Report on a Phase 2 Environmental Investigation

Location:	1 Long Moor Lane Shelley, Huddersfield, HD8 8LY.
For:	Mark Bruin
Report No.	C3197/22/E/4849 Report date: January 2023

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

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Report Summary[1]

Item	Comments	Section
Development	Construction of a single new residential dwelling with an associated garden area.	1.
Geology	Superficial geology – None. Solid geology – Pennine Lower Coal Measures Formation.	5.
Strata Conditions	Localised topsoil with made ground up to 1.10m, overlying cohesive deposits transitioning to completely weathered siltstone bedrock.	6.1
Groundwater	None encountered during investigation.	6.2
Contamination	Lead and localised asbestos contamination.	9.1.1
Gas	Characteristic Situation Level 1 adopted.	9.1.2
Effect of Sulphates	DC-1 concrete.	9.1.3

[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 1 Long Moor Road, Shelley is to be developed by the demolition of the existing shed and stables and subsequent construction of a single new residential dwelling with an associated garden area. 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 and to take 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 RB Geotechnical and the results were presented as report number RBG237 in June 2021. This report has been used extensively during the current intrusive investigation.

4. Fieldworks

The fieldworks were undertaken on the 15th December 2022 and included the following:

- Three windowless sample boreholes.
- Three dynamic probes.
- Three gas monitoring standpipes.

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

4.1 Windowless Sample Boreholes

These boreholes were sunk using a drive-in windowless sampler. The cores were undertaken in 1m lengths with diameters of 87mm and 77mm. 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.

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 Gas Monitoring Standpipes

Gas monitoring standpipes were installed between 1.10m and 2.10m 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 between 0.33m and 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.

5. Geology

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

Table 1: Geological Data for the Site

Strata Type	Strata Name[2]	Previous Name[3]	Description[3]
Superficial Geology	N/A	N/A	Not indicated to underlie the site.
Solid Geology	Pennine Lower Coal Measures Formation	Lower Coal Measures	Interbedded grey mudstone, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower part, and more numerous and thicker coal seams in the upper part.

[2] Sources: British Geological Survey (NERC) Map Sheet 86; Glossop; Solid and Drift Edition, and Geology of Britain Viewer [*online resource from www.bgs.ac.uk*]
[3] Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [*online resource from www.bgs.ac.uk*]

6. Strata Conditions

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

Table 2: Generalised Strata Profile

Depth m below ground level to underside of layer	**Strata Type**	**Positions Encountered**	**Groundwater Strikes** m below ground level
0.10 – 0.20	TOPSOIL.	WS01 & WS02	None
0.40 – 1.10	MADE GROUND (Granular).	All	None
0.55 – +1.10	MADE GROUND (Cohesive).	All	None
1.75 – +2.00	Sandy silty CLAY.	WS02 & WS03	None
+2.00	SILTSTONE.	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

6.1 General Strata

In general, the borehole records indicate that a 0.10m to 0.20m capping of topsoil was revealed at WS01 and WS02, but a 0.05m capping of asphalt was revealed within WS03.

Beneath this capping, granular and cohesive made ground was revealed to depths of 1.10m the base of which was not proven in WS01 due to refusal , overlying slightly sandy, slightly gravelly silty clay with localised gravel lenses in WS02 and WS03 at depths of 1.75m to +2.00m. Position WS03 then revealed extremely weak siltstone to termination depth. It is considered that this natural material is representative of the weathered fraction of the Pennine Lower Coal Measures Formation which is indicated to be present below 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 Gas and Water Level Monitoring

The standpipes were monitored between the 05th January and the 26th January 2023. The results of the gas monitoring undertaken to date are tabulated below and are shown in appendix 4.

Table 4: Gas monitoring

Location	Date	CH_4 (%)	CO_2 (%)	O_2 (%)	Flow (l/h)	Barometric Pressure (mb)	Water Level (m)	Standpipe Depth (m)
WS1	05.01.2023	0.1	0.5	21.4	0.0	998↓	0.92	1.13
	12.01.2023	0.1	0.5	21.2	0.0	979↔	0.89	
	19.01.2023	0.1	0.5	20.7	0.0	987↔	0.96	
	26.01.2023	0.0	0.6	21.0	0.0	1016↔	0.96	
WS2	05.01.2023	0.1	0.2	21.4	0.0	999↓	-	2.06
	12.01.2023	0.1	0.3	21.4	0.0	979↔	1.73	
	19.01.2023	0.1	0.3	21.5	0.0	988↔	1.99	
	26.01.2023	0.0	0.6	21.0	0.0	1016↔	-	
WS3	05.01.2023	0.1	0.5	21.4	0.0	999↓	1.64	2.08
	12.01.2023	0.1	0.5	21.1	0.0	979↔	1.34	
	19.01.2023	0.1	0.4	20.3	0.0	988↔	1.77	
	26.01.2023	0.0	0.9	21.0	0.0	1014↔	-	

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

The first three monitoring visits were undertaken using a Geotechnical Instruments (UK) Ltd. GA5000 (serial No G503524) which was last calibrated on the 24th August 2022. Subsequent monitoring rounds were also undertaken with a using a Ribble Enviro Ltd.GFM 436 (serial No. 10767) which was last calibrated on the 08th August 2022.

8. Laboratory Testing - Environmental

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

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

This testing was undertaken by i2 Analytical Ltd and the results of all of the chemical testing are presented in Appendix 4 of this report.

9. Discussion of Ground Conditions - Environmental

9.1 Discussion of Test Results

It is understood that the site is to be developed by the demolition of the existing shed and stable and subsequent construction of a single new residential dwelling with an associated garden area. Consequently, the site may be classified as residential with plant uptake.

9.1.1 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 4.0% and 5.2%. 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[4] 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 5: Summary of contaminated areas

Location	Strata	Depth (m)	Contaminants found to be exceeding SSVs (Residential with plant uptake)
WS01	Made Ground	0.6	Lead. PAHs (Chrysene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene).
WS02	Made Ground	0.4	PAHs (Chrysene, indeno[1,2,3-c,d]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene)
WS03	Made Ground	1.0	Lead. PAHs (Benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[g,h,i]perylene). Asbestos – Chrysotile and Amosite 0.001%

Concentrations of chromium(VI), mercury, selenium, free cyanide, phenols (total) and total petroleum hydrocarbons (aliphatic C5 to C12; aromatic C5 to C12) were below the detection limits for the tests. Detectable levels of all other contaminants were recorded, but these fell below the associated Atrisk Soil Screening Values.

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[5]. 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:

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

Table 6: Summary of areas contaminated by PAHs & TPHs			
Location	**Strata**	**Depth (m)**	**Contaminants found to be exceeding SSVs (Residential with plant uptake)**
WS1	Made Ground	0.60	None.
WS2	Made Ground	0.40	None.
WS3	Made Ground	1.00	None.

On the basis of the information above it can be concluded that the made ground can be generally classified as contaminated with lead. Asbestos fibres were detected in WS03, quantification of asbestos fibres returned as 0.001%

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9.1.2 Gas Concentrations

With respect to ground gas, the results of the monitoring visits indicated concentrations of methane at ranging between 0.0% and 0.1%, with concentrations of carbon dioxide ranging between 0.2% and 0.9%, in association with oxygen levels of between 20.3% and 21.5%. 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 979mb and 999mb.

In order to establish the gas screening value (GSV) for carbon dioxide or methane, the maximum gas concentration (expressed as a decimal) is multiplied by the borehole flow rate (l/hr). In this case 0.1% (0.001) methane was recorded along with 0.9% (0.005) carbon dioxide, in association with a maximum flow rate of 0.0 l/hr. Where no flow rates are recorded a maximum of 0.1l/hr shall be assumed. This results in a GSV of 0.00001 l/hr for methane and 0.0009% for carbon dioxide.

In accordance with table 2 of BS8485: 2015*, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings,* the site may be characterised as *Characteristic Situation Level 1*. It is therefore considered that there is a very low risk of harm to end users and site operatives and no special precautionary measures are required in accordance to Table 8.6, *Typical scope of gas protection measures,* of CIRIA report C665.

With regard to the number of monitoring visits required reference is made to Tables 5.5a and 5.5b of CIRIA report C665 (2007)[6]. Accepting that the proposed development is of high sensitivity (residential with gardens) and that the generation potential is very low, these tables suggest that 6 readings could be undertaken over a period of 3 months.

In this context, it should be noted that the gas screening value threshold for Characteristic Situation level 1, is <0.07 l/hr. Assuming the flow rate remains negligible the gas concentration would need to exceed 100% 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 over 100 l/hr which represents a

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

seven-hundred-fold increase. It is considered that these increases are not feasible given the flow rates and gas concentrations encountered.

In light of the above, it is considered that the site may be fully characterised as *Characteristic Situation Level 1*.

9.1.3 Effect of Sulphates

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

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

9.2 Site Specific Risk Assessment

9.2.1 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]

[7] Table C2, *Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations*
[8] Table D1, *Selection of the DC Class and the number of APMs for concrete elements where the hydraulic gradient due to groundwater is 5 or less: for general in-situ use of concrete.*
[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.

9.2.2 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 7. Sources of contamination include the following:

On-site – Made Ground (Lead and asbestos).

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 7.

Table 7: Conceptual Site Model and Site Specific Risk Assessment [Contamination: Lead and asbestos]				
Conceptual Site Model			**Site Specific Risk Assessment**	
Pathways	**Receptor**	**Linkage Present?**	**Risk Rating**	**Notes**
Direct contact/dermal absorption/soil ingestion	Operative	Yes – lead contamination found to be present at the site and contact with soil likely during works.	High	Lead contamination is present within the made ground underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways.
	End User	Yes – lead contamination found to be present at the site and site to be developed into a residential dwelling with landscaped areas.	High	
	Neighbours	Yes – lead contamination found to be present at the site and a populated residential and commercial area surrounds the site.	High	
Inhalation of Dust/Vapours	Operative	Yes – dust may be derived from contaminated soils. However, lead contamination is not considered likely to represent a significant vapour risk. Asbestos fibres present in made ground.	High (Dust) Low (Vapours)	Lead contamination is present within the made ground underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways. Measures to minimise dust generation on site.
	End User	Yes – dust may be derived from contaminated soils. However, lead contamination is not considered likely to represent a significant vapour risk.	High (Dust) Low (Vapours)	
	Neighbours	Yes – contamination found to be present at the site and residential and commercial properties located within 250m radius of the site. Possible inhalation of dust during the works. Asbestos fibres present in made ground which may escape offsite from dust generation.	High (Dust) Low (Vapours)	
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	Lead contamination is present in the soils underlying the site. Precautionary measures will be required during the construction phase. Remediation will be required to either remove the contamination or break pathways.
	End User	Yes – lead contamination found to be present at the site and site to be developed into a residential dwelling with landscaped areas.	High	
	Neighbours	Yes – Lead contamination found to be present at the site and residential area adjoins the site.	High	

Migration of hazardous gases via permeable strata or shallow mining activity	Operative	Yes – levels of methane and carbon dioxide revealed and site are Characteristic Situation Level 1.	Low	Low concentrations of harmful gases (methane and carbon dioxide) were detected at the site. With further monitoring being undertaken, and should gas conditions remain the same, then no special precautionary measures would be required. No special protection measures required.
	End User		Low	
	Neighbours	No – as no adjoining structures are present, it is considered that ground gasses will vent directly to atmosphere.	Low	
Spillage/loss/run off direct to receiving water	Controlled Waters	Yes – known controlled waters within 250m, stream directly adjacent to south and east of site.. However, the lead contamination unlikely to be significantly mobile.	Moderate	Lead contamination has is present in the soils underlying the site. Remediation will be required to either remove the contamination or break pathways. Old services to be removed or capped. Measures to avoid spills or run-off entering adjacent stream.
Migration via permeable unsaturated strata	Controlled Waters	Yes – Secondary A aquifer is present beneath the site and the site is underlain by granular soils. Lead unlikely to be significantly mobile.	Moderate	
Run off via drainage/sewers etc	Controlled Waters	Yes – old services may be present on site. Lead unlikely to be significantly mobile.	Moderate	
Direct contact with contaminated soils	Plants	Yes – lead contamination present at the site which may affect plants.	High	Lead contamination has is present in the soils underlying the site. Remediation will be required to either remove the contamination or break pathways.
Uptake via root system			High	
Direct contact with contaminated soils	Building Materials	Yes – minor PAH contamination revealed at the site may represent a risk to building materials or plastic water pipes. Moreover, testing indicates that the aggressive chemical environment for concrete classification is AC-1(s).	Moderate (plastic services) Low (buried concrete)	Please see section 9.3.3 for information on good building practice.
Direct contact with contaminated groundwater				
Exposure to Radon	Operative	Yes – The property is in an Intermediate probability radon area (1 to 3% of homes are estimated to be at or above the Action Level).	Low	The publication BR211 states that no protection measures are necessary.
	End User			

9.3 Indicative Remediation Strategy

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

9.3.1 Remediation Objectives

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

- To protect the site operatives during the construction process from the ingestion of soil or dust, dermal contact with the soil and inhalation of dust.
- To protect the end user from the ingestion of soil or dust, dermal contact with the soil and inhalation of dust.
- To protect neighbours from the inhalation and ingestion dust and asbestos fibres during the construction process.

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

9.3.2 Development Requirements

Whilst the precise nature of this development has not been finalised it is understood that it is to be developed by the demolition of the existing shed and stables, and subsequent construction of a single new residential dwelling with an associated garden area. In view of the above a site-specific remediation strategy should be undertaken after the proposed development has been finalised. However, for preliminary design and costing the following remediation proposals are offered.

9.3.3 Outline Strategy

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

Controlled Waters

The made ground on site has been proven to be elevated in lead with respect to the proposed end use. Such made ground penetrates up to 1m deep overlying generally cohesive deposits of generally low permeability. No groundwater has been observed during the investigation and the lead is unlikely to be particularly mobile thus the risk to the underlying aquifer is deemed to be relatively low. No specific remedial measures are likely to be required to protect the aquifer.

Ground-works

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

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

During the groundworks phase it is recommended that a 'watching brief' be employed during excavation works and should any Asbestos Containing Materials (ACMs) be suspected the area shall be isolated and samples undertaken for testing to determine the risks prior to work in that area continuing.

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

Construction

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

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

Landscaped Areas

It is understood that there is proposed to include soft landscaped areas with trees and shrubs. In view of this and the potential lead contamination on site, it is considered that landscaped areas will require some remediation. It is expected that given the thickness of made ground encountered on the site this should be fully encapsulated beneath either a clean cover system or beneath permanent hardstanding such as roads or buildings.

Should made ground not be entirely removed garden and landscaped areas within the development remediation could include the provision of a clean cover system. This system would need to employ a capping layer of say 500mm of inert material, which will put the contaminated ground out of the end users' dig range. At the base of this layer, a granular capillary break of say 100mm of free draining granular soil should be placed in order to prevent mobile contamination rising upward. This expedient should also provide a suitable root barrier to isolate the plants from the underlying contaminated ground.

9.4 Fill Materials

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

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

- It is a suitable growing media if it is to be employed as such, including compliance with BS3883 (2007)
- It is free from obvious contamination i.e. visual or olfactory evidence
- It has not come from areas where Japanese Knotweed or other invasive or injurious plants are suspected to be growing
- It is not a statutory nuisance, such as being odorous
- It is free from unsuitable material i.e. whole bricks, brick ties, timber or glass.

It should also be appreciated that any fill should be subjected to validation testing to assess its suitability. The following table has been taken from YALPAG[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 9: 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 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
TPH CWG	See attached summary sheet		Atrisk^{SOIL} SSVs
PAH 16 USEPA	See attached summary sheet		Atrisk^{SOIL} SSVs

See Appendix 6 for full details on fill screening values.

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.

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

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.

9.5 Verification Report

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

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

Remediation of Made Ground and Suitability of Imported Fill

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

10. 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.
- Production of a site-specific remediation statement.
- 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 contractors in relation to the suitability of materials and installation methods for gas protection measures.
- Discussions with service providers regarding suitable materials for pipe work given the nature of chemical determinands found within the soils on site.
- Produce a validation report to demonstrate that the geo-environmental risks discussed in this report have been mitigated.

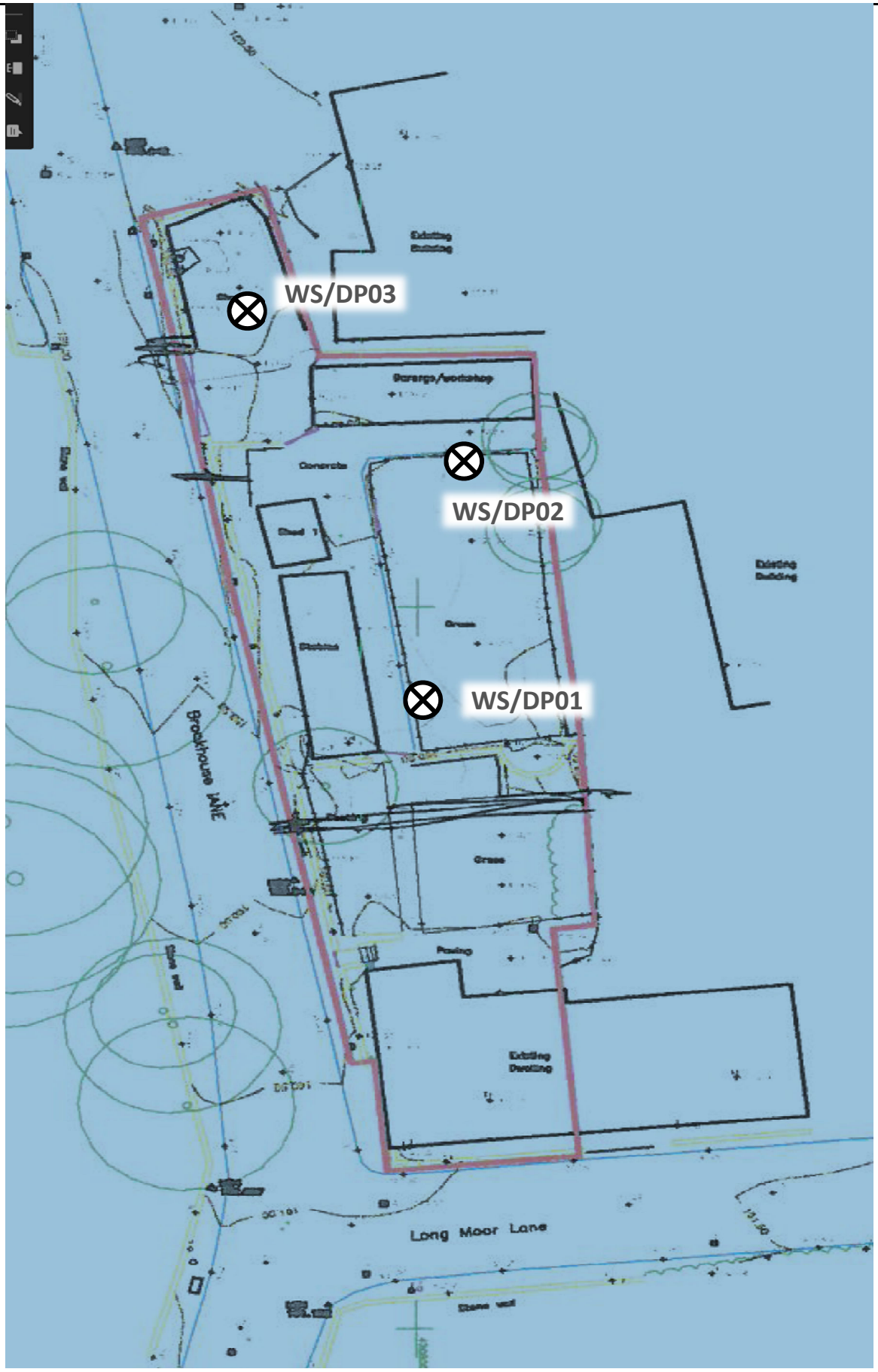
Clearly Rogers Geotechnical Services Ltd would be happy to offer advice with respect to the above and assist where necessary.

11. 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.
- British Standards Institution (2015) BS5930: *Code of practice for site investigations,* B.S.I., London.
- British Standards Institution (2011), BS 10175: *Investigation of potentially contaminated sites – Code of Practice,* British Standards Institute.
- British Standards Institution (2015) BS8485: *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings,* B.S.I., London.
- British Standards Institution (2013), BS 8576 Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds.
- British Standards Institution (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**

	Site Name:	Job No:	
RGS Environmental Geotechnical Specialists	**Garden of 1 Long Moor Lane, Shelley**	C3197/22/E/4849	t. 0843 50 666 87 www.rogersgeotech.co.uk

Appendix 2

Borehole Records

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **WS01**

Sheet 1 of 1

Project Name:	Garden of 1 Long Moor Lane, Shelley	Project No. C3197/22/E/4849	Co-ords:	Hole Type WLS
Location:	1 Long Moor Lane, Shelley, Huddersfield, West Yorkshire, HD8 8LY		Level:	Scale 1:25
Client:	Mark Bruin		Dates: 15/12/2022	Logged By TM

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.20			TOPSOIL (Loose, brown, organic, silty fine to medium SAND.)
							0.30			MADE GROUND (Loose, reddish brown, silty fine to medium SAND).
		0.60 - 0.70	D	87	70		0.45			MADE GROUND (Medium dense, orangish brown, silty, sandy angular to sub-angular and fine to coarse GRAVEL of sandstone. Sand is fine to coarse).
										0.3m: MEMBRANE
				77	50		1.10			MADE GROUND (Firm, dark brown, slightly sandy, slightly gravelly, silty CLAY. Sand is fine to coarse. Gravel is angular to sub-rounded and fine to coarse of sandstone, brick, glass and slate).
										End of Borehole at 1.10m

1 2 3 4 5

Remarks

AGS

Borehole Log

Environmental Geotechnical Specialists

Borehole No. **WS02**

Sheet 1 of 1

Project Name:	Garden of 1 Long Moor Lane, Shelley	Project No. C3197/22/E/4849	Co-ords:	Hole Type WLS
Location:	1 Long Moor Lane, Shelley, Huddersfield, West Yorkshire, HD8 8LY		Level:	Scale 1:25
Client:	Mark Bruin		Dates: 15/12/2022	Logged By TM

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.10			TOPSOIL (Loose, brown, organic, silty fine to medium SAND).
							0.30			MADE GROUND (Loose, reddish brown, silty fine to medium SAND).
		0.40	D	87	100		0.40			MADE GROUND (Medium dense, orangish brown, silty, sandy angular to sub-angular and fine to coarse GRAVEL of sandstone. Sand is fine to coarse).
							0.55			MADE GROUND (Stiff, dark brown, slightly sandy, silty CLAY. Sand is fine to medium). REWORKED
							0.75			Stiff becoming firm, orangish brown mottled grey becoming orangish brown, slightly sandy, silty CLAY. Sand is fine to medium. RESIDUAL PENNINE LOWER COAL MEASURES FORMATION
				77	100		1.50			Stiff, brown speckled orangish brown, slightly sandy, slightly gravelly, silty CLAY. Sand is fine to coarse. Gravel is angular to sub-angular and fine to coarse of sandstone. RESIDUAL PENNINE LOWER COAL MEASURES FORMATION
							1.60			Dense, orangish brown, clayey, silty, sandy angular to sub-angular and fine to coarse GRAVEL of sandstone. Sand is fine to coarse. RESIDUAL PENNINE LOWER COAL MEASURES FORMATION
							2.00			Very stiff, greyish brown, slightly sandy, silty CLAY. Sand is fine to medium. RESIDUAL PENNINE LOWER COAL MEASURES FORMATION
										End of Borehole at 2.00m

1 2 3 4 5

Remarks

AGS

Borehole Log

Borehole No. **WS03**

Sheet 1 of 1

Project Name:	Garden of 1 Long Moor Lane, Shelley	Project No. C3197/22/E/4849	Co-ords:	Hole Type WLS
Location:	1 Long Moor Lane, Shelley, Huddersfield, West Yorkshire, HD8 8LY		Level:	Scale 1:25
Client:	Mark Bruin		Dates: 15/12/2022	Logged By TM

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.
							0.10			MADE GROUND (Loose, dark grey, sandy angular to sub-angular and fine to coarse GRAVEL of various lithologies and bituminous materials. Sand is fine to coarse).
							0.25			MADE GROUND (Loose, light brown, silty, very gravelly fine to coarse SAND. Gravel is angular to sub-angular and fine to medium of sandstone).
				87	65		0.40			MADE GROUND (Firm, dark brown, slightly sandy, slightly gravelly, clayey SILT. Sand is fine to coarse. Gravel is angular to sub-angular and fine to coarse of sandstone and mudstone).
							0.55			MADE GROUND (Stiff, dark brown, slightly sandy, clayey SILT. Sand is fine to medium).
		1.00	D							MADE GROUND (Medium dense, dark brown, clayey, silty, very sandy angular to sub-rounded and fine to coarse GRAVEL of sandstone, ceramic and glass. Sand is fine to coarse).
							1.10			Stiff, brown becoming orangish brown mottled grey, slightly sandy, silty CLAY. Sand is fine to medium. RESIDUAL PENNINE LOWER COAL MEASURES FORMATION
				77	80		1.75			Extremely weak, very thinly bedded, orangish brown, friable, crystalline, SILTSTONE. PENNINE LOWER COAL MEASURES FORMATION
G							2.00			End of Borehole at 2.00m

Remarks

AGS

Appendix 3

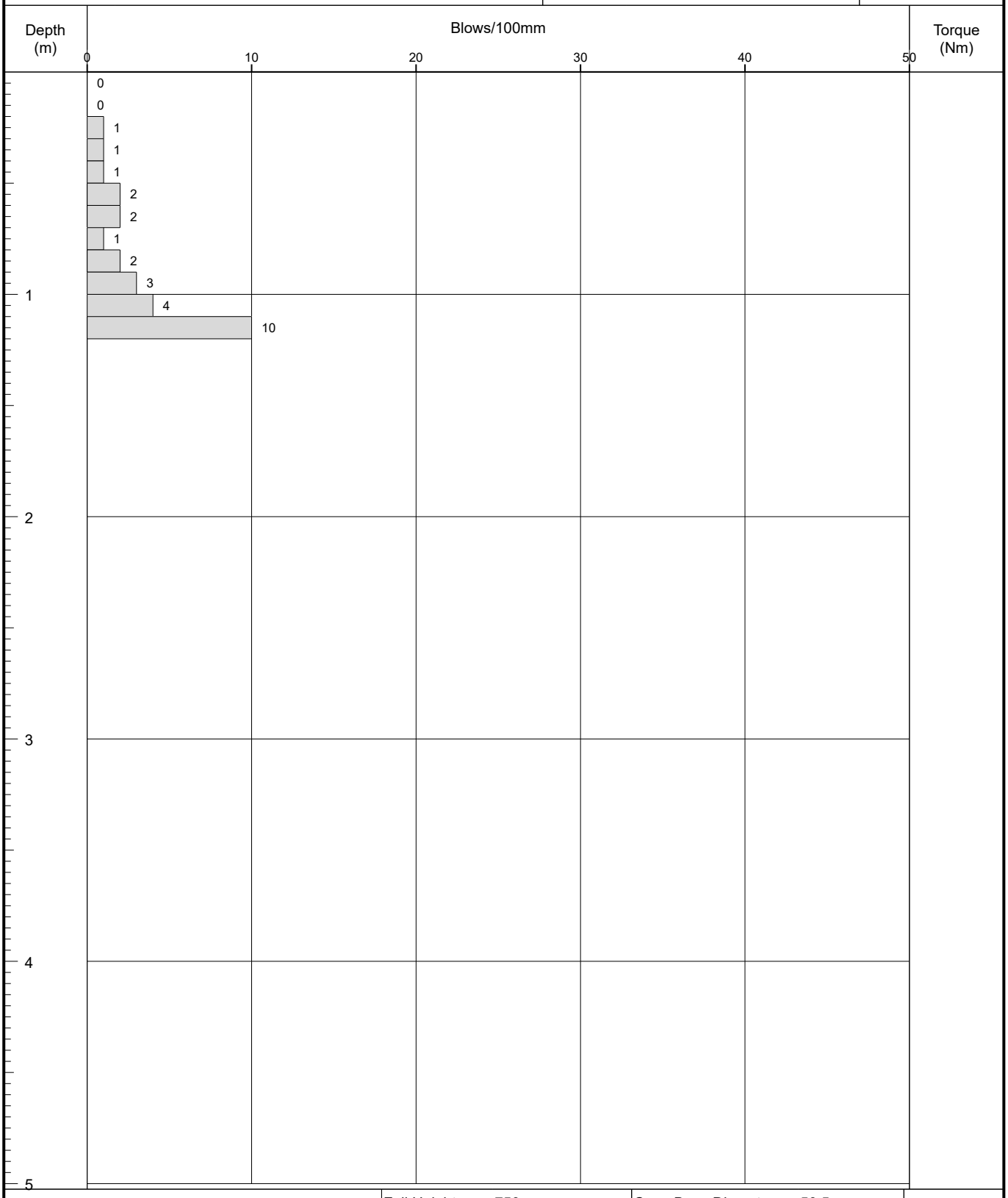
Dynamic Probing Records

Probe Log

Probe No. **DCP01**

Sheet 1 of 1

Project Name: Garden of 1 Long Moor Lane, Shelley	Project No. C3197/22/E/4849	Co-ords:	Hole Type DCP
Location: 1 Long Moor Lane, Shelley, Huddersfield, West Yorkshire, HD8 8LY		Level:	Scale 1:25
Client: Mark Bruin		Dates: 15/12/2022	Logged By AB



Remarks:		Fall Height	750mm	Cone Base Diameter	50.5mm
		Hammer Wt	63.5kg	Final Depth	1.11m
		Probe Type	DPSH-B		

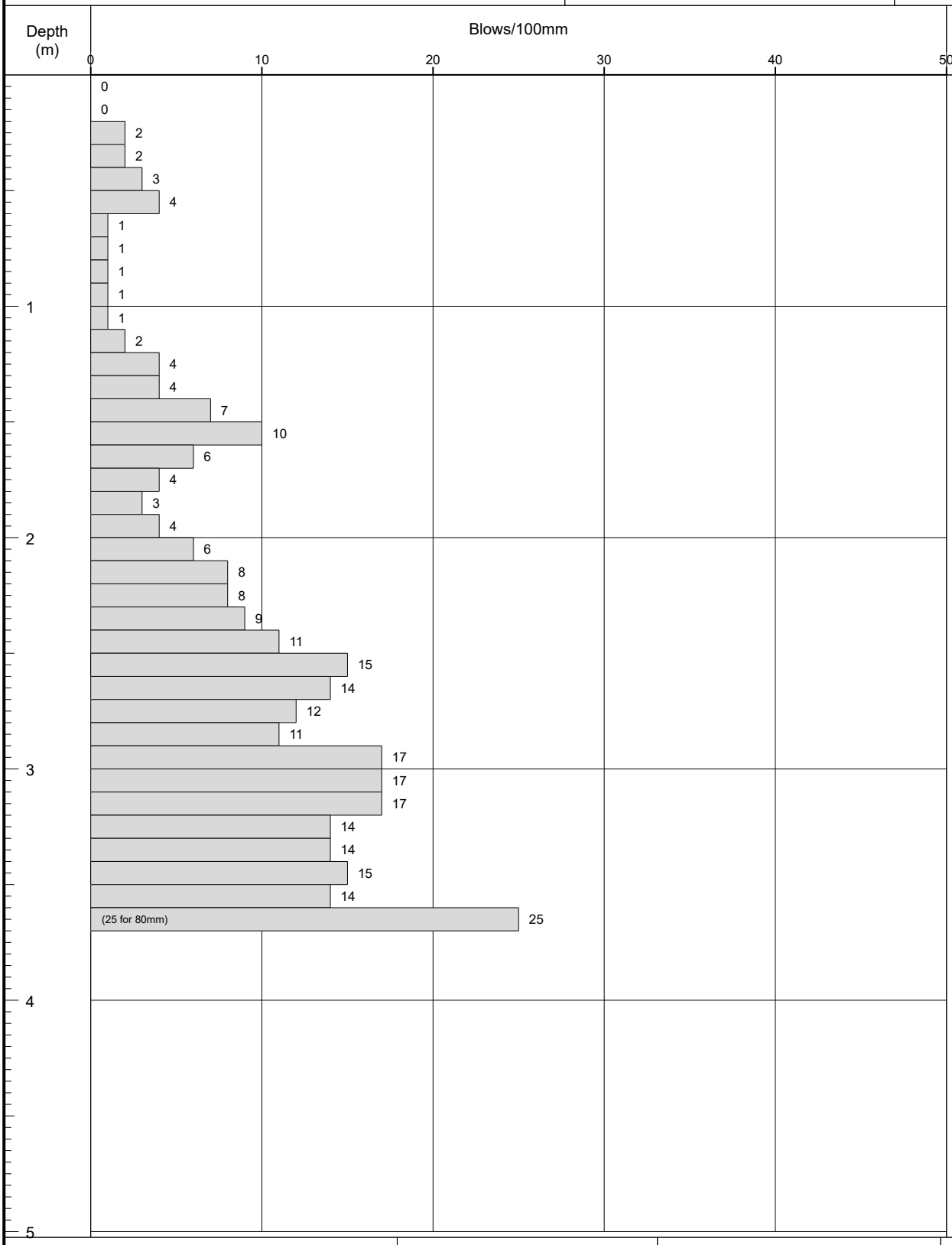
Probe Log

Environmental Geotechnical Specialists

Probe No. **DCP02**

Sheet 1 of 1

Project Name: Garden of 1 Long Moor Lane, Shelley	Project No. C3197/22/E/4849	Co-ords:	Hole Type DCP
Location: 1 Long Moor Lane, Shelley, Huddersfield, West Yorkshire, HD8 8LY		Level:	Scale 1:25
Client: Mark Bruin		Dates: 15/12/2022	Logged By AB



Remarks:

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	3.68m
Probe Type	DPSH-B		

AGS

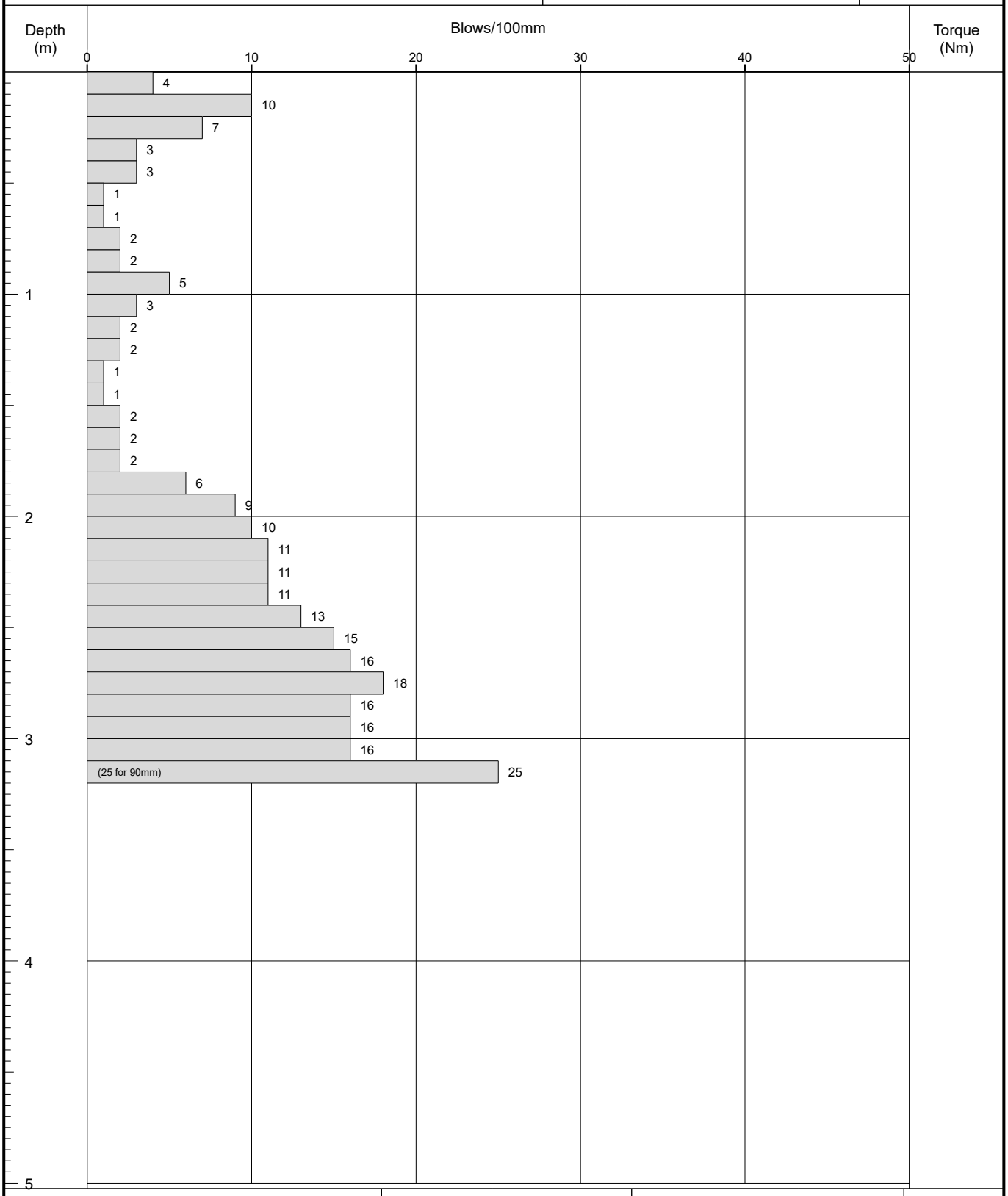
Probe Log

Environmental Geotechnical Specialists

Probe No. **DCP03**

Sheet 1 of 1

Project Name: Garden of 1 Long Moor Lane, Shelley	Project No. C3197/22/E/4849	Co-ords:	Hole Type DCP
Location: 1 Long Moor Lane, Shelley, Huddersfield, West Yorkshire, HD8 8LY		Level:	Scale 1:25
Client: Mark Bruin		Dates: 15/12/2022	Logged By AB



Remarks:

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	3.19m
Probe Type	DPSH-B		

AGS

Appendix 4

Ground Gas Monitoring Records

Rogers Geotechnical Services Ltd

GAS/WATER MONITORING - SITE RECORD

Client:

Site:

Input by : M. Tuck Checked by : T. Merry

Date : 26.01.2023 Date : 26.01.2023

Gas Monitor: Geotech GA5000
Serial No. G503524
Calibration Date: 24.08.2022
Dip Meter: 003

(If second monitor is used)
Gas Monitor: GFM 436
Serial No. 10767
Calibration Date 08.08.2022
Dip Meter

Note: Please do not change cloumn widths or row height. They have been set at a size, so the table so be copied straight over into reports.

Borehole No	Date	CH_4 (%)	CO_2 (%)	O_2 (%)	Flow (l/hr)	Barometric Pressure (mb)	Water Level (m)	Standpipe Depth (m)	Depth During Visit	Atmospheric Conditions	COMMENTS
1	05.01.2023	**0.1**	0.5	21.4	**0.0**	998	0.92		1.13	Overcast	Falling pressure, CO 1
	12.01.2023	**0.1**	0.5	21.2	**0.0**	**979**	0.89		1.13	Overcast	Steady pressure, CO 0
	19.01.2023	**0.1**	0.5	20.7	**0.0**	987	0.96		1.13	Sunny icy	Steady pressure, CO 0
	26.01.2023	**0.0**	0.6	21.0	**0.0**	**1016**	0.96		1.13	Overcast	Steady pressure, CO 0
3	05.01.2023	**0.1**	**0.2**	21.4	**0.0**	999	_		2.06	Overcast	Falling Pressure, CO 1
	12.01.2023	**0.1**	0.3	21.4	**0.0**	**979**	1.73		2.06	Overcast	Steady pressure, CO 0
	19.01.2023	**0.1**	0.3	**21.5**	**0.0**	988	1.99		2.06	Sunny icy	Steady pressure, CO 0
	26.01.2023	**0.0**	0.4	21.0	**0.0**	**1016**	_		2.06	Overcast	Steady pressure, CO 0
4	05.01.2023	**0.1**	0.5	21.4	**0.0**	999	1.64		2.08	Overcast	Falling pressure, CO 1
	12.01.2023	**0.1**	0.5	21.1	**0.0**	**979**	1.34		2.08	Overcast	Steady pressure, CO 0
	19.01.2023	**0.1**	0.4	**20.3**	**0.0**	988	1.77		2.08	Sunny icy	Steady pressure, CO 0
	26.01.2023	**0.0**	**0.9**	21.0	**0.0**	1014	_		2.08	Overcast	Steady pressure, CO 10

Appendix 5

Laboratory Testing

Harry Letch
Rogers Geotechnical Services Ltd
Offices 1&2 Barncliffe Business Pk
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Huddersfield
West Yorkshire
HD8 8LU

t: 01484 604354

e: harry.letch@rogersgeotech.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

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

Analytical Report Number : 22-14742

Replaces Analytical Report Number: 22-14742, issue no. 1
Additional analysis undertaken.

Project / Site name:	Garden of 1 Long Moor Lane	**Samples received on:**	21/12/2022
Your job number:	C3197 22 E 4849	**Samples instructed on/ Analysis started on:**	22/12/2022
Your order number:		**Analysis completed by:**	18/01/2023
Report Issue Number:	2	**Report issued on:**	20/01/2023
Samples Analysed:	3 soil samples		

Signed:

Adam Fenwick
Technical Reviewer
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

Excel copies of reports are only valid when accompanied by this PDF certificate.

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

Analytical Report Number: 22-14742
Project / Site name: Garden of 1 Long Moor Lane

Lab Sample Number				2542548	2542549	2542550
Sample Reference				WS01	WS02	WS03
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.60-0.70	0.40	1.00
Date Sampled				21/12/2022	21/12/2022	21/12/2022
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	26	20	9.4
Total mass of sample received	kg	0.001	NONE	0.6	0.6	0.6
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	Chrysotile & Amosite
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Detected
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	-	-	0.001
Asbestos Quantification Total	%	0.001	ISO 17025	-	-	0.001
Asbestos Analyst ID	N/A	N/A	N/A	LFT	LFT	LFT
General Inorganics						
pH - Automated	pH Units	N/A	MCERTS	7.8	7.4	8.0
Free Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Total Sulphate as SO4	%	0.005	MCERTS	0.08	0.052	0.118
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	22	25	150
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.011	0.012	0.074
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	11.1	12.3	73.5
Organic Matter (automated)	%	0.1	MCERTS	5.2	4	4
Total Phenols						
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Speciated PAHs*						
Naphthalene	mg/kg	0.05	NONE	0.11	0.15	0.18
Acenaphthylene	mg/kg	0.05	NONE	0.1	< 0.05	0.61
Acenaphthene	mg/kg	0.05	NONE	0.07	0.18	0.16
Fluorene	mg/kg	0.05	NONE	0.1	0.14	0.2
Phenanthrene	mg/kg	0.05	NONE	1.2	1.4	1.8
Anthracene	mg/kg	0.05	NONE	0.25	0.24	0.94
Fluoranthene	mg/kg	0.05	NONE	2.5	2.2	6
Pyrene	mg/kg	0.05	NONE	2.3	1.9	5.6
Benzo(a)anthracene	mg/kg	0.05	NONE	1.2	0.86	3
Chrysene	mg/kg	0.05	NONE	1.2	0.92	3.3
Benzo(b)fluoranthene	mg/kg	0.05	NONE	1.2	0.97	5.3
Benzo(k)fluoranthene	mg/kg	0.05	NONE	0.61	0.4	2.4
Benzo(a)pyrene	mg/kg	0.05	NONE	1	0.8	3.6
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	NONE	0.58	0.44	2.4
Dibenz(a,h)anthracene	mg/kg	0.05	NONE	0.13	0.12	0.54
Benzo(ghi)perylene	mg/kg	0.05	NONE	0.66	0.49	2.8
Total PAH*						
Speciated Total EPA-16 PAHs	mg/kg	0.8	NONE	13.2	11.2	38.8
Heavy Metals / Metalloids						
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	25	27	21
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	3.8
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8
Copper (aqua regia extractable)	mg/kg	1	MCERTS	44	33	62
Lead (aqua regia extractable)	mg/kg	1	MCERTS	380	120	230
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	17	15	29
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	32	34	35

Analytical Report Number: 22-14742
Project / Site name: Garden of 1 Long Moor Lane

Lab Sample Number				2542548	2542549	2542550
Sample Reference				WS01	WS02	WS03
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				0.60-0.70	0.40	1.00
Date Sampled				21/12/2022	21/12/2022	21/12/2022
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	220	110	210
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	0.001	NONE	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8 $_{HS\_1D\_AL}$	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10 $_{HS\_1D\_AL}$	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001
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	< 2.0	< 2.0	5.2
TPH-CWG - Aliphatic >EC16 - EC21 $_{EH\_CU\_1D\_AL}$	mg/kg	8	MCERTS	< 8.0	< 8.0	120
TPH-CWG - Aliphatic >EC21 - EC35 $_{EH\_CU\_1D\_AL}$	mg/kg	8	MCERTS	20	< 8.0	190
TPH-CWG - Aliphatic (EC5 - EC35) $_{EH\_CU+HS\_1D\_AL}$	mg/kg	10	NONE	23	< 10	310
TPH-CWG - Aromatic >EC5 - EC7 $_{HS\_1D\_AR}$	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8 $_{HS\_1D\_AR}$	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10 $_{HS\_1D\_AR}$	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001
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	8.4
TPH-CWG - Aromatic >EC16 - EC21 $_{EH\_CU\_1D\_AR}$	mg/kg	10	MCERTS	10	21	160
TPH-CWG - Aromatic >EC21 - EC35 $_{EH\_CU\_1D\_AR}$	mg/kg	10	MCERTS	25	41	390
TPH-CWG - Aromatic (EC5 - EC35) $_{EH\_CU+HS\_1D\_AR}$	mg/kg	10	NONE	35	62	570

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

*Data reported unaccredited due to quality control parameter failure associated with this result; other checks applied prior to reporting the data have been accepted and the failure justified as having no significant impact on sample data reported.

Analytical Report Number: 22-14742
Project / Site name: Garden of 1 Long Moor Lane
Your Order No:

Certificate of Analysis - Asbestos Quantification

Methods:

Qualitative Analysis

The samples were analysed qualitatively for asbestos by polarising light and dispersion staining as described by the Health and Safety Executive in HSG 248.

Quantitative Analysis

The analysis was carried out using our documented in-house method A006-PL based on HSE Contract Research Report No: 83/1996: Development and Validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (Davies et al, 1996) and HSG 248. Our method includes initial examination of the entire representative sample, then fractionation and detailed analysis of each fraction, with quantification by hand picking and weighing.

The limit of detection (reporting limit) of this method is 0.001 %.

The method has been validated using samples of at least 100 g, results for samples smaller than this should be interpreted with caution.

Both Qualitative and Quantitative Analyses are UKAS accredited.

Sample Number	Sample ID	Sample Depth (m)	Sample Weight (g)	Asbestos Containing Material Types Detected (ACM)	PLM Results	Asbestos by hand picking/weighing (%)	Total % Asbestos in Sample
2542550	WS03	1.00	139	Loose Fibrous Debris	**Chrysotile & Amosite**	0.001	**0.001**

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Analytical Report Number : 22-14742
Project / Site name: Garden of 1 Long Moor Lane

* 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 *
2542548	WS01	None Supplied	0.60-0.70	Brown clay with glass.
2542549	WS02	None Supplied	0.4	Brown clay and loam with gravel and vegetation.
2542550	WS03	None Supplied	1	Brown sand with clinker and gravel

Analytical Report Number : 22-14742
Project / Site name: Garden of 1 Long Moor Lane

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.	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	L073B-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS
Asbestos Quantification - Gravimetric	Asbestos quantification by gravimetric method - in house method based on references.	HSE Report No: 83/1996, HSG 248, HSG 264 & SCA Blue Book (draft).	A006-PL	D	ISO 17025
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	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
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

Analytical Report Number : 22-14742
Project / Site name: Garden of 1 Long Moor Lane

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

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

Analytical Report Number : 22-14742

Project / Site name: Garden of 1 Long Moor Lane

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
WS01	None Supplied	S	2542548	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS01	None Supplied	S	2542548	b	Monohydric phenols in soil	L080-PL	b
WS01	None Supplied	S	2542548	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS01	None Supplied	S	2542548	b	TPHCWG (Soil)	L088/76-PL	b
WS02	None Supplied	S	2542549	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS02	None Supplied	S	2542549	b	Monohydric phenols in soil	L080-PL	b
WS02	None Supplied	S	2542549	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS02	None Supplied	S	2542549	b	TPHCWG (Soil)	L088/76-PL	b
WS03	None Supplied	S	2542550	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS03	None Supplied	S	2542550	b	Monohydric phenols in soil	L080-PL	b
WS03	None Supplied	S	2542550	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS03	None Supplied	S	2542550	b	TPHCWG (Soil)	L088/76-PL	b

Appendix 6

Fill Screening Values

Rogers Geotechnical Services: Soil Screening Values Comparison Sheet

Rogers Geotechnical Services Ltd: Soil Screening Value (SSV) Comparison Sheet

Job Number	C3197/22/E/4849
Job Name	Garden of 1 Long Moor Lane, Shelley
Date	23/01/2023
Client	Mark Bruin

A = WS Atkins PLC, Atrisk Soil Screening Values.
A+ = Values updated June 2017.
A* = Atrisk's SSV is lower than Chemtest's detectable limit for this compound.
B = health criterion values, which are available from toxicological reviews published in the C4SL project methodology report.
C = Category 4 Screening Levels (C4SLs) based on 6% soil organic matter.
D = Value provided is based on Methyl Mercury. Should elemental mercury be observed or a source be known then a limit of 102 should be used.

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

Determinand	Units	Ref	LOD	Residential With Plant Uptake 1%		Sample Location	WS01	WS02	WS03							
				Atrisk 2015 (No Free Product	Atrisk 2017	Depth Top	0.6	0.4	1.0							
						Depth Base										
Cadmium	mg/kg	C	0.2		22.1		< 0.2	< 0.2	< 0.2							
Chromium (Hexavalent)	mg/kg	B/C	1.8	20.5	3.62		< 1.8	< 1.8	< 1.8							
Copper	mg/kg	A+	1.0		4730		44	33	62							
Mercury	mg/kg	A/D	0.3		8.81		< 0.3	< 0.3	< 0.3							
Nickel	mg/kg	A+	1.0		136		17	15	29							
Lead	mg/kg	C	1.0		200		380	120	230							
Zinc	mg/kg	A+	1.0		20000		220	110	210							
Vanadium	mg/kg	A+	1.0		136		32	34	35							
Arsenic	mg/kg	C	1.0		37		25	27	21							
Selenium	mg/kg	A	1.0		375		1.00	1.00	1.00							
Cyanide (Free)	mg/kg	A	1.0		34		< 1.0	< 1.0	< 1.0							
Total Phenols	mg/kg	A	1.0		267		< 1.0	< 1.0	< 1.0							
Naphthalene	mg/kg	A+	0.05	0	0.829		0.11	0.15	0.18							
Acenaphthylene	mg/kg		0.05				0.1	< 0.05	0.61							
Acenaphthene	mg/kg	A+	0.05	608	157		0.07	0.18	0.16							
Fluorene	mg/kg	A+	0.05	0	735		0.1	0.14	0.2							
Phenanthrene	mg/kg		0.05				1.2	1.4	1.8							
Anthracene	mg/kg	A+	0.05	0	10200		0.25	0.24	0.94							
Fluoranthene	mg/kg	A+	0.05		983		2.5	2.2	6							
Pyrene	mg/kg	A+	0.05		668		2.3	1.9	5.6							
Benzo[a]anthracene	mg/kg	A	0.05	4.52	1.71		1.2	0.8	3							
Chrysene	mg/kg	A	0.05	585	0.44		1.2	0.92	3.3							
Benzo[b]fluoranthene	mg/kg	A	0.05	7.72	1.22		1.2	0.97	5.6							
Benzo[k]fluoranthene	mg/kg	A	0.05	84.4	0.686		0.61	0.4	2.4							
Benzo[a]pyrene	mg/kg	B/C	0.05	4.95	1.51		1	0.8	3.6							
Indeno(1,2,3-c,d)Pyrene	mg/kg	A*	0.05	7.31	0.0614		0.58	0.44	2.4							
Dibenz(a,h)Anthracene	mg/kg	A	0.05	0.838	0.00393		0.13	0.12	0.54							
Benzo[g,h,i]perylene	mg/kg	A	0.05	96.2	0.0187		0.66	0.49	2.8							
Total Of 16 PAH's	mg/kg		0.8													
Aliphatic TPH >C5-C6	mg/kg	A+	0.001	0	42.7		< 0.001	< 0.001	< 0.001							
Aliphatic TPH >C6-C8	mg/kg	A+	0.001	0	99.3		< 0.001	< 0.001	< 0.001							
Aliphatic TPH >C8-C10	mg/kg	A+	0.001	0	13.9		< 0.001	< 0.001	< 0.001							
Aliphatic TPH >C10-C12	mg/kg	A+	1.0	81.7	49.9		< 1.0	< 1.0	< 1.0							
Aliphatic TPH >C12-C16	mg/kg	A+	2.0	385	20.9		< 2.0	< 2.0	5.2							
Aliphatic TPH >C16-C21	mg/kg	A+	8.0		210000		< 8.0	< 8.0	120							
Aliphatic TPH >C21-C35	mg/kg	A+	8.0		210000		20	< 8.0	190							
Aliphatic TPH >C35-C44	mg/kg		10.0													
Total Aliphatic Hydrocarbons	mg/kg		10.0													
Aromatic TPH >C5-C7	mg/kg	A+	0.001		0.137		< 0.001	< 0.001	< 0.001							
Aromatic TPH >C7-C8	mg/kg	A+	0.001	0	113		< 0.001	< 0.001	< 0.001							
Aromatic TPH >C8-C10	mg/kg	A+	0.001	0	20.5		< 0.001	< 0.001	< 0.001							

Rogers Geotechnical Services: Soil Screening Values Comparison Sheet

Rogers Geotechnical Services Ltd: Soil Screening Value (SSV) Comparison Sheet

Job Number	C3197/22/E/4849
Job Name	Garden of 1 Long Moor Lane, Shelley
Date	23/01/2023
Client	Mark Bruin

A = WS Atkins PLC, Atrisk Soil Screening Values.
A+ = Values updated June 2017.
A* = Atrisk's SSV is lower than Chemtest's detectable limit for this compound.
B = health criterion values, which are available from toxicological reviews published in the C4SL project methodology report.
C = Category 4 Screening Levels (C4SLs) based on 6% soil organic matter.
D = Value provided is based on Methyl Mercury. Should elemental mercury be observed or a source be known then a limit of 102 should be used.

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

Determinand	Units	Ref	LOD	Residential With Plant Uptake 1%		Sample Location	WS01	WS02	WS03
						Depth Top	0.6	0.4	1.0
						Depth Base			
Aromatic TPH >C10-C12	mg/kg	A+	1.0	0	70		< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	mg/kg	A+	2.0	165	155		< 2.0	< 2.0	8.4
Aromatic TPH >C16-C21	mg/kg	A+	10.0		319		10	21	160
Aromatic TPH >C21-C35	mg/kg	A+	10.0		1120		25	41	390
Aromatic TPH >C35-C44	mg/kg		10.0						
Total Aromatic Hydrocarbons	mg/kg		10.0						
Total Petroleum Hydrocarbons	mg/kg		10.0						
pH			N/A				7.8	**7.4**	**8.0**
Sulphate (2:1 Water Soluble) as SO4	g/l		0.0013				**0.01**	0.012	**0.074**
ACM Type			N/A						
Asbestos Identification	%						-	-	Chysotile, Amosite
ACM Detection Stage			N/A						
Moisture	%		0.01				26	20.0	9
Soil Colour			N/A				N/A	N/A	N/A
Other Material			N/A				N/A	N/A	N/A
Soil Texture			N/A				N/A	N/A	N/A
Sulphate (Total)	%		0.005				0.08	0.052	0.118
Organic Matter	%		0.1				**5.2**	**4.0**	**4.0**