GEO Environmental Engineering

PHASE 2: GROUND INVESTIGATION REPORT

PROPOSED RESIDENTIAL DEVELOPMENT OF

LAND AT THORNLEA NEAR CARLETON

EGREMONT, CUMBRIA

FOR:

LAMMISA ZARRINI

DOCUMENT CONTROL SHEET

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1.0 Introduction

1.1 Brief

GEO Environmental Engineering Ltd (GEO) were commissioned by Lammisa Zarrini, herein referred to as the "Client", to carry out a ground investigation on land at Thornlea near Carleton, Egremont, Cumbria as indicated on the site location plan included in Appendix I.

The investigation was carried out to determine the ground conditions across the site and to assess the risk to human health and environmental receptors from possible contamination.

1.2 Site Location and Description

The site is located in the southern part of Carleton, c.1km south east of Egremont as indicated on the site location plan included in Appendix I. Access to the site is from an unnamed road to the north.

- National Grid Reference: 301683, 509230
- Post Code: CA22 2NU (approximate only)

The site is an area of scrub vegetation and bushes immediately north of an existing residential property.

The site undulates with a rises from the lowest area in the western part to the highest elevation in the east. to the south gently with a slight fall in level from south to north. A topographical survey has not been provided, however, Ordnance Survey data suggests that the site is at an elevation of c.100m OD.

1.3 Proposed Development

It is understood that the Client plans to develop the site for residential end use. A plan of the site has not been provided, however, it is anticipated that the development will a comprise conventional house with private garden, soft landscaping, driveway / car parking and other associated infrastructure.

The Client is also considering the use of a soak-away drainage system if the ground conditions prove suitable.

1.4 Other Reports/Studies

GEO have completed a Phase 1: Desk Top Study (DTS) Report for the site, details of which are included below:

- Phase I Desk Top Study (Preliminary Environmental Risk Assessment), ref: 2018-3324, dated: 11.01.2021.

It is recommended that the DTS is read in conjunction with this report.

The DTS indicated a moderate geotechnical risk associated with the site with the main concern being possible mineral vein extraction beneath the site. The report recommends a more detailed mining search of desk-based information to ascertain if the risk warrants intrusive investigation.

A low risk of ground contamination was deemed appropriate for the site. The report indicated a potential for made ground associated with historical buildings on the site.

2.0 Ground Investigation Report

2.1 Ground Investigation Aims and Objectives

The overall objective of this Ground Investigation is to provide information relating to the geotechnical and environmental properties of the ground and groundwater across the development area in order to facilitate foundation and drainage design and determine any risks to human health or the surrounding environment.

2.2 Guidelines, Codes of Practice and Third Part Accreditations

This report contains information relating to the geotechnical properties of the soils encountered on site to aid foundation design by a Structural Engineer. The report also incorporates a Level 1 Ground Contamination and Ground Gas Risk Assessment for Human Health (Generic Quantitative Risk Assessment – GQRA).

The laboratory testing (geotechnical and ground contamination) was completed by UKAS and MCERTS accredited laboratories with details given in Sections 6, with copies of the test reports contained within Appendix III.

This Ground Investigation Report has generally been completed in accordance with the following documents:

- Land Contamination Risk Management Stages 1 to 4 (LCRM – www.gov.uk).
- BS10175: 2017: Code of Practice for the Investigation of Potentially Contaminated Sites.
- BS5930: 2015: Code of Practice for Site Investigations.
- BS1377: 1990: Methods of test for soils for civil engineering purposes.
- Eurocode 7 – Geotechnical Design (Part 1: General Rules and; Part 2: Ground Investigation and Testing).
- UK Specification for Ground Investigation, 2nd Edition. Site Investigation Steering Group, 2011.
- Effective Site Investigation. Site Investigation Steering Group, 2013.
- SP1010 Development of Category 4 Screening Levels Main Report, 2014.
- The LQM/CIEH S4UL's for Human Health Risk Assessment, 2015.

2.3 Ground Investigation Limitations of Use

Although every effort is made to ensure a full and comprehensive investigation has been completed, it should always be borne in mind that ground conditions have the potential to vary between exploratory hole locations and it is recommended that a prudent developer adopt a "watching brief" during the redevelopment works, to ensure that any potential variations encountered are identified and dealt with in an appropriate manner.

In addition, this Ground Investigation Report and its contents are limited to the boundaries of the site, as indicated on the Plans in Appendix I. No reliance, copying or use of this report (in part or whole) by any Third Party is permitted without prior written approval from Geo Environmental Engineering Ltd, with intellectual copyright remaining the sole property of the author. Reliance on the report and its associated information is strictly in accordance with Geo Environmental Engineering Ltd Terms and Conditions, copies of which are available on request.

2.4 Consideration for Residential End Use

It is understood that the site will be developed for residential end use with a house, gardens, car parking, access roads, and other associated infrastructure. Consequently, when considering the intended

development, the site is considered suitable for assessment using a Level 1 Generic Quantitative Risk Assessment (GQRA).

A GQRA provides details of potential future risks to Human Health (proposed end users) from any contamination which may be identified on site in made ground or natural soils. For the Human Health Risk Assessment, it is considered that the future residents will be subjected to the greatest exposure periods and consequently the most risk. Therefore, in accordance with current guidance and legislation a CLEA end use classification of *residential* has been considered most appropriate.

3.0 Ground Investigation Fieldwork

The ground investigation works were completed on the 17th August 2021. The exploratory holes were located across the site to provide general site coverage taking into consideration areas of steep ground and surface obstructions.

The exploratory hole location plan is provided in Appendix I.

The ground investigation works comprised:

- 7 No. Mechanically Excavated Trial Pits (TP01 to TP02) to depths of between c.1.50m and c.2.10m bgl.
- Soil Infiltration Tests in trial pits TP02 (1 No. test) and TP06 (2 No. Tests).
- Site supervision by a suitably qualified and experienced Geo-Environmental Engineer.
- Laboratory chemical screening of soil samples.

The investigation fieldworks were undertaken in accordance with BS5930:1999, BS1377:1990 and Eurocode 7 (Part I and II).

At each exploratory hole location, the surfacing type, made ground, natural ground and groundwater conditions were observed, with in-situ testing undertaken and samples recovered. Details of the ground conditions are included on the exploratory hole logs which are included in Appendix II together with other relevant ground investigation data (Gas and Groundwater Monitoring results).

The results of the chemical laboratory screening are provided in Appendix III.

All depths included in the report are in metres below ground level (m bgl), unless stated otherwise.

4.0 Ground and Groundwater Conditions

4.1 General

The following section provides a summary of the ground conditions encountered across the site during the investigation. Reference should be made to the exploratory hole logs included in Appendix II for detailed descriptions of the strata and groundwater conditions.

All depths are reported in metres below ground level (m bgl) unless stated otherwise.

4.1.1 Made Ground and Topsoil

Made ground was encountered across the site to depths of between c.0.18m and c.0.50m bgl. The made ground comprised sandy gravelly loam with occasional ash and clinker, sandy gravel of mixed aggregate with occasional brick, clinker, slag, concrete and asphalt, and occasional fused slag.

During the investigation, GEO did not identify any visual or olfactory evidence of fuel/oil type contamination (no staining, odour or free product) or any landfill type waste such as potentially biodegradable, decomposable or putrescible materials.

4.1.2 Natural Drift Deposits

Natural drift deposits were encountered beneath the made ground in all of the trial pits and was noted as granular throughout. The drift comprised silty sandy fine to coarse sub-rounded gravel with many cobbles and bands or lenses of slightly silty gravelly sand.

The stability of the pits was occasionally poor and complete collapse of the side walls was occasionally noted.

4.1.3 Solid Geological Deposits (Bedrock)

Solid strata/bedrock was not encountered during the ground investigation.

4.2 Groundwater

During the intrusive site works, groundwater was encountered at depths of between c.1.40m and 1.50m bgl. The trial pits were left open and standing groundwater was recorded at similar levels after 20 minutes.

Trial pits TP04, 05 and 07 which were excavated to depths of between c.1.70m and 2.10m bgl in the south western part of the site were recorded as dry.

The groundwater levels should be considered when determining if soakaway drainage is appropriate for the site. See Section 5.1 for the results of the soil infiltration tests.

Based on the results of the ground investigation, groundwater ingress should be anticipated into excavations, particularly across the central and north-east parts during wetter periods of the year, as the materials encountered may deteriorate following exposure to surface water.

5.0 Exploratory Hole Testing

In-situ site testing and monitoring was generally undertaken in accordance with BS5930:1999, BS1377:1990 and Eurocode 7 (Part I and II).

5.1 Ground Permeability (Soil Infiltration Tests)

It is understood that the Client is considering the use of soak-away style drainage as part of the proposed development. In order to facilitate the soak-away design, soil infiltration tests were completed in trial pits TP02 and TP06. The test involved excavating trial pits to the appropriate depth (c.1.50m and c.1.80m bgl) and partially filling the pits with water. The water level was monitored at regular intervals until the water had drained sufficiently, or until the test was terminated having failed.

During the test, the water level in trial pit TP02 was monitored over a duration of 199 minutes. During this time, the water level rose from 0.66m bgl to 0.63m bgl, possibly due to the ingress of groundwater. The test was classified as a fail.

Two infiltration tests were completed in trial pit TP06. The tests were run for a duration of 130 and 137 minutes respectively. The tests indicate soil infiltration rates of between 2.3x10-05m/s and 2.2x10-05m/s. It should be noted however, that groundwater ingress was recorded in trial pit TP06 prior to the infiltration tests at a depth of c.1.45m bgl. The groundwater levels should be taken into consideration when determining if soakaway drainage is appropriate for the site.

6.0 Laboratory Testing

6.1 Chemical Screening

6.1.1 Determination of pH and Water-Soluble Sulphate

In order to determine the correct concrete classification for buried structures (foundations), 4 No. samples of made ground (c.0.10m bgl) recovered from the exploratory holes were scheduled for laboratory pH and water-soluble sulphate (SO_4) screening. The testing was completed generally in accordance with BS1377:1990: Part 1 to 4 by the following UKAS and MCERTS accredited laboratory:

- Chemtech Environmental Testing of Stanley, County Durham.

The results of the testing are summarised in section 9 and presented in the Chemtech report (ref: 99853) contained in Appendix III.

6.1.2 Contamination Testing for Human Health

To enable the completion of a Level 1 Generic Quantitative Risk Assessment (GQRA) for Human Health, 5 No. samples of made ground (loamy soils and granular deposits) from across the site were subjected to analysis at the following UKAS and MCERTS accredited laboratory:

- Chemtech Environmental Testing of Stanley, County Durham.

Potential Contaminants of Concern (PCOC's) have been determined for the development area based on the descriptions of the materials encountered within the exploratory holes and the potential for made ground of an unknown source associated with the former development. Relevant samples of the made ground from across the site were screened for the contaminants below.

- **Inorganic Soil Suite (Human Health Risk Assessment):** Metal (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium and Zinc), Cyanide and Total Organic Carbon.
- **Organic Soil Suite (Human Health Risk Assessment):** Speciated Polycyclic Aromatic Hydrocarbons (PAH – USEPA 16).
- **Other:** Asbestos

The full catalogue of soil screening results and test detection limits can be seen in the Chemtech report (ref: 99853) contained in Appendix III.

No visual or olfactory evidence of mobile or organic contamination was identified during the fieldworks and none were expected given the site's history. Therefore, the samples were not screened for TPH, BTEX, MTBE, SVOC or VOC.

No evidence of mobile or organic contamination was noted within the natural drift deposits, therefore, no samples of the drift were scheduled for chemical screening.

6.2 Controlled Waters Risk Assessment

The Phase I Desk Top Study indicated a negligible risk to Controlled Waters based on the site's history and the lack of sensitive receptors. During the intrusive site works, no evidence of significant contamination or mobile contaminants was encountered. As such, no further assessment is deemed to be required with respect to controlled waters.

7.0 Generic Quantitative Risk Assessment (GQRA)

7.1 Methodology for Assessing Risks to Human Health

Within the UK, the current framework for assessing potential ground contamination is utilising the Contaminated Land Exposure Assessment (CLEA) model as set out by the Department of the Environment, Farming and Rural Affairs (DEFRA) and comprises of the established pollutant linkage model of *Source – Pathway – Receptor*. For a risk to be present to the proposed end user (*Receptor*) there must be an identified *Source* and a plausible *Pathway*. Where one or more of the links are missing then risk is negated. In order for the land to be classified as contaminated under Part IIa of the Environmental Protection Act (EPA) 1990 all three elements of the pollutant linkage must be present.

A human health risk assessment can completed using the contamination levels recorded in the soils by comparing the values against published Generic Assessment Criteria (GAC), such as CLEA Soil Guideline Values (SGV's), CL:AIRE Category 4 Screening Levels (C4SLs), Land Quality Management (LQM) and Chartered Institute of Environmental Health (CIEH) S4UL Values and Atkins ATRISK^{SOIL} Soil Screening Values (SSV's). The guidelines are generally based on three main land uses as outlined below:

- *Residential (with or without plant uptake)*
- *Allotments*
- *Commercial*

Where these land uses are not deemed appropriate, other land use values can be considered with the DEFRA C4SLs, LQM S4UL's values and the ATRISK^{SOIL} SSV's (i.e. parks/playing fields/Public Open Space). Alternatively, it is possible to determine site specific intervention values as part of a Detailed Quantitative Risk Assessment (DQRA).

It is anticipated that the proposed development will incorporate a residential development with private gardens. Therefore, for the purposes of this basic Human Health ground contamination risk assessment, the maximum site recorded values for the soil samples have been compared to GAC for a CLEA end use classification of: *Residential with Plant Uptake End Use* to determine if a potential risk is present to the proposed end users.

Contaminant Analysis Sheets that include the results of the relevant Human Health Risk Assessment and the Generic Assessment Criteria (GAC) values are presented in Appendix IV.

7.2 Human Health Risk Assessment – Comparison with Guidance Levels

7.2.1 Inorganic Contaminants – Soil

The maximum concentration values for each inorganic analyte have been compared to the most relevant published Generic Assessment Criteria (GAC) as part of the Maximum Value Test. The GAC have been selected using the following guidance documents:

- LQM/CIEH S4UL 2015 (Residential with Plant Uptake End Use).
- CL:AIRE Category 4 Screening Levels C4SL (Residential with Plant Uptake End Use).
- Atkins ATRISK Screening Values (Residential with Consumption of Homegrown Produce).

As discussed in section 7.1, the contaminant concentrations have been assessed against GAC for a residential with plant uptake end use as it is anticipated that the proposed development will incorporate private gardens.

Based on the results of the contaminant analysis sheet contained in Appendix IV, it can be seen that a single elevated concentration of lead has been recorded in the made ground from trial pit TP05 at c.0.10m bgl.

The concentration of lead was recorded at low levels in the other samples and none of the other inorganic contaminant concentrations exceed the assessment criteria.

The results indicate a potential risk to human health and this is discussed in Section 9.

7.2.2 Organic Contaminants – Soil

The maximum concentration values for the organic analytes tested for (i.e., Speciated PAH) have been compared to the most relevant and appropriate published guidance values (generic assessment criteria) as part of the Maximum Value Test. The GAC have been selected using the following guidance documents:

- LQM/CIEH S4UL 2015 (Residential with Plant Uptake End Use).

Taking in to account the average TOC of the soils on the site, this assessment has been completed utilising a 1.0% SOM.

Based on the results of the contaminant analysis sheet contained in Appendix IV it can be seen that none of the organic contaminant concentrations exceed the assessment criteria and as such do not pose a risk to human health.

7.2.3 Asbestos Containing Materials (ACM's) – Soil

4 No. samples of the made ground have been subjected to laboratory microscopic analysis to determine the presence or not of Asbestos Containing Materials (ACM's) in accordance with the methodology within HSG 248.

Of the samples tested, all returned a negative result for ACM's and were recorded as NAD (no asbestos detected), i.e., no asbestos was encountered.

7.2.4 Human Health Risk Assessment – Summary

The following is a summary of the Human Health risk assessment based on a *Residential with Plant Uptake End Use*:

- **Generic Contamination:** Elevated lead in the made ground (TP05 at c.0.10m bgl).
- **Organic Contamination:** None.
- **Other Contamination:** None.

Based on the Human Health risk assessment above, it can be seen that the concentration of lead in the made ground encountered in trial pit TP05 exceeds the assessment criteria for a residential end use where private gardens are proposed. The concentration of lead was over 13 times the assessment criteria value at 2659mg/kg. The made ground at this location comprised sandy gravel of mixed aggregate, slag and concrete. No obvious sources for the lead were noted.

There is a plausible risk to human health through dermal contact, inhalation or consumption associated with the made ground encountered in trial pit TP05 and potentially elsewhere on site. However, the risk is only present where there is a plausible pathway such as in areas of soft landscaping or private gardens. Any hardcover (roads, car parks, buildings, etc…) will effectively break the established Source – Pathway – Receptor pollutant linkage model, by removing the Pathway element.

There was nothing noted in trial pit TP05 to explain the elevated lead concentration. As such, it is possible that elevated lead may be present elsewhere on the site and it is recommended that further screening is undertaken to delineate the elevated lead. Alternatively, remediation or protection measures should be adopted for the site as a whole where gardens or soft landscaping are planned. As the made ground was generally not considered suitable for re-use within landscaped areas, this may be the preferable option.

Remedial options are discussed briefly in Section 9.3.

Any imported materials required on site should be screened prior to placement on site to ensure contaminated materials are not being brought to site and that they are suitable for use within a residential setting.

If topsoil is brought on to site, the materials should be as specified in BS 3882:2015 as 'suitable for the intended purpose'. BS3882:2015 relates to nutrient content of topsoil and phytotoxic contamination and does not consider contaminants that pose a risk specifically to human health. Soils should be tested for contaminants that are considered to pose a risk to human health in addition to BS3882:2015 to ensure that they are suitable for their intended use. All materials brought on to site that are to be used as part of soft landscaped areas should be assessed with regards to human health criteria.

7.3 Determination of pH and Water-Soluble Sulphate

As indicated in Section 6, selected samples of the made ground have been screened to determine the pH and soluble sulphate potential to aid the design of buried concrete. The results of the chemical screening are presented in the Chemtech report (ref: 99853) contained in Appendix III.

From the results, the following observations can be seen:

- pH values in the soils ranged from 7.8 to 8.8 (slightly alkali).
- Water Soluble Sulphate (SO_4) levels were recorded as ranging from 100mg/l to 1225mg/l.

In accordance with BRE Special Digest 1: 2005 the results recorded equate to a Design Sulphate classification of DS-2 and an ACEC classification of AC-2 which should be adopted for buried concrete.

8.0 Construction Related Excavations and Off-Site Disposal

During the construction works it is likely that materials will be excavated on site (i.e. future foundations and buried utilities, etc.) that will not be able to be accommodated on site during to space and level constraints, ultimately requiring removal off site.

During the construction works, different materials should be stockpiled separately, and an appropriate waste disposal classification should be determined by the Design Team prior to removal. It may be the case that WAC testing is required to aid the assessment.

Where made ground materials or disturbed natural strata is to be removed, the results of the soil testing undertaken within this report can be used as a preliminary assessment and the anticipated waste disposal facility should be provided with a copy of the results for review. It may be the case that the waste facility requires additional contamination screening to aid the characterisation of the made ground for off-site disposal (i.e., Waste Acceptance Criteria – WAC) and it is recommended that this be confirmed by the design team prior to commencing on site.

During the construction phase, it may be the case that WAC screening is required to aid classification for disposal, and it is recommended that all materials are classified prior to excavation and disposal off site.

Conversely, if materials are required to be brought to site to raise site levels or as part of a clean cover system then certification and/or soil testing results should be reviewed by a suitably experienced and qualified geo-environmental engineer to ensure that potentially contaminated materials are not being brought to site.

Any material movements may require a Material Management Plan (MMP) in accordance with CL:AIRE.

9.0 Discussion and Recommendations

9.1 Ground and Groundwater Conditions Summary

The ground investigation encountered shallow loamy granular made ground with much anthropogenic materials including clinker, ash, brick, concrete, slag and asphalt to a maximum depth of c.0.50m bgl. Localised deeper made ground may be encountered associated with the former building foundations and/or any buried utilities.

The made ground was underlain by natural granular drift deposits comprising gravels and cobbles of mixed lithology with occasional gravelly sand.

Groundwater was noted from depths of c.1.40m bgl, typically in the central and eastern parts of the site. Several trial pits excavated across the western parts were noted as dry. As such, groundwater ingress should anticipated and it is recommended that allowance be made for some groundwater control measures (i.e. pumping equipment) particularly during wetter periods of the year, as the materials encountered may deteriorate following exposure to surface water.

The results of the soil infiltration tests and the groundwater levels should be taken into consideration when determining if soakaway drainage is appropriate for the site.

During the investigation, GEO did not identify any visual or olfactory evidence of fuel/oil type contamination (no staining, odour or free product) or any landfill type waste, with no potentially biodegradable, decomposable or putrescible materials.

9.2 Future Foundations, Pavements and Buried Structures

It is understood that the proposed development will incorporate residential housing. Based on the results of the ground investigation, conventional strip foundations in the natural drift deposits are considered appropriate, subject to confirmation by a Structural Engineer.

With respect to buried structures (concrete), the pH levels and soluble sulphate concentrations in the soils equate to a Design Sulphate classification of DS-2 and an ACEC classification of AC-2 (BRE Special Digest 1: 2005 – (assuming mobile groundwater).

Based on the ground conditions and the results of the DCP tests, conventional road and pavement construction techniques should be suitable. However, it is always recommended that the appropriate CBR value is confirmed by way of plate load testing at formation level prior to construction.

9.3 Ground Contamination

The results of the contamination assessment indicate elevated lead in the made ground from trial pit TP05 in the western part of the site, however, no other contaminants exceeded the assessment criteria.

No evidence was noted in trial pit TP05 to explain the elevated lead concentration at this location, therefore, further sampling and laboratory screening for lead could be undertaken to delineate the areas of the site which are impacted by the lead contamination. It may be possible to isolate the contamination to TP05 only. However, the made ground was generally not deemed suitable for re-use within areas of soft landscaping. Therefore, site wide remediation in areas soft landscaping may be more appropriate.

Elevated concentrations of lead within exposed soils can pose a risk to the end user in areas such as private gardens or soft landscaping due to possible inhalation, ingestion and direct contact with the contaminated soils. It is also feasible that home grown produce (vegetables) will be grown in the gardens

for human consumption and there is a plausible risk to human health through ingestion of contaminants that have been taken up through the plants. Where private gardens are not proposed, such as areas of hard standing and buildings, the risk from contamination is negligible as the pathway to the end user will be broken.

In view of the above, remediation is considered necessary to reduce the risk to the end user to acceptable levels. It is out-with the scope of this report to fully detail suitable remediation strategies, however, possible remediation options, based on the results of the investigation include the removal of the contaminated made ground from the proposed private garden areas, or the inclusion of a clean cover system.

Imported, clean topsoil would be required to replace the contaminated materials and provide a suitable growing medium for plants, shrubs and trees.

For proposed private gardens, it is generally accepted that a clean cover layer of 600mm is required to protect the end user from contamination in the made ground including uptake by any vegetables grown for human consumption. This would typically comprise a suitably compacted “no-dig layer” (comprising 150mm of compacted virgin quarry stone / gravel) underlain by a geotextile marker layer and at least 450mm of subsoil/topsoil at the surface (minimum 150mm topsoil). As well as providing a barrier between the contaminated material and the end user, the clean cover layer also provides a suitable growing medium for plants, shrubs and trees. Deepening of the clean cover is recommended where large plants and trees are proposed.

Based on the ground investigation, it is likely that the most suitable form of remediation would be to excavate and remove the made ground (typically less than 0.50m thick) and replace with clean imported soils. The site will therefore require a Remediation Strategy.

Given the results of the chemical screening, standard water supply pipes are likely to be suitable. However, it is recommended that the relevant utility suppliers are contacted in this respect, as a site-specific risk assessment may be required.

If topsoil is brought on to site, the materials should be as specified in BS 3882:2015 as ‘suitable for the intended purpose’. BS3882:2015 relates to nutrient content of topsoil and phytotoxic contamination and does not consider contaminants that pose a risk specifically to human health. Soils should be tested for contaminants that are considered to pose a risk to human health in addition to BS3882:2015 to ensure that they are suitable for their intended use. All materials brought on to site that are to be used as part of soft landscaped areas should be assessed with regards to human health criteria.

9.4 Supplementary Iron Ore Mining Assessment

The P1 DTS identified a potential risk associated with historical iron ore mining. No specific body is responsible for maintaining iron ore mining records and therefore assessing iron ore mining risk can be difficult.

The information obtained for the DTS identified that the site was underlain by the St Bees Sandstone (bedrock), with the potential for iron ore mining within the deeper strata beneath the St Bees Sandstone. Unfortunately, no 1:10,000 scale geological plan is available for this area, which is what would normally indicate areas of recorded iron ore mining. However, access is available to historical borehole records through the British Geological Survey (BGS). Whilst no historical borehole records are present directly on site, numerous are noted in the surrounding area and six records have been consulted for boreholes to the north, south, east and west of the site.

In summary, the boreholes note similar (deeper) ground conditions with the Permo Triassic St Bees Sandstone overlying the Brockram Breccia and older (therefore deeper) Carboniferous Limestone, inturn underlain (at significant depth) by the Ordovician Borrowdale Volcanic Group. The historical boreholes

noted the St Bees Sandstone to be between c.138m and c.269m in thickness, with one borehole noting iron ore at a depth of c.403m. Consequently, should this information be accurate and representative of the local geological setting, including the site locality, any iron ore mine workings should be sufficiently deep to not pose a significant risk at surface.

Whilst the desk-based information available to GEO suggests a low risk of shallow iron ore mining geohazards, it is recommended that the developer implement a watching brief on site and ensure a contingency sum in the event that should evidence of mine workings/entries be identified during construction, then they can be dealt with in an appropriate manner.

GEO is not responsible for third party information and records may be inaccurate or incomplete. Consequently, GEO recommends that care and consideration of potential mining features should be made by the developer during construction.

9.5 General Comments

Consideration must be made for variations to occur in the ground conditions between the exploratory hole locations for which GEO holds no responsibility and areas where limited access was available. It is therefore recommended that a “watching brief” and “observational technique” be applied to this site to ensure that if ground conditions appear to vary from those identified within this investigation report then advice should be sought from a suitably qualified and experienced Engineering Geologist, Geotechnical or Geo-Environmental Engineer.

The recommendations and opinions expressed in this report are based on the strata observed within the exploratory holes in addition to the results of the site and laboratory tests commissioned by GEO. Consequently, GEO takes no responsibility for conditions that have not been revealed or which occur between them. GEO takes no responsibility for the accuracy of third party information provided by sub-contract drillers or laboratories. Any items not specifically mentioned cannot be assumed to be covered.

The conclusions and recommendations presented within this report are considered reasonable based on the available information. However, these cannot be guaranteed to gain regulatory approval. Therefore, the report should be passed to the appropriate regulatory authorities and/ or other key stakeholders in order to seek their approval of the findings prior to undertaking any works on site.

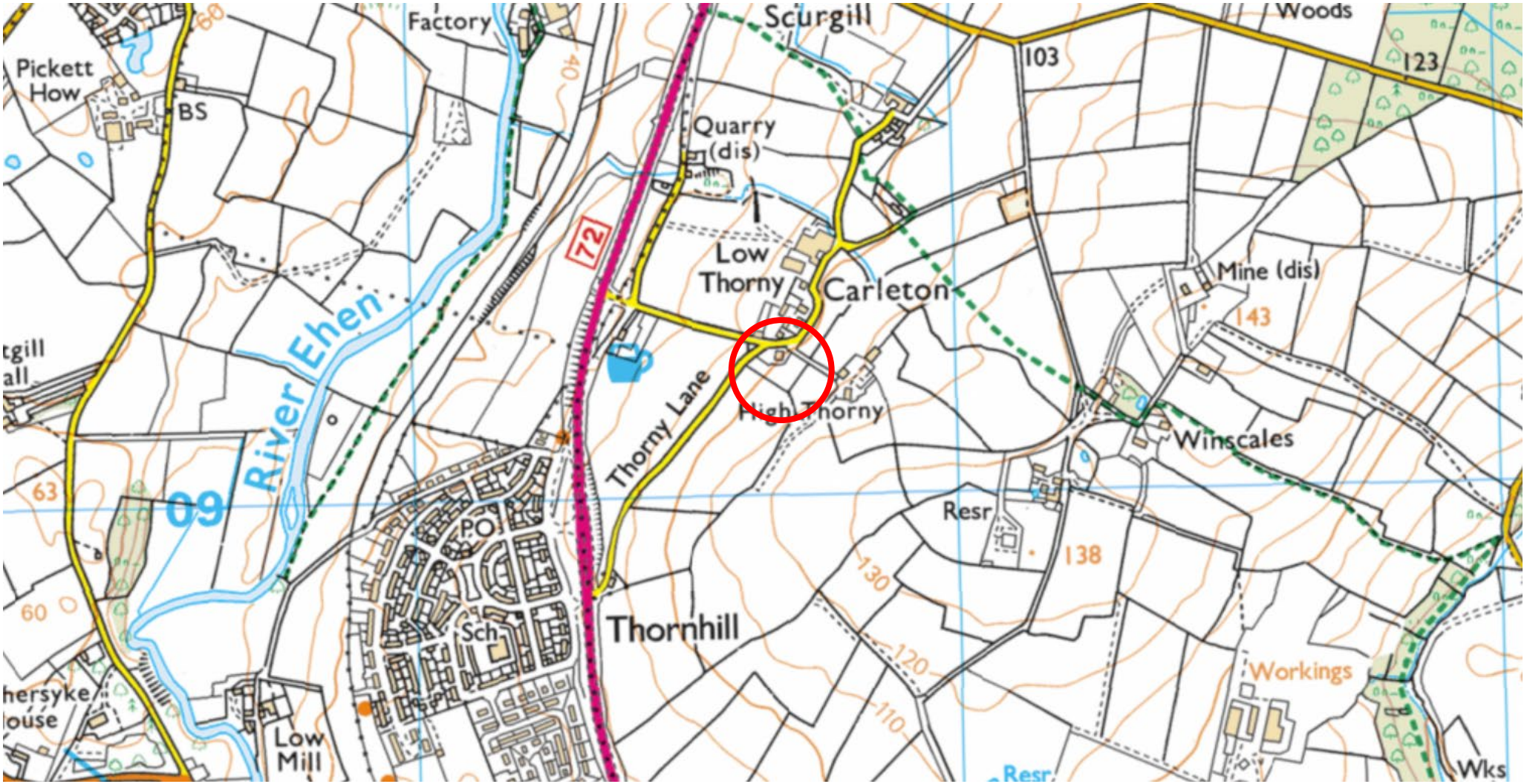
End of Report

Appendix I

- Site Location Plan
- Exploratory Hole Location Plan

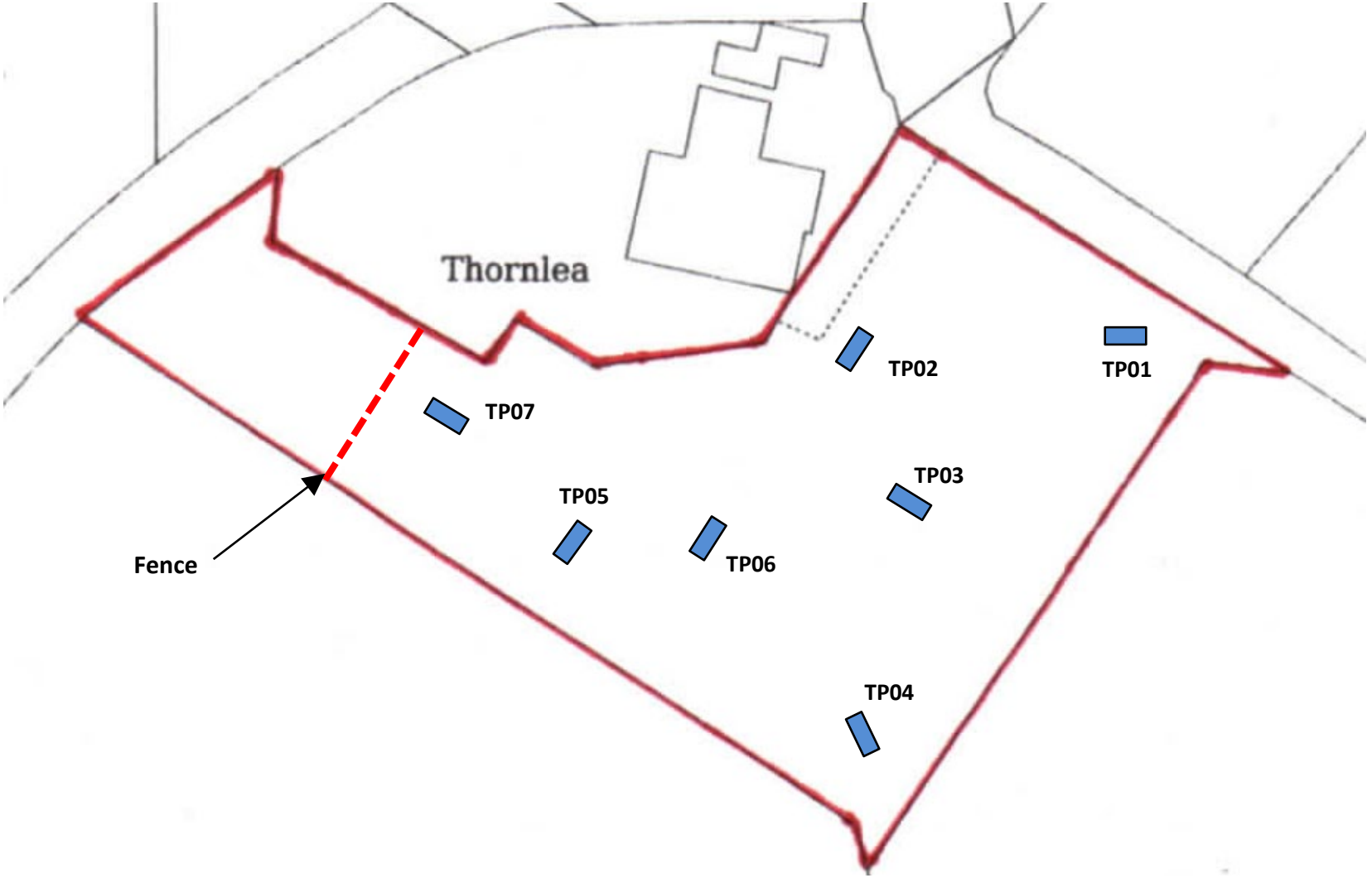
GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – Site Location



Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – Exploratory Hole Location Plan



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Appendix II

- Exploratory Hole Logs
- Soil Infiltration Test Results and Calculations

GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP01

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.18	TOPSOIL: Dark grey brown sandy gravelly LOAM with occasional clinker.		0.10 - J
0.18	0.87	Brown slightly silty very sandy fine to coarse sub-rounded GRAVEL with many cobbles.		
0.87	1.50	Brown slightly silty gravelly medium SAND.		
1.50	2.00	Brown slightly silty very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Occasional boulders.		
		End of trial hole at 2.00m due to complete collapse. Groundwater ingress at 1.50m bgl. Standing groundwater at 1.50m bgl on completion. Complete collapse of trial pit at 2.00m bgl. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP02

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.24	MADE GROUND: Dark brown silty sandy fine to coarse angular to sub-rounded GRAVEL of mixed aggregate with occasional brick, clinker and asphalt.		0.10 - J
0.24	0.90	Brown slightly silty very sandy fine to coarse sub-rounded GRAVEL with many cobbles.		
0.90	1.20	Brown slightly silty gravelly medium SAND.		
1.20	1.50	Brown slightly silty very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Occasional boulders.		
		End of trial hole at 1.50m – Soil Infiltration Test Completed. Groundwater ingress at 1.50m bgl. Standing groundwater at 1.50m bgl on completion. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator
Dimensions: 2.10m x 0.90m

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

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GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP03

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.38	MADE GROUND: Grey brown silty very sandy fine to coarse sub-rounded GRAVEL of mixed lithology with occasionally concrete/slag.		0.20 - J
0.38	2.00	Brown slightly silty very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Occasional boulders.		1.00 - J
		End of trial hole at 2.00m. Groundwater ingress at 1.40m bgl. Standing groundwater at 1.40m bgl on completion. Trial pit collapsing during excavation. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP04

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.22	MADE GROUND: Brown silty sandy gravelly LOAM with occasional clinker.		0.10 - J
0.22	0.41	MADE GROUND: Blue grey fused SLAG. Strong sulphurous odour. Difficult to excavate.		
0.41	1.80	Brown slightly silty, very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Occasional boulders. Occasional pockets of very gravelly sand.		1.00 - J
		End of trial hole at 1.80m. Trial Pit dry and stable on completion. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP05

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.50	MADE GROUND: Grey brown sandy fine to coarse angular GRAVEL of mixed aggregate, slag and concrete. Plastic pipe at surface.		0.10 - J
0.50	1.10	Grey brown very silty gravelly SAND.		
1.10	1.70	Brown slightly silty, very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Ceramic field drain at 1.10m bgl.		
		End of trial hole at 1.70m. Trial Pit dry and stable on completion. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP06

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.40	MADE GROUND: Grey brown sandy fine to coarse angular GRAVEL of mixed aggregate, slag and concrete.		0.10 - J
0.40	1.80	Brown slightly silty, very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Occasional boulders.		
		End of trial hole at 1.80m – Soil Infiltration Test Completed. Groundwater ingress at 1.45m bgl. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator
Dimenions: 2.00m x 1.00m

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO Environmental Engineering

GEO2021-4903: Land Adjacent to Thornlea, Carleton, Egremont, Cumbria – TP07

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.20	MADE GROUND: Grey brown loamy soil with occasional ash (former bonfire).		0.10 - J
0.20	1.30	Brown slightly silty, very sandy fine to coarse sub-rounded GRAVEL and COBBLES of mixed lithology. Occasional boulders.		
1.30	2.10	Brown silty gravelly medium SAND		
		End of trial hole at 2.10m. Trial Pit dry and stable on completion. Trial hole backfilled with arisings on completion.		

Engineer: J.Brock
Site Works Date: 17/08/2021
Plant: Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 08456 768 895 / 07883 440 186

GEO2021-4903: Carleton, Egremont, Cumbria – Soil Infiltration Test Results

TP02 – Test 1

Duration (mins)	Water Level (m bgl)
0	0.66
11	0.66
36	0.65
72	0.65
128	0.64
199	0.63

TP06 – Test 1

Duration (mins)	Water Level (m bgl)
0	0.83
13	0.88
58	0.98
130	1.07

TP06 – Test 2

Duration (mins)	Water Level (m bgl)
0	0.73
137	0.98

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SOIL INFILTRATION TEST CALCULATION SHEET

SITE:	**Thornlea, Carleton, Egremont**
JOB NO:	**2021-4903**
TRIAL PIT:	**TP06**
TEST NO.:	**1**

GROUND CONDITIONS: See Trial Pit Logs for Details

TEST HOLE SIZE:

Width	**1000**	mm
Length	**2000**	mm
Depth of hole	**1800**	mm
Change Water Level	**240**	mm

MONITORING RESULTS:

Recorded Time			Total Time	Depth of water
Hours	Minutes	Seconds	(secs)	(mm)
0	0	0	0	830
0	13	0	780	880
0	58	0	3480	980
0	130	0	7800	1070

PERCOLATION TEST RESULTS AND SOIL INFILTRATION ASSESSMENT

TEST NO.: **1**

SOIL INFILTRATION RATE ASSESSMENT:

Vol. Outflowing between 75% and 25% effective depth:

V_{p75-25} = **0.24** m^3

Mean surface area (pit sides to 50% effective depth + base of pit):

A_{p50} = **2.72** m^2

Time for the outflow between 75% and 25% effective depth:

t_{p75-25} = **3900** secs

Soil Infiltration rate:

f = **2.3E-05** m/s

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SOIL INFILTRATION TEST CALCULATION SHEET

SITE:	**Thornlea, Carleton, Egremont**
JOB NO:	**2021-4903**
TRIAL PIT:	**TP06**
TEST NO.:	**2**

GROUND CONDITIONS: See Trial Pit Logs for Details

TEST HOLE SIZE:

Width	**1000**	mm
Length	**2000**	mm
Depth of hole	**1800**	mm
Change Water Level	**250**	mm

MONITORING RESULTS:

Recorded Time			Total Time (secs)	Depth of water (mm)
Hours	Minutes	Seconds		
0	0	0	0	730
0	137	0	8220	980

PERCOLATION TEST RESULTS AND SOIL INFILTRATION ASSESSMENT

TEST NO.: **2**

SOIL INFILTRATION RATE ASSESSMENT:

Vol. Outflowing between 75% and 25% effective depth:

V_{p75-25} = **0.25** m^3

Mean surface area (pit sides to 50% effective depth + base of pit):

A_{p50} = **2.75** m^2

Time for the outflow between 75% and 25% effective depth:

t_{p75-25} = **4110** secs

Soil Infiltration rate:

f = **2.2E-05** m/s

Appendix III

- Laboratory Test Results

ANALYTICAL TEST REPORT

Contract no: 99853

Contract name: Thornlea, Carleton, Egremont

Client reference: GEO2020-4302

Clients name: Geo Environmental Engineering

Clients address: 4 Culgarth Avenue
Cockermouth
Cumbria
CA13 9PL

Samples received: 27 August 2021

Analysis started: 27 August 2021

Analysis completed: 06 September 2021

Report issued: 06 September 2021

Notes:
Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key:
U UKAS accredited test
M MCERTS & UKAS accredited test
$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing
NAD No Asbestos Detected

Approved by:

Rachael Burton
Customer Support Squad Leader

Chemtech Environmental Limited

SAMPLE INFORMATION

MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

All results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.
Analytical results are inclusive of stones.

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
99853-1	TP01	0.10	Loam with Gravel & Roots	-	-	18.8
99853-2	TP02	0.10	Loam with Gravel & Roots	-	-	16.1
99853-3	TP04	0.10	Loam with Gravel & Roots	-	-	15.5
99853-4	TP05	0.10	Sandy Loam with Gravel & Roots	-	-	14.5
99853-5	TP07	0.10	Sandy Loam with Gravel & Roots	-	-	41.7

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SOILS

Lab number			99853-1	99853-2	99853-3	99853-4	99853-5
Sample id			TP01	TP02	TP04	TP05	TP07
Depth (m)			0.10	0.10	0.10	0.10	0.10
Date sampled			25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Test	**Method**	**Units**					
Arsenic (total)	CE127 M	mg/kg As	12	7.4	12	6.6	-
Cadmium (total)	CE127 M	mg/kg Cd	<0.2	<0.2	<0.2	<0.2	-
Chromium (total)	CE127 M	mg/kg Cr	106	54	116	16	-
Chromium (III)	CE208	mg/kg CrIII	106	54	116	16	-
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1	-
Copper (total)	CE127 M	mg/kg Cu	22	9.9	21	11	-
Lead (total)	CE127 M	mg/kg Pb	37	13	43	2659	-
Mercury (total)	CE127 M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	-
Nickel (total)	CE127 M	mg/kg Ni	15	10	18	5.6	-
Selenium (total)	CE127 M	mg/kg Se	1.1	1.1	0.9	4.0	-
Zinc (total)	CE127 M	mg/kg Zn	45	62	63	43	-
pH	CE004 M	units	7.8	7.9	8.1	8.8	-
Sulphate (2:1 water soluble)	CE061 U	mg/l SO_4	501	354	100	1225	-
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1	-
Total Organic Carbon (TOC)	CE197	% w/w C	1.8	1.5	0.9	1.8	-
PAH							
Naphthalene	CE087 M	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	CE087 M	mg/kg	0.02	<0.02	0.04	<0.02	<0.02
Acenaphthene	CE087 M	mg/kg	0.03	0.03	<0.02	<0.02	<0.02
Fluorene	CE087 U	mg/kg	0.03	<0.02	<0.02	<0.02	<0.02
Phenanthrene	CE087 M	mg/kg	0.41	0.18	0.19	0.02	<0.02
Anthracene	CE087 U	mg/kg	0.10	0.05	0.07	<0.02	<0.02
Fluoranthene	CE087 M	mg/kg	0.76	0.41	0.40	0.06	<0.02
Pyrene	CE087 M	mg/kg	0.58	0.37	0.34	0.04	<0.02
Benzo(a)anthracene	CE087 U	mg/kg	0.35	0.22	0.27	0.04	0.03
Chrysene	CE087 M	mg/kg	0.40	0.20	0.22	0.04	<0.03
Benzo(b)fluoranthene	CE087 M	mg/kg	0.42	0.32	0.34	0.05	<0.02
Benzo(k)fluoranthene	CE087 M	mg/kg	0.18	0.12	0.14	<0.03	<0.03
Benzo(a)pyrene	CE087 U	mg/kg	0.27	0.23	0.21	0.03	<0.02
Indeno(123cd)pyrene	CE087 M	mg/kg	0.22	0.17	0.18	0.03	<0.02
Dibenz(ah)anthracene	CE087 M	mg/kg	0.04	<0.02	0.03	<0.02	<0.02
Benzo(ghi)perylene	CE087 M	mg/kg	0.18	0.14	0.15	0.03	<0.02
PAH (total of USEPA 16)	CE087	mg/kg	4.01	2.43	2.58	0.35	<0.34
Subcontracted analysis							
Asbestos (qualitative)	$	-	NAD	NAD	NAD	NAD	-

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE127	Arsenic (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg As
CE127	Cadmium (total)	Aqua regia digest, ICP-MS	Dry	M	0.2	mg/kg Cd
CE127	Chromium (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cr
CE208	Chromium (III)	Calculation: Cr (total) - Cr (VI)	Dry		1	mg/kg CrIII
CE146	Chromium (VI)	Acid extraction, Colorimetry	Dry		1	mg/kg CrVI
CE127	Copper (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cu
CE127	Lead (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Pb
CE127	Mercury (total)	Aqua regia digest, ICP-MS	Dry	M	0.5	mg/kg Hg
CE127	Nickel (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Ni
CE127	Selenium (total)	Aqua regia digest, ICP-MS	Dry	M	0.3	mg/kg Se
CE127	Zinc (total)	Aqua regia digest, ICP-MS	Dry	M	5	mg/kg Zn
CE004	pH	Based on BS 1377, pH Meter	As received	M	-	units
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry	U	10	mg/l SO_4
CE077	Cyanide (total)	Extraction, Continuous Flow Colorimetry	As received		1	mg/kg CN
CE072	Total Organic Carbon (TOC)	Removal of IC by acidification, Carbon Analyser	Dry		0.1	% w/w C
CE087	Naphthalene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Acenaphthylene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Acenaphthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Fluorene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Phenanthrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Anthracene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Fluoranthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(a)anthracene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Chrysene	Solvent extraction, GC-MS	As received	M	0.03	mg/kg
CE087	Benzo(b)fluoranthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(k)fluoranthene	Solvent extraction, GC-MS	As received	M	0.03	mg/kg
CE087	Benzo(a)pyrene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Indeno(123cd)pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Dibenz(ah)anthracene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(ghi)perylene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	PAH (total of USEPA 16)	Solvent extraction, GC-MS	As received		0.34	mg/kg
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

Chemtech Environmental Limited

DEVIATING SAMPLE INFORMATION

Comments
Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.
For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.
Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
99853-1	TP01	0.10	N	
99853-2	TP02	0.10	N	
99853-3	TP04	0.10	N	
99853-4	TP05	0.10	N	
99853-5	TP07	0.10	N	

Appendix IV

- GEO Chemical Assessment Sheet

Geo Environmental Engineering Ltd

Chemical Assessment Sheet - Soils

Lab number			99853-1	99853-2	99853-3	99853-4	99853-5	Generic Assessment Criteria Residential With Plant Uptake 1.0% SOM		
Sample id			TP01	TP02	TP04	TP05	TP07			
Depth (m)			0.10	0.10	0.10	0.10	0.10	GAC	GAC Exceeded?	GAC Ref:
Date sampled			25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021			
Test	**Method**	**Units**								
Arsenic (total)	CE127 M	mg/kg As	12	7.4	12	6.6	-	37	No	LQM S4UL
Cadmium (total)	CE127 M	mg/kg Cd	<0.2	<0.2	<0.2	<0.2	-	11	No	LQM S4UL
Chromium (III)	CE208	mg/kg CrIII	106	54	116	16	-	910	No	LQM S4UL
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1	-	6	No	LQM S4UL
Copper (total)	CE127 M	mg/kg Cu	22	9.9	21	11	-	2400	No	LQM S4UL
Lead (total)	CE127 M	mg/kg Pb	37	13	43	2659	-	200	YES	CL:AIRE C4SL
Mercury (total)	CE127 M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	-	40	No	LQM S4UL
Nickel (total)	CE127 M	mg/kg Ni	15	10	18	5.6	-	130	No	LQM S4UL
Selenium (total)	CE127 M	mg/kg Se	1.1	1.1	0.9	4.0	-	250	No	LQM S4UL
Zinc (total)	CE127 M	mg/kg Zn	45	62	63	43	-	3700	No	LQM S4UL
pH	CE004 M	units	7.8	7.9	8.1	8.8	-	N/A	N/A	N/A
Sulphate (2:1 water soluble)	CE061 U	mg/l SO_4	501	354	100	1225	-	N/A	N/A	N/A
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1	-	34	No	ATRISK SSV
Total Organic Carbon (TOC)	CE197	% w/w C	1.8	1.5	0.9	1.8	-	-	-	-
PAH										
Naphthalene	CE087 M	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	2.3	No	LQM S4UL
Acenaphthylene	CE087 M	mg/kg	0.02	<0.02	0.04	<0.02	<0.02	170	No	LQM S4UL
Acenaphthene	CE087 M	mg/kg	0.03	0.03	<0.02	<0.02	<0.02	210	No	LQM S4UL
Fluorene	CE087 U	mg/kg	0.03	<0.02	<0.02	<0.02	<0.02	170	No	LQM S4UL
Phenanthrene	CE087 M	mg/kg	0.41	0.18	0.19	0.02	<0.02	95	No	LQM S4UL
Anthracene	CE087 U	mg/kg	0.10	0.05	0.07	<0.02	<0.02	2400	No	LQM S4UL
Fluoranthene	CE087 M	mg/kg	0.76	0.41	0.40	0.06	<0.02	280	No	LQM S4UL
Pyrene	CE087 M	mg/kg	0.58	0.37	0.34	0.04	<0.02	620	No	LQM S4UL
Benzo(a)anthracene	CE087 U	mg/kg	0.35	0.22	0.27	0.04	0.03	7.2	No	LQM S4UL
Chrysene	CE087 M	mg/kg	0.40	0.20	0.22	0.04	<0.03	15	No	LQM S4UL
Benzo(b)fluoranthene	CE087 M	mg/kg	0.42	0.32	0.34	0.05	<0.02	2.6	No	LQM S4UL
Benzo(k)fluoranthene	CE087 M	mg/kg	0.18	0.12	0.14	<0.03	<0.03	77	No	LQM S4UL
Benzo(a)pyrene	CE087 U	mg/kg	0.27	0.23	0.21	0.03	<0.02	2.2	No	LQM S4UL
Indeno(123cd)pyrene	CE087 M	mg/kg	0.22	0.17	0.18	0.03	<0.02	27	No	LQM S4UL
Dibenz(ah)anthracene	CE087 M	mg/kg	0.04	<0.02	0.03	<0.02	<0.02	0.24	No	LQM S4UL
Benzo(ghi)perylene	CE087 M	mg/kg	0.18	0.14	0.15	0.03	<0.02	320	No	LQM S4UL
PAH (total of USEPA 16)	CE087	mg/kg	4.01	2.43	2.58	0.35	<0.34	-	-	-
Subcontracted analysis										
Asbestos (qualitative)	$	-	NAD	NAD	NAD	NAD	-	Present	No	Presence

Notes:
GAC = Generic Assessment Criteria
YES = GAC Exceeded
CLEA SGV = Clea Soil Guideline Value (Residential with Plant Uptake End Use based on 1% SOM)
LQM S4UL = LQM/CIEH 'Suitable 4 Use Levels' S4ULs (Residential with Plant Uptake End Use based on 1% SOM)
CL:AIRE C4SL = Category 4 Screening Levels (Residential with Plant Uptake End Use based on 1% SOM)
ATRISK SSV = Atkins Soil Screening Values (Residential with Consumption of Home Grown Produce at 1% SOM)

GEO Environmental Engineering

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Geotechnical
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