GEO Environmental Engineering

SUPPLEMENTARY PHASE 2:

GROUND INVESTIGATION REPORT

(GROUND GAS RISK ASSESSMENT)

PROPOSED RESIDENTIAL DEVELOPMENT OF

LAND THE FORMER FISH FACTORY, HENSINGHAM

WHITEHAVEN, CUMBRIA

FOR:

G & A.M LAWSON LTD

GEO Environmental Engineering

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DOCUMENT CONTROL SHEET

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1.0 Introduction

1.1 Brief

GEO Environmental Engineering Ltd (GEO) was commissioned by G & A.M Lawson Ltd, herein referred to as the "Client", to carry out supplementary ground investigation on land at The Former Fish Factory in Hensingham near Whitehaven, Cumbria as indicated on the site location plan included in appendix I.

The investigation was carried out to assess the ground gas concentrations to determine if gas protection measures are required in the proposed residential dwellings.

This is a second phase of gas monitoring. The first phase of monitoring was completed in 2014 prior to the demolition of the former fish processing plant. The second phase of monitoring has been completed following large scale earthworks to remove all unsuitable materials from a former backfilled quarry located immediately west of the proposed residential development. See section 1.4 for further details.

1.2 Site Location and Description

The site, occupying an area of c.1.34ha is located in the northern part of Hensingham, c.2km south east of Whitehaven in Cumbria, as indicated on the site location plan included in Appendix I. Access to the site is from an unnamed road to the south.

- National Grid Reference: 299510, 517570.
- Post Code: CA28 8TU (approximate only)

The site was a former fish processing plant. At the time of the investigation, the site was used for storing building materials for the construction of the adjacent commercial development (office blocks). Several mounds of sand and gravel and occasional stockpiles of soil were also present on the site. The ground generally comprised exposed soils and gravel hardstand with areas of soft, waterlogged ground present in the northern part.

The site undulates with an overall fall in level to the north. A topographical survey data was not available, however, Ordnance Survey data indicates that the site is at an elevation of c.137m AOD.

1.3 Proposed Development

It is understood that the Client plans to develop the site for residential end use. A preliminary site layout plan indicates c.31 separate residential units (detached and semi-detached houses) with private gardens, soft landscaping, access roads, car parking and other associated infrastructure.

1.4 Other Reports/Studies

GEO have previously completed a Phase 2: Ground Investigation Report (GIR) and Ground Gas Addendum for the site, details of which are included below:

- Phase 2 Ground Investigation Report, Redevelopment of Land at The Former Fish Factory, Hensingham, Whitehaven, Cumbria for G & A.M Lawson Ltd, ref: 2013-890, dated: 25th March 2014.
- Ground Gas Addendum, Former Fish Factory, Hensingham, dated: 11th November 2014.

It is recommended that these documents are read in conjunction with this report.

The previous ground investigation/ground gas addendum was completed prior to the demolition of the former fish processing plant. The ground investigation identified historical records which noted a former backfilled quarry in the western part of the site which has recently been developed for commercial use (offices). Ground gas monitoring on the site in 2014 identified elevated concentrations of CO2 (carbon dioxide) and CH4 (methane). CO2 was recorded up to 13.0% and CH4 was recorded up to 4.2%. As such, the report recommended gas protection measures for the whole site, including the proposed residential development.

It was understood during the previous ground investigation that the Client was proposing earthworks to remove any unsuitable and/or potentially organic material from the former quarry and replace the suitable granular fraction as engineered fill.

The previous ground gas addendum report included the following comment regarding any earthworks within the former quarry:

> *"Should significant and extensive earthworks be completed on site or adjacent to the site then it may be necessary to complete additional ground gas monitoring and assessment to determine if the changes made on site have influenced the ground gas regime identified."*

It is considered likely that the elevated concentrations of ground gas identified during the previous investigation were a result of the unsuitable, potentially organic material within the infilled quarry. As all of the unsuitable materials have now been removed, it was considered appropriate to reassess the ground gas levels and associated risk to the proposed end users.

Therefore, a second phase of gas monitoring has been completed. 5 No. boreholes were sunk across the site in November 2018 and wells installed in each borehole to facilitate a second phase of ground gas monitoring.

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 ground gas concentrations across the development area in order to determine any risks to human health (residents).

2.2 Guidelines, Codes of Practice and Third Part Accreditations

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

- BS5930: 2015: Code of Practice for Site Investigations.
- BS8485: 2015: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.
- BS8576: 2013: Guidance on Ground Gas Investigations.
- CIRIA Report C665: 2015.
- 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.

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.

3.0 Ground Investigation Fieldwork

3.1 Intrusive Investigation Fieldworks Summary

The ground investigation works were completed on the 8th November 2018. The boreholes were located across the site to provide general site coverage taking cognisance of buried utilities, site topography, mounds of materials and locations of the proposed residential units. The exploratory hole location plan is provided in Appendix I.

The ground investigation works comprised:

- 5 No. Dynamic Sampling Boreholes (BH01 to BH05) to depths of between c.0.95m and c.2.70m bgl.
- Site supervision by a suitably qualified and experienced Geo-Environmental Engineer.
- Gas and groundwater monitoring (6 visits completed to date).

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.

The results of the ground gas monitoring visits are included in Appendix II.

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.

4.1.1 Made Ground

Made ground was encountered in all of the exploratory hole locations to depths of between c.0.20m and c.0.70m bgl, however, boreholes BH01 and BH05 were terminated in possible made ground at depths of between c.0.95m and c.1.90m bgl due to refusal.

The made ground comprised a shallow layer of dark grey brown medium to coarse angular gravel of mixed aggregates, sandstone, limestone, slag, concrete and brick (c.0.20m to c.0.70m bgl). This was underlain in boreholes BH01 and BH05 (located in the central and western part of the site) by possible made ground comprising brown and grey very silty, sandy fine to coarse gravel and cobbles of sandstone.

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 in boreholes BH02 to BH04 from depths of between c.0.20m and c.0.70m bgl. The natural drift comprised firm to stiff brown sandy gravelly clay.

Boreholes BH02 to Bh04 were terminated in the natural drift deposits due to refusal (further penetration not possible) on suspected cobbles/boulders or possible shallow bedrock.

4.1.3 Solid Geological Deposits (Bedrock)

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

4.2 Groundwater

During the intrusive ground investigation works, groundwater was only encountered in borehole BH01 at a slight ingress from c.0.20m bgl, however, all of the other boreholes were recorded as dry.

Groundwater monitoring has been carried out on six occasions between November 2018 and February 2019. Standing groundwater levels have been recorded between ground level and c.1.50m bgl. Borehole BH05 in the central part of the site was recorded as dry at c.1.90m bgl throughout the monitoring period.

The groundwater levels are likely to be a result of perched (trapped) groundwater rather than a continuous shallow groundwater table. Even so, 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.

5.0 Exploratory Hole Testing

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

5.1 Ground Gas Monitoring

To assess the on-site potential for hazardous ground gases, the boreholes (BH01 to BH05) were installed with ground gas monitoring wells to facilitate a period of ground gas monitoring.

The boreholes were installed to depths of between c.0.95m and c.2.70m bgl with a 50mm diameter HDPE standpipe with a bentonite seal for the upper section and a gravel surround for the remainder of the pipe, finished with a plastic end cap and rubber gas bung. The installation details are presented on each borehole log in Appendix II.

The monitoring and assessment has been completed in accordance with BS8485: 2007: Code of practice for the characterisation and remediation from ground gas affected developments, CIRIA Report C665, November 2007 and the NHBC Document; Guidance on the evaluation of development proposals on site where methane and carbon dioxide are present, March 2007.

As it is the intention of the Client to develop the site for Residential end use, the monitoring of ground gas monitoring must comprise at least six site visits over a minimum period of three-months.

The wells have been monitored on six occasions between the 16th November 2018 and 13th February 2019. The monitoring was completed in general accordance with CIRIA C665 (Table 5.5a and 5.5b) using a GA2000 Ground Gas Analyser with external flow pod.

The results of monitoring are included on the Ground Gas Monitoring Record Sheets included in Appendix II.

The ground gas risk assessment is presented in Section 6 of this report.

6.0 Ground Gas Risk Assessment

During the monitoring, atmospheric air pressures varied between 989mb and 1016mb and included both rising and falling pressure trends.

A maximum Carbon Dioxide (CO_2) concentration of 3.8%v/v has been recorded and no Methane (CH_4) was detected. The minimum Oxygen (O_2) concentration was 11.0%.

Flow rates were noted to be typically low (<0.1l/h), however, an initial brief peak flow rate of up to 9.0l/h was noted for a very short duration on one occasion before dropping back to <0.1l/h. The high rate of flow is likely to be associated with pressure equalisation between the well and the atmospheric air pressure and is not associated with the generation of ground gasses.

In accordance with CIRIA C665 the maximum recorded CO_2 concentration has been converted to a Gas Screening Value (GSV), summarised as follows.

In this instance, the CO_2 GSV is:

- **CO_2 GSV = (Max CO_2 (%) / 100) x Max Flow (l/hr),**
- **Therefore; (3.8 / 100) x 0.1 = 0.0038 l/hr GSV**

Since no Methane have been detected no GSV has or can be formulated.

Therefore, in accordance with CIRIA C665 Table 8.5, taking into consideration the GSV for CO_2 and the maximum gas concentrations, the site falls into Characteristic Situation 1 (CS1) or the Green Classification when utilising the NHBC Characterisation System. This indicates that gas precautions are not necessary at this stage.

Depleted O2 levels have also been noted. Whilst these levels are unlikely to pose a risk to the above ground structures and end users, they may potentially pose a risk to the construction workforce during any below ground works (i.e. installing utilities etc.). As a result, this report should be passed to the Principal Contractor as a Workforce Health and Safety risk assessment lies beyond the scope of this report.

7.0 Discussion and Recommendations

7.1 Ground Gas

The results of the ground gas monitoring indicate no methane, low concentrations of carbon dioxide and low flow rates. The results indicate that the source of the ground gas previously encountered on the site has been successfully removed during the earthworks for the development of the office blocks.

Based on the results of the recent gas monitoring, gas protection measures are not considered necessary at this stage.

Depleted O2 levels have been noted. Whilst these levels are unlikely to pose a risk to the above ground structures and end users, they may potentially pose a risk to the construction workforce during any below ground works (i.e. installing utilities etc.). As a result, this report should be passed to the Principal Contractor as a Workforce Health and Safety risk assessment lies beyond the scope of this report.

Radon protection measures are not considered necessary at this time.

7.2 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 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.

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.

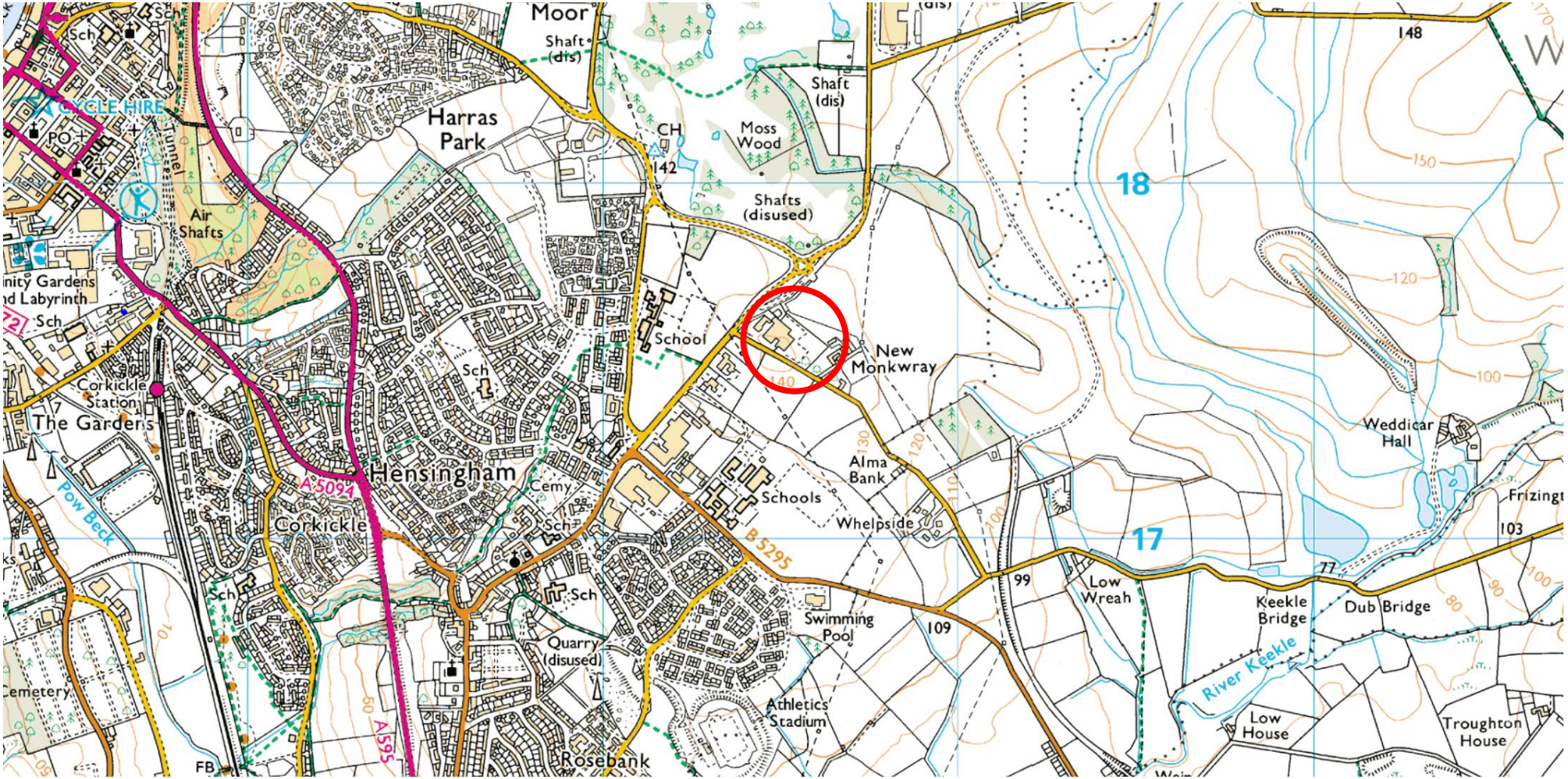
End of Report

Appendix I

- Site Location Plan
- Exploratory Hole Location Plan

GEO Environmental Engineering

GEO2018-3413: Former Fish Factory, Whitehaven, Cumbria – Site Location



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GEO2018-3413: Former Fish Factory, Whitehaven, Cumbria – Exploratory Hole Location Plan

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Appendix II

- Exploratory Hole Logs
- Ground Gas and Groundwater Monitoring Record Sheets

GEO Environmental Engineering

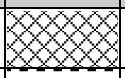
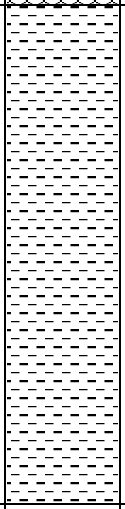
GEO2018-3413: Former fish factory, Whitehaven, Cumbria – BH01

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.45	MADE GROUND: Dark grey brown medium to coarse angular GRAVEL of slag, concrete and brick.		
0.45	0.95	POSSIBLE MADE GROUND: Brown and grey very silty sandy fine to coarse GRAVEL and COBBLES of weak coarse-grained sandstone.		
		End of borehole at 0.95m due to sample tube and SPT refusal. Slight groundwater ingress at 0.20m bgl. Borehole remained open and dry on completion. Installed: 0m to 0.40m – Plain pipe and bentonite surround. 0.40m to 0.95m – Slotted pipe and gravel surround.		No samples.

Site: Former fish factory, Whitehaven, Cumbria
Engineer: J.Brock
Site Works Date: 08.11.2018
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
CBR = California Bearing Ratio (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

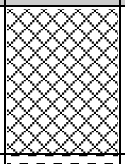
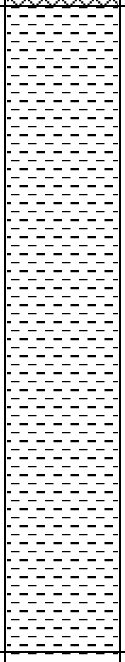
GEO2018-3413: Former fish factory, Whitehaven, Cumbria – BH02

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.20	MADE GROUND: Dark brown very silty, sandy fine to coarse angular GRAVEL of brick, concrete, mixed aggregates and slag.		
0.20	1.90	Firm to stiff brown sandy, very gravelly CLAY. Gravel is fine to coarse sub-rounded to sub-angular sandstone and mixed lithology.		
		End of borehole at 1.90m due to sample tube and SPT refusal. Borehole remained open and dry on completion. Installed: 0m to 1.00m – Plain pipe and bentonite surround. 1.00m to 1.90m – Slotted pipe and gravel surround.		No samples.

Site: Former fish factory, Whitehaven, Cumbria
Engineer: J.Brock
Site Works Date: 08.11.2018
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
CBR = California Bearing Ratio (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO2018-3413: Former fish factory, Whitehaven, Cumbria – BH03

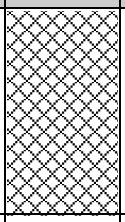
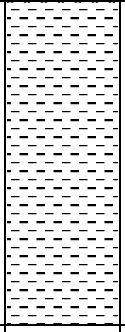
Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.50	MADE GROUND: Dark brown very silty, sandy fine to coarse angular GRAVEL of brick, concrete, mixed aggregates and slag.		
0.50	2.70	Firm to stiff brown sandy, very gravelly CLAY. Gravel is fine to coarse sub-rounded to sub-angular limestone, sandstone and mixed lithology.		
		End of borehole at 1.90m due to sample tube and SPT refusal. Borehole remained open and dry on completion. Installed: 0m to 1.00m – Plain pipe and bentonite surround. 1.00m to 2.70m – Slotted pipe and gravel surround.		No samples.

Site: Former fish factory, Whitehaven, Cumbria
Engineer: J.Brock
Site Works Date: 08.11.2018
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
CBR = California Bearing Ratio (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO Environmental Engineering

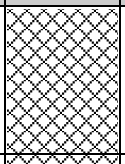
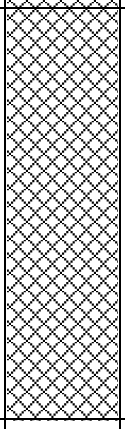
GEO2018-3413: Former fish factory, Whitehaven, Cumbria – BH04

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.70	MADE GROUND: Dark brown very silty, sandy fine to coarse angular GRAVEL and COBBLES of sandstone, limestone and concrete.		
0.70	1.80	Firm to stiff brown sandy, very gravelly CLAY. Gravel is fine to coarse sub-rounded to sub-angular limestone, sandstone and mixed lithology.		
		End of borehole at 1.80m due to sample tube and SPT refusal. Borehole remained open and dry on completion. Installed: 0m to 1.00m – Plain pipe and bentonite surround. 1.00m to 1.80m – Slotted pipe and gravel surround.		No samples.

Site: Former fish factory, Whitehaven, Cumbria
Engineer: J.Brock
Site Works Date: 08.11.2018
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
CBR = California Bearing Ratio (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO2018-3413: Former fish factory, Whitehaven, Cumbria – BH05

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.50	MADE GROUND: Dark grey brown medium to coarse angular GRAVEL of slag, concrete and brick.		
0.50	1.90	POSSIBLE MADE GROUND: Brown and grey very silty sandy fine to coarse GRAVEL and COBBLES of weak coarse-grained sandstone.		
		End of borehole at 0.95m due to sample tube and SPT refusal. Borehole remained open and dry on completion. Installed: 0m to 1.00m – Plain pipe and bentonite surround. 1.00m to 1.90m – Slotted pipe and gravel surround.		No samples.

Site: Former fish factory, Whitehaven, Cumbria
Engineer: J.Brock
Site Works Date: 08.11.2018
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
CBR = California Bearing Ratio (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

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Ground Gas & Groundwater Monitoring Record Sheet 01

Site: The Old Fish Factory, Whitehaven

Project No: 2018-3413

Date: 16/11/2018

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1008 F	0	0	0.1	0.1	19.4	19.4	<0.1	0.51	0.95	-
BH02	1008 F	0	0	0.3	0.3	19.8	19.8	+9.0 / <0.1	0.54	1.90	-
BH03	1008 F	0	0	0.7	0.7	19.6	19.6	0.2	1.26	2.70	-
BH04	1008 F	0	0	1.0	1.0	18.5	18.5	<0.1	1.19	1.80	-
BH05	1008 F	0	0	0.1	0.1	18.6	18.6	<0.1	DRY	1.90	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Overcast and Dry. Temperature 15.0°C.

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 02

Site: The Old Fish Factory, Whitehaven

Project No: 2018-3413

Date: 26/11/2018

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1000 F	0	0	2.9	1.9	11.0	12.5	<0.1	nm	0.95	-
BH02	1000 F	0	0	0.3	0.3	15.1	16.4	<0.1	Nm	1.90	-
BH03	1000 F	0	0	0.5	0.5	18.4	18.7	<0.1	Nm	2.70	-
BH04	1000 F	0	0	3.8	1.0	16.2	19.3	<0.1	Nm	1.80	-
BH05	1000 F	0	0	2.4	1.0	16.6	18.3	<0.1	nm	1.90	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry. Temperature -1.0°C.

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Ground Gas & Groundwater Monitoring Record Sheet 03

Site: The Old Fish Factory, Whitehaven

Project No: 2018-3413

Date: 19/12/2018

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	983 F	0	0	0.6	0.7	20.3	20.0	<0.1	0.60	0.95	-
BH02	983 F	0	0	0.7	0.6	20.1	20.0	<0.1	0.30	1.90	-
BH03	983 F	0	0	0.2	0.2	20.3	20.0	<0.1	1.50	2.70	-
BH04	983 F	0	0	0.6	0.7	19.3	18.6	<0.1	0.46	1.80	-
BH05	983 F	0	0	0.7	0.5	20.3	20.3	<0.1	DRY	1.90	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure

Monitoring Completed By: JM

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Overcast and Dry. Temperature 8.0°C.

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 04

Site: The Old Fish Factory, Whitehaven

Project No: 2018-3413

Date: 07/01/2019

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	996 R	0	0	0.2	0.1	17.3	17.2	<0.1	0.52	0.95	-
BH02	996 R	0	0	0.6	0.5	17.8	17.9	<0.1	0.10	1.90	-
BH03	996 R	0	0	0.7	0.8	16.8	17.3	<0.1	1.25	2.70	-
BH04	996 R	0	0	0.6	0.6	19.6	19.6	<0.1	1.25	1.80	-
BH05	996 R	0	0	1.2	1.3	18.6	18.6	<0.1	DRY	1.90	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry. Temperature 4.0^{o}C.

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Ground Gas & Groundwater Monitoring Record Sheet 05

Site: The Old Fish Factory, Whitehaven

Project No: 2018-3413

Date: 23/01/2019

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	989 F	0	0	0.2	0.2	16.6	16.6	<0.1	0.53	0.95	-
BH02	989 F	0	0	0.4	0.4	18.2	18.2	<0.1	GL	1.90	-
BH03	989 F	0	0	0.8	0.8	18.9	18.9	<0.1	1.27	2.70	-
BH04	989 F	0	0	0.3	0.3	20.1	20.1	<0.1	1.32	1.80	-
BH05	989 F	0	0	2.7	2.7	18.0	18.0	<0.1	DRY	1.90	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry. Temperature 2.0^{o}C.

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 06

Site: The Old Fish Factory, Whitehaven

Project No: 2018-3413

Date: 13/02/2019

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1016 F	0	0	0.1	0.1	10.3	10.3	<0.1	0.53	0.95	-
BH02	1016 F	nm	nm	nm	nm	nm	nm	nm	GL	1.90	-
BH03	1016 F	0	0	0.4	0.4	19.6	19.6	<0.1	1.11	2.70	-
BH04	1016 F	0	0	0.4	0.4	18.8	18.8	<0.1	1.24	1.80	-
BH05	1016 F	0	0	1.3	1.3	18.5	18.5	<0.1	DRY	1.90	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry. Temperature 6.0°C.

Notes: Groundwater at surface in BH02 – unable to monitor.

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