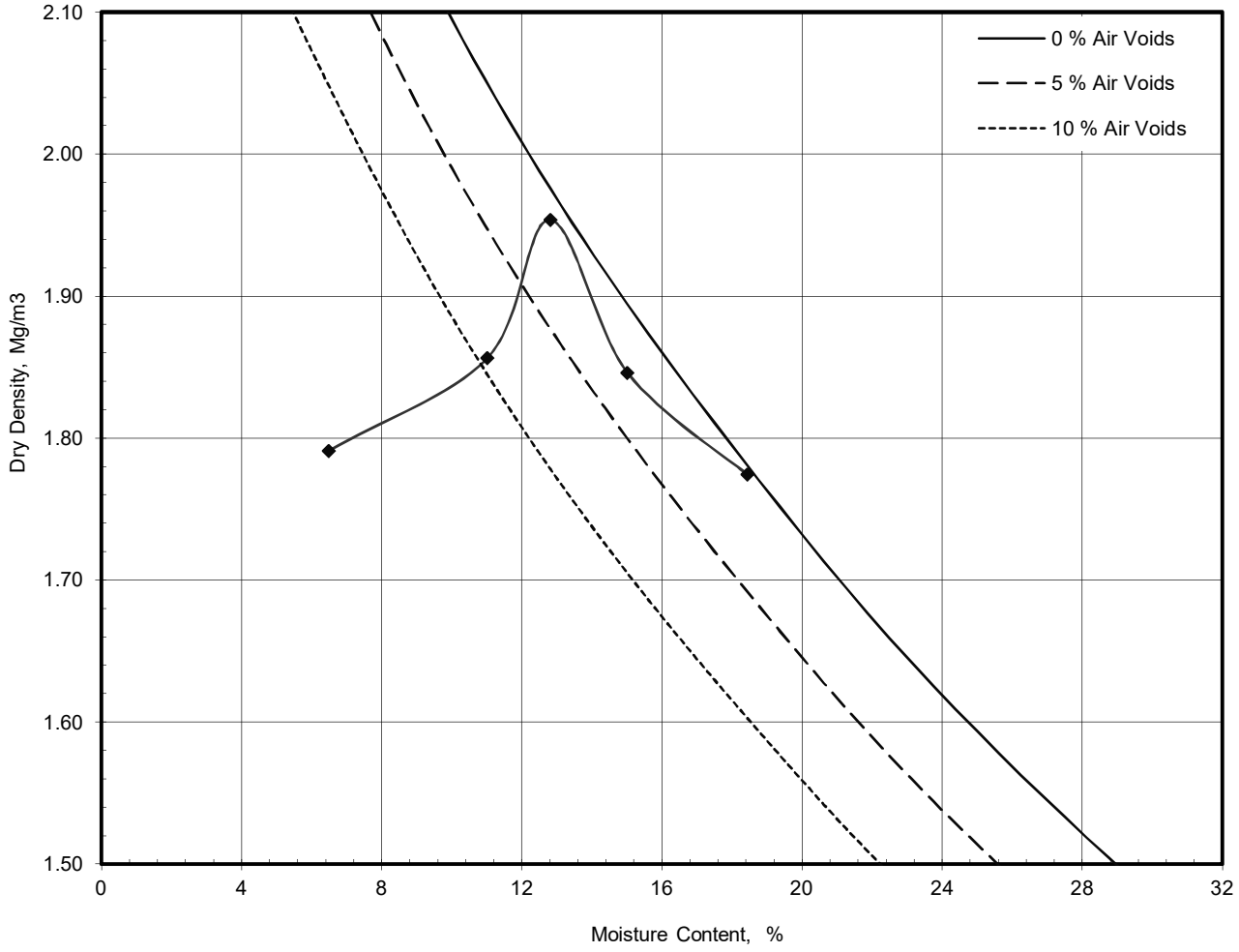
Summary of Geotechnical Chemical Test Results

Project No.	Project Name
C3875/23/E/5885	Crows Nest Farm, Crawshaw Lane, Flockton

Hole No.	Sample				Soil Description	Org	LOI	pH	Sulphate as SO_4			Chloride, Cl		CO_2	TDS	<2mm	Remarks
	Ref	Top	Base	Type					Total acid sol.	2:1 water :soil	ground water	water sol.	acid sol.				
						%	%		%	g/l	g/l	%	%	%	mg/l	%	
WS01	2	1.40	1.40		Stiff grey and brown slightly sandy gravelly silty CLAY. Sand is			4.88		0.04							

Key				Date Printed	Approved By	Table
Tests performed in accordance with BS 1377 unless annotated otherwise						
Org	Organic matter content	Cl	Chloride content	20/11/2023		2
LOI	Mass loss on ignition at 440°C	CO_2	Carbonate content (rapid titration)			sheet
		TDS	Total Dissolved Solids		HJL	1

	Dry Density / Moisture Content Relationship Light Compaction				Job Ref	**C3875/23/E/5885**
					Borehole / Pit No	A
Site Name	**Crows Nest Farm, Crawshaw Lane, Flockton**				Sample No	A
Soil Description	Amalgamation of gravels from all three boreholes.				Depth	0.00 m
Specimen Ref.	4	Specimen Depth	0	m	Sample Type	
Test Method	BS1377:Part 4:1990, clause 3.4, 2.5kg rammer				Keylab ID	A
					Compaction Test Reference/No.	1



Preparation		Material used was natural
Mould Type		CBR
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	16
Particle Density - Assumed	Mg/m³	2.65
Grading Zone		3
Maximum Dry Density	Mg/m³	**1.95**

Optimum Moisture Content	%	**13**

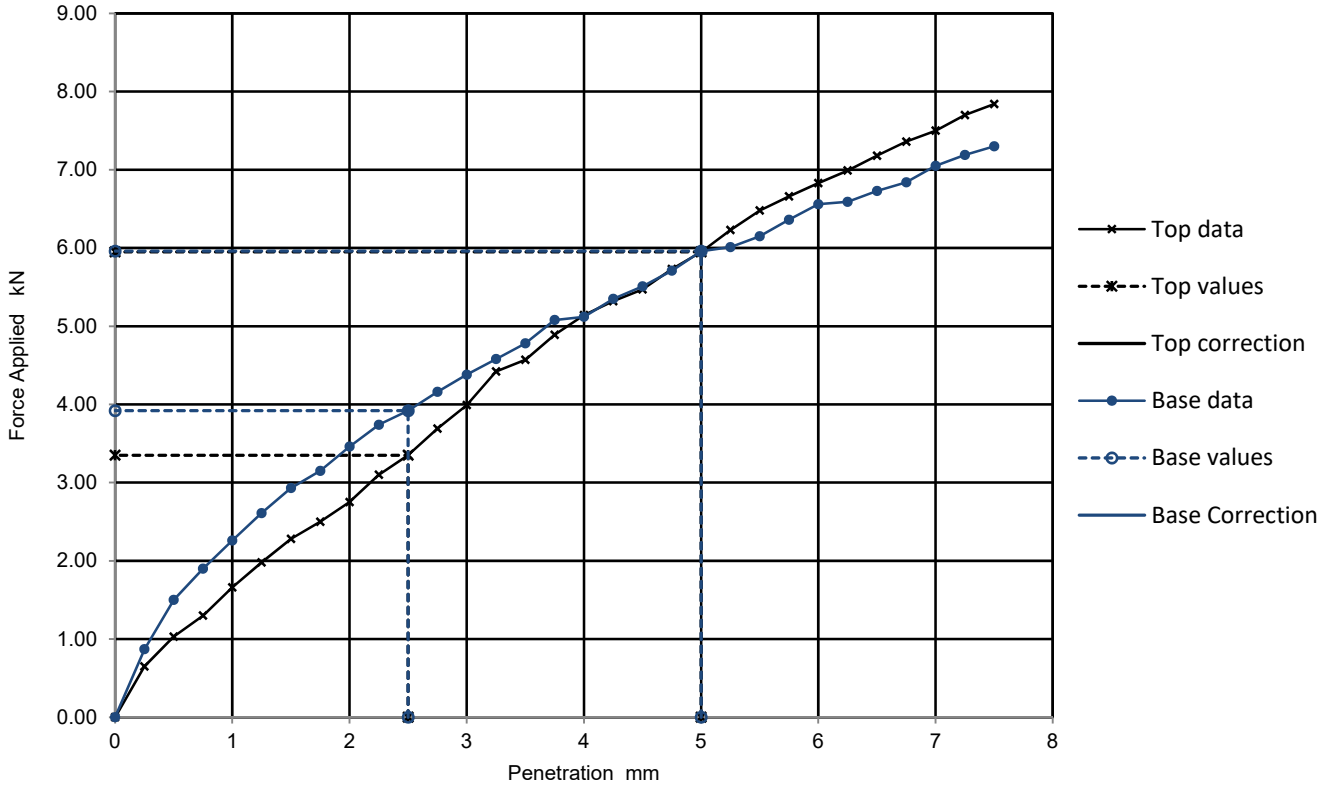
Operator	Checked	Approved	Remarks	
EC	Harry	Harry		**Fig 3**
				Sheet 1 of 1

RGS	**California Bearing Ratio (CBR)**				Job Ref	C3875/23/E/5885
					Borehole/Pit No.	A
Site Name	Crows Nest Farm, Crawshaw Lane, Flockton				Sample No.	A
Soil Description	Amalgamation of gravels from all three boreholes.				Depth m	0.00
Specimen Reference	3	Specimen Depth	0.00	m	Sample Type	
Specimen Description	Amalgamation of gravels from all three boreholes.				KeyLAB ID	A
Test Method	BS 1377- 4:1990				CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		16	%	Dry density after soaking		Mg/m^3
Initial Specimen details	Bulk density	2.04	Mg/m^3	Surcharge applied	2	kg
	Dry density	1.86	Mg/m^3		1	kPa
	Moisture content	9.8	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP		25	30	30	30	10.3
BASE		30	30	30		8.4

General remarks	Test specific remarks	Approved
	Results reported under 1kN are below the loadcells lower limit and are outside of the calibrated range.	Harry

Fig No.	4
Sheet No	1

Lab Sheet Reference :

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RGS Environmental Geotechnical Specialists

Rogers Geotechnical Services Ltd
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Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 23-67642

Project / Site name:	Crows Nest Farm	**Samples received on:**	08/11/2023
Your job number:	C3875	**Samples instructed on/ Analysis started on:**	08/11/2023
Your order number:	RGS3875	**Analysis completed by:**	16/11/2023
Report Issue Number:	1	**Report issued on:**	16/11/2023
Samples Analysed:	3 soil samples		

Signed:

Dominika Liana
Junior Reporting Specialist
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 23-67642
Project / Site name: Crows Nest Farm
Your Order No: RGS3875

Lab Sample Number				2872130	2872131	2872132
Sample Reference				WS01	WS03	TP01
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.50	0.00-0.50	0.00-0.50
Date Sampled				07/11/2023	07/11/2023	07/11/2023
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Stone Content	%	0.1	NONE	26	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	13	12	13
Total mass of sample received	kg	0.001	NONE	0.5	0.6	0.5
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	MJN	MJN	MJN

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.3	7.7	7.6
Free Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Total Sulphate as SO4	%	0.005	MCERTS	0.019	0.023	0.022
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	18	150	20
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.0089	0.0728	0.01
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	8.9	72.8	10
Organic Matter (automated)	%	0.1	MCERTS	2.4	1.6	2

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	0.25	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	0.21	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.05	1.8	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	0.42	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.07	2.4	< 0.05
Pyrene	mg/kg	0.05	MCERTS	0.08	2.1	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.88	< 0.05
Chrysene	mg/kg	0.05	MCERTS	0.09	0.76	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	0.09	0.97	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	0.33	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.06	0.88	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.37	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.1	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.06	0.46	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	< 0.80	11.9	< 0.80

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Analytical Report Number: 23-67642
Project / Site name: Crows Nest Farm
Your Order No: RGS3875

Lab Sample Number				2872130	2872131	2872132
Sample Reference				WS01	WS03	TP01
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.50	0.00-0.50	0.00-0.50
Date Sampled				07/11/2023	07/11/2023	07/11/2023
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Heavy Metals / Metalloids						
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.4	8.1	8.3
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8
Copper (aqua regia extractable)	mg/kg	1	MCERTS	23	25	19
Lead (aqua regia extractable)	mg/kg	1	MCERTS	43	16	18
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	21	18	22
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	23	22	26
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	100	61	61
Monoaromatics & Oxygenates						
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
p & m-xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
o-xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0
Petroleum Hydrocarbons						
TPH-CWG - Aliphatic >EC5 - EC6 $_{HS\_1D\_AL}$	mg/kg	0.02	NONE	< 0.020	< 0.020	< 0.020
TPH-CWG - Aliphatic >EC6 - EC8 $_{HS\_1D\_AL}$	mg/kg	0.02	NONE	< 0.020	< 0.020	< 0.020
TPH-CWG - Aliphatic >EC8 - EC10 $_{HS\_1D\_AL}$	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050
TPH-CWG - Aliphatic >EC10 - EC12 $_{EH\_CU\_1D\_AL}$	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16 $_{EH\_CU\_1D\_AL}$	mg/kg	2	MCERTS	2.2	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21 $_{EH\_CU\_1D\_AL}$	mg/kg	8	MCERTS	10	< 8.0	19
TPH-CWG - Aliphatic >EC21 - EC35 $_{EH\_CU\_1D\_AL}$	mg/kg	8	MCERTS	100	31	42
TPH-CWG - Aliphatic (EC5 - EC35) $_{EH\_CU+HS\_1D\_AL}$	mg/kg	10	NONE	120	33	61
TPH-CWG - Aromatic >EC5 - EC7 $_{HS\_1D\_AR}$	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010
TPH-CWG - Aromatic >EC7 - EC8 $_{HS\_1D\_AR}$	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010
TPH-CWG - Aromatic >EC8 - EC10 $_{HS\_1D\_AR}$	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050
TPH-CWG - Aromatic >EC10 - EC12 $_{EH\_CU\_1D\_AR}$	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16 $_{EH\_CU\_1D\_AR}$	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21 $_{EH\_CU\_1D\_AR}$	mg/kg	10	MCERTS	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35 $_{EH\_CU\_1D\_AR}$	mg/kg	10	MCERTS	80	72	< 10
TPH-CWG - Aromatic (EC5 - EC35) $_{EH\_CU+HS\_1D\_AR}$	mg/kg	10	NONE	81	78	< 10

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

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number : 23-67642
Project / Site name: Crows Nest Farm

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
2872130	WS01	None Supplied	0.00-0.50	Brown clay and sand with gravel and stones.
2872131	WS03	None Supplied	0.00-0.50	Brown clay and sand with gravel.
2872132	TP01	None Supplied	0.00-0.50	Brown clay and sand with gravel.

Analytical Report Number : 23-67642
Project / Site name: Crows Nest Farm

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with dispersion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards. Refer to CoA for analyte specific accreditation.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS. Individual components MCERTS accredited	In-house method based on USEPA8260. Refer to CoA for analyte specific accreditation	L073B-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID. Refer to CoA for band specific accreditation.	In-house method with silica gel split/clean up.	L088/76-PL	D	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in NaOH and addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Total Sulphate in soil as %	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-PL	D	MCERTS

Analytical Report Number : 23-67642
Project / Site name: Crows Nest Farm

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

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

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

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

Sample Deviation Report

Analytical Report Number : 23-67642
Project / Site name: Crows Nest Farm

This deviation report indicates the sample and test deviations that apply to the samples submitted for analysis.Please note that the associated result(s) may be unreliable and should be interpreted with care.

Key: a - No sampling date b - Incorrect container c - Holding time d - Headspace e - Temperature

Sample ID	Other ID	Sample Type	Lab Sample Number	Sample Deviation	Test Name	Test Ref	Test Deviation
TP01	None Supplied	S	2872132	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
TP01	None Supplied	S	2872132	b	TPHCWG (Soil)	L088/76-PL	b
WS01	None Supplied	S	2872130	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS01	None Supplied	S	2872130	b	TPHCWG (Soil)	L088/76-PL	b
WS03	None Supplied	S	2872131	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS03	None Supplied	S	2872131	b	TPHCWG (Soil)	L088/76-PL	b

End of Report

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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	3.63	20.5	B/C
	Copper	4730		4790		A+
7	Mercury	8.81		15.80		A/D
8	Nickel	136		136		A+
	Lead	200		200		C
	Zinc	20000		20300		A+
	Vanadium	136		138		A+
	Semi and Non Metals					
1	Arsenic	37		37		C
10	Selenium	375		375		A
	Free Cyanide	34		34		A
9	Phenols (total)	267		1200		A
	Poly Aromatic Hydrocarbons	Free product	No free product	Free product	No free product	
20	Napthalene	0.829		12.2		A+
	Acenaphthene	157	608	2760		A+
	Fluorene	735		2610		A+
	Anthracene	10200		26200		A+
	Fluoranthene	983		2980		A+
	Pyrene	668		2120		A+
	Benzo(a)anthracene	1.71	4.52			A
2	Chrysene	0.44	585			A
2	Benzo(b)fluoranthene	1.22	7.72			A
2	Benzo(k)fluoranthene	0.686	84.4			A
2	Benzo(a)pyrene	1.51	4.95	2.05	4.95	B/C
2	Dibenzo(a,h)anthracene	0.00393	0.838			A*
2	Indeno(1,2,3-cd)pyrene	0.0614	7.31			A
2	Benzo(g,h,i)perylene	0.0187	96.2			A
	Petroleum Hydrocarbons					
	Aliphatic C5-C6	42.7		369		A+
	Aliphatic C6-C8	99.3		768	1240	A+
	Aliphatic C8-C10	13.9		204		A+
	Aliphatic C10-C12	49.9	81.7	297	1180	A+
	Aliphatic C12-C16	20.9	385	125	4130	A+
	Aliphatic C16-C21	210000		210100		A+
	Aliphatic C21-C35	210000		210100		A+
	Aromatic C5-C7 (Benzene)	0.137		0.871		A+
	Aromatic C7-C8 (Toluene)	113		780		A+
	Aromatic C8-C10	20.5		232		A+
	Aromatic C10-C12	70		468		A+
	Aromatic C12-C16	155	165	830		A+
	Aromatic C16-C21	319		1040		A+
	Aromatic C21-C35	1120		1710		A+

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.