



Goldfinch
ENVIRONMENTAL LTD

**PROPOSED RESIDENTIAL
DEVELOPMENT
LAND OFF GAS HOUSE LANE
SUTTON BRIDGE
SPALDING
LINCS**

**PROPOSED RESIDENTIAL
DEVELOPMENT
LAND OFF GAS HOUSE LANE
SUTTON BRIDGE
SPALDING
LINCS.**

**GEOENVIRONMENTAL
GROUND GAS INVESTIGATION
REPORT – PHASE 2**

Report Ref.: 0578/2a

Prepared by :

D Sargeant
D Sargeant

Date:

July 2019

CONTENTS

1.	INTRODUCTION	3
2.	LIMITATIONS	4
3.	LEGISLATIVE AND REGULATORY SETTING	5
4.	SITE LOCATION AND DESCRIPTION	6
5.	GROUND GAS INVESTIGATION	7
6.	DISCUSSION OF GROUND GAS & VAPOUR MONITORING PROGRAM	10
7.	UPDATED CONCEPTUAL MODEL & RISK ASSESSMENT (GROUND GAS)	14
8.	REMEDIALATION RECOMMENDATIONS	16
9.	CONCLUSIONS	17

FIGURES

- Figure 1 - Site Location Plan**
- Figure 2 - Borehole Location Plan
(Over Proposed Layout)**

APPENDICES

- Appendix 1 - Exploratory Location Records**
- Appendix 2 - Summary Ground Gas and Groundwater Monitoring Results**

PROPOSED RESIDENTIAL DEVELOPMENT

LAND OFF GAS HOUSE LANE

SUTTON BRIDGE

SPALDING

LINCS.

1. INTRODUCTION.

1.1. General.

This report describes the findings of a geoenvironmental ground gas investigation undertaken by Goldfinch Environmental Limited, on the instruction of Mrs A Robinson (the Client) at a site located off Gas House Lane, Bridge Road, Sutton Bridge, to the east of Spalding, Lincolnshire.

A site location plan has been provided as Figure 1 towards the back of this report.

The purpose of the investigation was to characterise the ground gas regime at the site in the context of the potential risk to human health as required by the Regulator (SHDC).

The site has been proposed for development to a residential end use. A proposed layout plan has been included as Figure 2 towards the back of this report, which also shows the locations of the ground gas monitoring standpipes.

Prior to commencement of the fieldwork described below, the scope for the investigation reported in this document was discussed and agreed with SHDC Environmental Health (the Regulator), as required by current practice.

This report describes the fieldwork carried out and discusses its outcome with variation to the approved strategy being documented as the investigation progressed.

1.2 Additional Information.

The reader should be aware that a Phase 1 Desk Study, prepared by Goldfinch Environmental Ltd, Report reference 0441/1 dated June 2017, and a Phase 2 Ground Investigation Report also prepared by Goldfinch Environmental Ltd, Report reference 0460/2 dated October 2017, were submitted to SHDC as part of the application for the redevelopment of the site. The referred reports should be read in conjunction with this Phase 2 Vapour Assessment report as their content has not been reproduced within this document.

2. LIMITATIONS.

This report is for the sole reliance and use of the referred Client. Any Third Party coming into possession of this report relies on it at their own risk unless written permission is expressly sought from Goldfinch Environmental Limited. The author owes them no duty of care and skill. Goldfinch Environmental Ltd accepts no responsibility or liability for the consequences of this document being used for purposes other than that for which it was commissioned and the assessments provided herein should not be relied on as a legal opinion.

The findings and opinions expressed in this report are relevant to the time of the site visit and information review and should not be relied upon to represent conditions at substantially later dates. The assessments and opinions given in this report are based upon information available at the time of the report. Where additional information comes available which may affect or identify a need to review our conclusions or assessments we request the opportunity (and reserve the right), to review the information and where warranted, modify our assessment / opinion in part or wholly, accordingly.

This intrusive (Phase 2) investigation report does not include any geotechnical considerations pertaining to the site as these were outside the agreed brief. Goldfinch Environmental Ltd cannot and does accept any responsibility or liabilities for geotechnical inferences, assumptions or conclusions drawn by any other Parties as a result of information included in this report.

The risk assessment was based on the source-pathway-receptor framework, with respect to the geoenvironmental condition of the site in the context of various sensitive receptors. Goldfinch Environmental Ltd have based this desk study upon the sources given in this report, and believes them to be reliable but cannot and does not guarantee the authenticity or reliability of the data it has relied upon

The recommendations given in this report are based on guidance and best practice in place at the time of issue of the report, the information available at the time of the investigation, the nature of the indicated proposed development and associated end user behaviour patterns. Should any of the foregoing change at any time this report should be reviewed (by a suitably qualified person), in the context of proposed changes.

This investigation report and the Conceptual Model and Risk Assessment included in Section 7 of this report have been based upon the construction details, layout drawings and pattern of occupancy/usage provided by the Client and/or their Agent. Where these details are subject to change either by the commissioning Party (Client), (or a subsequent owner where a site is 'sold-on'), then this report will need to be reviewed and amended accordingly in the light of any such proposed design changes. It is reasonably anticipated this review would be required by the Local Planning Authority/Regulator.

3. LEGISLATIVE & REGULATORY SETTING.

The Environmental Protection Act of 1990 created the framework for the identification and remediation of contaminated land. The Act defines “contaminated land” as any land, which appears by the Local Authority to be “in such a condition, by reason of substances, in, on, or under the land that significant harm is being caused or there is significant possibility of such harm being caused, or, pollution of Controlled Waters is being, or is likely to be, caused”.

Land potentially affected by ‘contamination’ is a material consideration for planning purposes together with its relationship with ‘regulatory intervention’ (Part IIa), and ‘voluntary’ investigation (which includes redevelopment of sites which may be affected by contamination). The Model Procedures (CLR-11, Environment Agency 2004), provide a generic framework indicating key technical activities applicable in each of these contexts.

The management of land contamination broadly comprises three components, which are identified as ‘Risk assessment’, ‘Options appraisal’ and ‘Implementation’. These, in turn, determine if any *unacceptable* risks exist, ascertain the most appropriate remediation strategy for the site and, finally, demonstrate that the strategy will be effective.

In accordance with this and other current guidance, where a ‘land quality’ risk assessment is required each ‘Relevant Pollutant Linkage’ (RPL, formerly referred to as “source-pathway-receptor” framework), is separately identified and a level of risk attached. This is documented in the form of a ‘Conceptual Model’.

The outcome of the assessment of established, plausible relevant pollutant linkages is used to determine qualitatively the need for further investigation, or remediation with ensuing mitigation of the determined unacceptable risk. (In accordance with the Model Procedures and Regulatory preference, detailed remedial measures should be provided in a separate phase).

The risk assessment takes account of the local environment, end user behaviour patterns, and the nature of the development in relation to proven ‘unacceptable’ risk. This is the approach advocated by current guidance and therefore has been adopted in the assessment of this site.

4. SITE LOCATION AND DESCRIPTION.

At the time the fieldwork was carried out as part of this investigation the site comprised a plot of 'cleared' land on the western side of Gas House Lane off the northern side of Bridge Road.

5. GROUND GAS INVESTIGATION.

5.1. Fieldwork.

Three number narrow diameter perforated standpipes were installed by percussive [drive-in] methods to depths of approximately 4.0-5.0m to collect ground vapour information.

The exploratory locations, (referenced WS1-3 inclusive), are shown on a plan of the site (not to scale), in Figure 2 towards the back of this report.

5.2. Gas and Groundwater Monitoring.

While current best practice recommends initially that six number return visits to site are made to carry out monitoring for the presence of ground gases, and establish resting groundwater levels within the referred standpipes. In this instance it had been agreed with the Regulator that three visits would be carried out as a 'screening' exercise with the need for further visits to be determined on the basis of the results of these three sets of data.

A review of the collected data after three visits showed a consistency which suggested the monitoring could cease at this stage. The ground gas monitoring visits were carried out during 7 and 21 March, and 4 April 2019, respectively.

In accordance with recommended practice data collection included measurements taken during conditions of "falling atmospheric pressure" as well as at least one dataset from a barometric pressure of less than 1000mb.

At the time of each of the three visits the measured concentrations of oxygen, carbon dioxide and methane [or other hydrocarbon-containing species which the unit may record as 'methane'] were recorded together with associated parameters which included: depth to groundwater, flow, atmospheric oxygen and barometric pressure. This information has been tabulated and summarised in Appendix 3 of this report.

The summarised factual results are included in Appendix 3 in tabular form.

5.3 Vapours

As part of the ground gas assessment two absorbent sampling tubes were employed to allow collection of vapour samples for chemical laboratory analysis. The absorbent tubes were deployed between the 7 and the 21 March 2019. The 'on' and 'off' times were recorded to allow the laboratory to calculate analyte concentrations as part of the test procedure. To assist the reader the sampling [i.e. exposure] time associated with these ['Tenax'] tubes was approximately 337.75 hours.

One sample was obtained from the proposed garden area towards the southwestern corner of the site and the second was obtained from the southeastern corner of the site

where the 'worst' contamination was encountered during the Phase 2 investigation as shown in Figure 2 towards the back of this report.

The two samples reference A and B were located in boreholes BH1 and BH3 respectively.

The vapour samples were analysed for Total Petroleum Hydrocarbons (TPHs), BTEX, Volatile Organic Compounds (VOCs) and Tentatively Identified Compounds (TICs).

The chemical laboratory test report has been included in Appendix 2 towards the back of this report.

5.4 Evidence of Contamination (Soils).

There were indicators, olfactory or visual or both, of potential contamination in the arising soils at exploratory locations BH1, BH2 and BH3. These comprised:~

Borehole I.D.	Remarks
BH1 (WS2)	Strong ammoniacal odour from 0.70 to 1.20m
BH2 (WS8)	Odours of ammonia/cresols/phenols with diffraction patterns to 2.5m where brick fill was encountered – possible former waste holder base with 'free-product' of black coal tars with strong phenolic odours.
BH3 (WS6)	Odours of ammonia and phenols/cresols ('creosote') from 1.70m with diffraction patterns ('rainbow sheen') in soils Pockets of free-phase tarry fluids from 2.90 to approximately 3.5-3.60m. No further staining or odours beyond this depth.

*The reader should note that the monitoring locations were installed by 'drive-in' methods therefore there were no arisings. However, as the chosen locations were close (i.e. <300mm) distant from the bracketted locations from the previous Phase 2 investigation then the field observations [including borehole logs] have been reproduced here to assist the reader.

5.5. Groundwater Observations During Fieldwork.

Groundwater was not encountered as distinct 'strikes' in any of the exploratory locations during the fieldwork.

6. DISCUSSION OF GROUND GAS & VAPOUR MONITORING PROGRAM.

6.1. Overview.

This section of the report provides an interpretation [with supporting commentary] of the ground gas monitoring data collected from the site. The outcome of the review is carried into a [vapour-only] Conceptual Model and Risk Assessment for the site which is included in Section 7 of this report.

The site has been proposed for residential development with private gardens and soft landscaping as shown in Figure 2 [which also shows the monitoring locations] towards the back of this report.

6.2. Discussion of the Ground Gas Monitoring Results.

6.2.1 Overview.

The site has been proposed for development via the establishment of new residential units with private gardens, a relatively large area of hardstanding and driveways. The assessment has been carried out broadly in accordance with guidance document CIRIA Report C665¹ and BS8485:2015², and under Situation B that is, low rise development with a ventilated subfloor void (*min 150mm*). *Where construction details differ from this it is recommended that these results are reviewed.*

CIRIA Report C665 recommends a risk based approach designed to allow identification of gas protection measures for low rise housing by comparing gas emission rates to generic “traffic light” scenarios. These include ‘typical maximum concentrations’ provided for initial screening purposes and risk based screening values (GSVs) for consideration in situations where the typical maximum concentrations are exceeded.

The method recommends calculating GSVs for both methane and carbon dioxide and adoption of the ‘worst case’ to establish appropriate protection levels.

6.3. Barometric Pressure Regime During the Monitoring Period.

Across the three visits, barometric pressure values varied between a minimum of 995 (gently rising from a ‘trough’) and a maximum of 1032mb (as a ‘peak’). This set of data meets with guidance recommendations which indicates that at least one set of data should be obtained when the operating barometric pressure regime is 1000mb or less (e.g. a ‘low’).

¹ Assessing risks posed by hazardous ground gases to buildings. CIRIA Report C665. 2007.

² Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. February 2016.

6.4. Flow

On each of the three monitoring visits and in all three monitoring standpipes measured flow rates were at, or below the limit of detection of the instrument ($<0.1 \text{ l hr}^{-1}$).

6.5. Discussion of Ground Gas Concentrations & GSV Calculation

6.5.1. Methane

As referred above, a 'peak' methane was detected in one borehole (BH2) on one of the monitoring visits. The measured concentration was recorded as 4.3% v/v. This quickly [i.e. less than one minute] reduced to a 'steady' value of 0.0% (i.e. $<0.1\%$ which is the detection limit of the instrument for this ground gas.).

Author Note: It is possible that the gas meter was detecting and recording volatile vapours that were output by the instrument as 'methane'. Field observations noted odours of ammonia/cresols/phenols in this location at the time the standpipe was installed as described in Section 5.4 of this report.

It is further considered by this Author that this was an 'isolated instance' and is *not* indicative that there is an 'active' ground gas source underlying or impacting the site.

Given the extent of the 'contamination' underlying a relatively large part of the site a GSV can be derived for this isolated instance of **0.0043 l hr^{-1}** .

A GSV of 0.0043 is associated with a 'very low' risk³ and a Characteristic Situation 1 classification according to BS8485:2015.

6.5.2. Carbon Dioxide

A 'peak' concentration of carbon dioxide of 0.9% v/v was recorded in borehole BH1 reducing to a 'steady' reading of 0.4% v/v after 60 seconds on the same monitoring visit. This value has been used as 'worst case' in derivation of the GSV.

This value of 0.9%, gives a gas screening value (GSV, from multiplying gas concentration % by flow rate) when combined with a flow rate of 0.1 l hr^{-1} (the detection limit of the instrument for this parameter) of $0.009 \times 0.1 = \mathbf{0.0009 \text{ l hr}^{-1}}$.

This is associated with a [BS8485:2015] 'hazard potential' of 'very low'³ and places the site into a **Characteristic Situation 1** classification. {BS8485:2015 adds: *Typically $<1\%$ methane concentration and $<5\%$ carbon dioxide*}.

The recommendations in the following sections of this report regarding ground gas are based upon this Characteristic Situation 1 assessment.

³ i.e. <0.07 = in accordance with BS8485:2015 Table 2; CS1

6.5.3. Oxygen

Oxygen levels were depleted in one borehole (BH2) with measured [minimum] values of 5.7 and 2.7%v/v. The latter value was obtained under 'worst case' conditions when the barometric pressure was below 1000mb (actual: 995mb). The reader should note that these values had 'recovered' to approximately 20% v/v after one minute of monitoring.

There is sometimes an empirical relationship between the depleted oxygen levels and recorded concentrations of carbon dioxide. This type relationship was not noted in this instance in association with the recorded depleted oxygen concentrations.

6.5.4. Tenax Tubes [Diffusion Sampling Tubes]

As part of the ground gas assessment two absorbent sampling tubes were employed to allow collection of vapour samples for chemical laboratory analysis as described in Section 5.3 of this report.

The vapour samples were analysed for Total Petroleum Hydrocarbons (TPHs), BTEX, Volatile Organic Compounds (VOCs) and Tentatively Identified Compounds (TICs). The analysis comprises approximately 120 chemical species.

A review of the results [given in $\mu\text{g}/\text{m}^3$ or, parts per billion, ppb] has shown that measurable concentrations of the following determinants were noted in one or both [diffusive-passive] vapour samples:~

- Aliphatic TPHs
- Aromatic TPHs
- Trichloromethane
- Benzene
- Toluene
- Ethylbenzene
- Xylene(-s)
- Styrene
- 1,2,4- , 1,2,3- & 1,3,5-Trimethylbenzene
- Naphthalene
- 1,3-Hexadien-5-yne
- 1-methylene-1H-Indene
- 2,6,10-Trimethyltridecane
- 3-phenyl-2-propenal
- 7-Pentadecyne
- Azulene
- 1-butyryl-Benzene
- 1-ethyl-2-methyl Benzene
- 2-propenyl Benzene
- 2-methyl-Benzo[b]thiophene
- Benzo[c]thiophene
- Benzofuran
- 1-methylCyclodecene

- Cyclohexanes (various)
- Cyclohexanones (various)
- Cyclohexenes
- Cyclopentanes
- Dodecane
- Heptanal
- Indene
- Isopropenylcyclopropane
- Naphthalenes (various)
- Pentanes (various)

The measured concentrations are considered too low to have registered during the [pumped] ground gas monitoring which has a detection limit of 0.1% v/v.

The chemical laboratory test report containing the factual results has been included in Appendix 2 towards the back of this report.

6.6. Concluding Remarks to Section 6.5

The ground gas assessment has shown that the site falls with Characteristic Situation 1 [CS1]. i.e. a 'very low' risk as described in guidance. However, this Author's previous experience has shown that the Regulator [in this instance South Holland District Council] request a minimum of Characteristic Situation 2 [CS2] ground gas protection measures in new developments. To comply with planning this requirement has been taken into account in the subsequent sections of this report.

The outcome of Section 6 of this report has been carried forward into the Conceptual Model and Risk Assessment in Section 7 of this report.

7. UPDATED CONCEPTUAL MODEL & RISK ASSESSMENT (GROUND GAS).

7.1. Overview.

In accordance with guidance current at the time of this report, there are three principal factors that are assessed whilst undertaking a qualitative risk assessment. These are described above in Section 3 in the context of 'Relevant Pollution Linkages' (RPL). At the time of this report, the site had been proposed for redevelopment to a residential end use.

7.1.1. Conceptual Model.

Sources (Proven)	Pathway	Target	Risk
Soil: n/a	❖ Dermal contact, ingestion and inhalation	• Present users • End users • Construction workers • General public	• n/a • n/a • n/a • n/a
	❖ Wind erosion and atmospheric dispersion	• Adjacent properties • General public	• n/a • n/a
	❖ Leaching	• Adjacent properties • Shallow groundwater • Services/construction materials • Plant life • Surface water	• n/a • n/a • n/a • n/a • n/a
Shallow groundwater: n/a	❖ Groundwater migration	• Adjacent properties • Deep groundwater • Services/construction materials • Plant life • Surface Water	• n/a • n/a • n/a • n/a • n/a
	❖ Dermal contact, ingestion and inhalation	• Present users • End users • Construction workers • General public	• Neg-Low • Neg-Low • Neg-Low • Neg-Low
Gas: The results of the fieldwork and their interpretation show that the ground gas regime operating at the site is classed as Characteristic Situation 1 (CS1) indicating 'low-level' protection measures are required. <i>Author Note: However, this Author's previous experience has shown that the Regulator [in this instance South Holland District Council] request a minimum of Characteristic Situation 2 [CS2] ground gas protection measures in new developments. To comply with planning this requirement has been taken into account in the subsequent sections of this report.</i>	❖ Direct inhalation ❖ Soil migration ❖ Services migration	• End users • Construction workers • Buildings	• Very Low • Very Low • Very Low
Negligible Risk Defined as the site should be considered suitable for present or future use and environmental setting. Contaminants unlikely to be present, which might have unacceptable impact on key targets. Low Risk Defined as the site should be considered suitable for present or future use and environmental setting. Contaminants may be present but unlikely to have unacceptable impact on key targets. Medium Risk Defined as the site may not be suitable for present or future use and environmental setting. Contaminants are probably present and might have unacceptable impact on key targets. High Risk Defined as the site is probably or certainly not suitable for present or future use and environmental setting. Contaminants probably or certainly present and likely to have an unacceptable impact on key targets.			

7.2. Risk Assessment.

7.2.1. Targets.

Potential targets/receptors, in the context of the risk assessment, where a plausible pathway can be proven, are discussed under separate subheadings as follows:-

7.2.2. Human Health (Site Users⁴ & Construction Workers).

The results of the fieldwork and their interpretation show that the ground gas regime operating at the site is classed as Characteristic Situation 1 (CS1) However, However, this Author's previous experience has shown that the Regulator [in this instance South Holland District Council] request a minimum of Characteristic Situation 2 [CS2] ground gas protection measures in new developments. To comply with planning this requirement has been taken into account in the subsequent sections of this report, indicating 'low-level' protection measures are required.

In the context of the proposed end use for the site and the localised distribution, depth, measured concentration and contaminant type:-

A Low risk has been identified indicating human health protection measures are required.

7.2.3. Construction Workers.

During the opening up and disturbance of ground at the referred locations, as part of demolition and construction works, construction staff, particularly groundworkers, are likely be exposed to Coal-Tar impacted soils and soil dusts and possible ground gas (e.g., when manually handling soil and working in excavations) below depths of approximately 1.5-1.8m relative to existing ground levels:-

A Medium risk has been identified.

⁴ Current & End User

8. REMEDIATION RECOMMENDATIONS.

8.1. Ground Gas

Based on the outcome of the ground gas monitoring program, 'remedial' measures for the protection of human health are required as discussed in Section 6 of this report and reproduced below:~

Based on the above (and according to CIRIA Report C665/BS8485:2015 and Regulator (SHDC) preferences) "*low level gas protection required*". These should comprise a membrane and ventilated subfloor void. The following measures should be considered for inclusion in the proposed development:

- Ventilation of confined spaces in the building and (where these are included), particularly confined spaces to which personnel may have access.
- Should a floor slab be included in the construction method this should include a low permeability gas control membrane which should comprise as a minimum a 2000 gauge LDPE [chemically-resistant] sheet overlapped and taped at the joints. The overlap should be at least 300mm.
- The membrane, which as a precaution should be hydrocarbon/chemically resistant will need to be linked into the DPC layers to ensure a continuous gas barrier is formed covering the whole building footprint. This should include any brick work cavities where these are present.
- It is recommended that consideration be given to increasing the frequency of air bricks above the standard figure by (say) approximately 15% to promote improved ventilation of the subfloor void underneath the building(s).
- Where possible, incoming services and ducting and pipes should be vented before entry into the buildings and above the level of the floor where appropriate. This is to minimise penetration of the gas membrane.
- Any entry points penetrating the membrane should be carefully constructed and the membrane sealed completely around the 'service'.

Specific remedial details, including floor construction details etc, should be included within a Remediation Method Statement which will need to be submitted to the LPA for their approval prior to anyworks being carried out.

It is understood that the proposed scheme will include raising the topographic levels at the site by as much as 1200mm. These details and foundation methods should be included in the referred RMS.

9. CONCLUSIONS.

Mrs A Robinson (the Client) propose to establish a new residential development at a site located off Gas House Lane, Bridge Road, Sutton Bridge, to the east of Spalding, Lincolnshire.

This geoenvironmental ground gas investigation has been carried out by Goldfinch Environmental Ltd as required by the Regulator [SHDC] to further assess the potential risk from ground gas following consultation with SHDC the Regulator.

The intrusive investigation has confirmed the presence of predominantly cohesive soils.

The ground gas regime is considered to be a 'CS1' based upon the collected ground gas data in the context of human health risk assessment for the proposed residential land use as described in Section 6 of this report. However, this Author's previous experience has shown that the Regulator [in this instance South Holland District Council] request a minimum of Characteristic Situation 2 [CS2] ground gas protection measures in new developments. To comply with the planning regime this requirement has been taken into account in the subsequent sections of this report, indicating 'low-level' protection measures are required.

'Remedial' works are necessary as discussed in outline in Sections 8 of this report and an outline remedial strategy for the 'management' of the ground gas regime has been included in Section 8 of this report.

Based on the foregoing results, and the qualifying comments notwithstanding, an overall Low risk is identified with the site with respect to ground gas, subject to the agreement of the Regulator who are the final arbiters in this matter. However, upon completion of the 'remedial works' to the satisfaction of SHDC Environmental Health Dept. this risk may be downgraded to 'Negligible-Low'.

This report has been based on the results of the fieldwork and assessment of the collected ground gas data. The possibility that different conditions may exist at other exploratory locations within the site, or at greater depth cannot be ruled out.

Specific remedial details, including floor construction details, specific membrane details etc, and any drawings detailing these measures should be included within a Remediation Method Statement which will need to be submitted to the LPA for their approval prior to anyworks being carried out.

This Phase 2 report and the recommendations within it are subject to the approval of the LPA/Regulator.

Should unanticipated contamination be suspected, or revealed during any groundworks, then the area should be temporarily isolated and further advice sought by a suitably independent qualified person and a management strategy for these occurrences would be required by the Local Authority.

FIGURES

Approximate Site Location



Figure 1

Ref: 0578/2a

Site Location Plan

Goldfinch
Environmental
Ltd

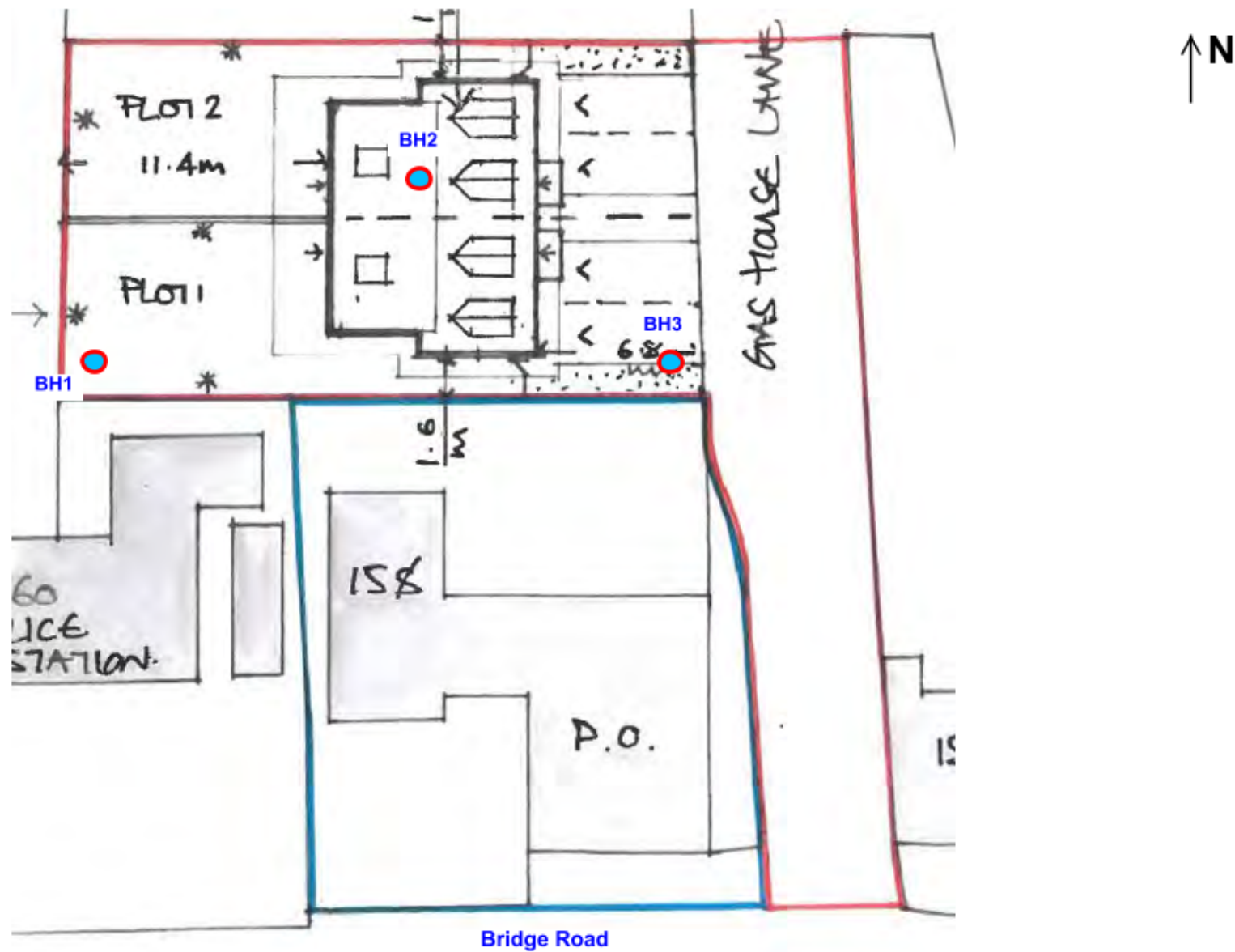


Figure 2

Plan To Show Monitoring Locations

Ref: 578/2a

Goldfinch
Environmental
Limited

APPENDIX 1

Borehole Records



EXPLORATORY LOCATION LOG

Site: Sutton Bridge

Project ref: 0578/2a

Location Ref: BH1

Date: 05/02/2019

Depth	Description	Sampling depth (m)	Remarks
0.00	MADE GROUND comprising weak (lean-mix) concrete.	-	-
0.04	MADE GROUND comprising loose grey sand and gravel. Gravel is grey angular to subangular comminuted concrete.	-	-
0.35	Loose gravel comprising fine to coarse angular fragments of comminuted red brick.	-	-
0.56	Soft to firm dark brown silty clay slightly mottled orange brown and slightly sandy from 1.10m.	-	Horizon not fully penetrated.

Notes:

1. Groundwater not encountered.
2. No apparent indicators of contamination.
3. Location terminated at 4.00m.



EXPLORATORY LOCATION LOG

Site: Sutton Bridge

Project ref: 0578/2a

Location Ref: BH2

Date: 05/02/2019

Depth	Description	Sampling depth (m)	Remarks
0.00	MADE GROUND comprising Firm to stiff (desiccated ?) brown gravelly silty clay. Gravel is grey angular comminuted concrete and red angular comminuted brick with occasional dark grey or black ash.	-	-
0.50	MADE GROUND comprising Firm to stiff (desiccated ?) brown gravelly silty clay. Gravel is grey angular comminuted concrete and red angular comminuted brick. 0.5m : Odours of ammonia & creosote (phenolics & cresyls) with 'rainbow' sheen (diffraction patterns) to 2.5m depth where brick 'fill' was encountered – possible former base -'free-product' of black coal-tars with strong phenolic/cresolic odours.	-	Horizon not fully penetrated.

Notes:

1. Groundwater not encountered but sands 'wet'.
2. Indicators of contamination noted to comprise: 2.a) Black staining in soils between approximately 0.5 and 2.5m
3. Location terminated at 4.00m



EXPLORATORY LOCATION LOG

Site: Sutton Bridge

Project ref: 0578/2a

Location Ref: BH3

Date: 05/02/2019

Depth	Description	Sampling depth (m)	Remarks
0.00	MADE GROUND comprising Firm to stiff (desiccated ?) brown gravelly silty clay. Gravel is grey angular comminuted concrete and red angular comminuted brick with occasional dark grey or black ash.	-	-
0.01	Firm to stiff dark brown (desiccated?) slightly gravelly silty clay with roots.	-	-
0.30	Firm to stiff dark brown slightly sandy silty clay with roots. 1.70m : Odours of ammonia & creosote (phenolics & cresyls) from 1.7m depth with 'rainbow' sheen (diffraction patterns) 2.90m Pockets of tarry fluid ('tars' as 'free-product') possibly to approx. 3.5-3.6m as no further staining or odours from this depth.	-	Horizon not fully penetrated.

Notes:

1. Groundwater not encountered but sands 'wet'.
2. Indicators of contamination noted to comprise: 2.a) Odours of ammonia & creosote (phenolics & cresyls) from 1.7m depth with 'rainbow' sheen (diffraction patterns) noted in soils possibly extending to approximately 4.0m depth.
3. Location terminated at 4.00m

APPENDIX 2

Chemical Laboratory Test Report - Vapour Data

Final Report

Report No.:	19-10189-1		
Initial Date of Issue:	29-Mar-2019		
Client	Goldfinch Environmental Ltd		
Client Address:	19 Palmer Street Walsham-le-Willows Bury St. Edmunds Suffolk IP31 3BZ		
Contact(s):	Group Email Address		
Project	0578/2 Sutton Bridge		
Quotation No.:	Q18-14030	Date Received:	22-Mar-2019
Order No.:		Date Instructed:	22-Mar-2019
No. of Samples:	2		
Turnaround (Wkdays):	7	Results Due:	01-Apr-2019
Date Approved:	29-Mar-2019		
Approved By:			
Details:	Robert Monk, Technical Manager		

Project: 0578/2 Sutton Bridge

Client: Goldfinch Environmental Ltd	Chemtest Job No.:				19-10189	19-10189
Quotation No.: Q18-14030	Chemtest Sample ID.:				798515	798516
	Sample Location:				A (BH1)	B (BH3)
	Sample Type:				GAS	GAS
	Date Sampled:				21-Mar-2019	21-Mar-2019
Determinand	Accred.	SOP	Units	LOD		
Aliphatic TPH >C5-C6	N	3675	µg/m³	N/A	1.6	3.1
Aliphatic TPH >C6-C8	N	3675	µg/m³	N/A	7.0	32
Aliphatic TPH >C8-C10	N	3675	µg/m³	N/A	2.3	9.1
Aliphatic TPH >C10-C12	N	3675	µg/m³	N/A	43	13
Aliphatic TPH >C12-C16	N	3675	µg/m³	N/A	< 1.00	33
Aromatic TPH >C5-C7	N	3675	µg/m³	N/A	< 1.00	1.3
Aromatic TPH >C7-C8	N	3675	µg/m³	N/A	< 1.00	< 1.00
Aromatic TPH >C8-C10	N	3675	µg/m³	N/A	67	21
Aromatic TPH >C10-C12	N	3675	µg/m³	N/A	80	50
Aromatic TPH >C12-C16	N	3675	µg/m³	N/A	< 1.00	200
Trichlorofluoromethane	N	3760	µg/m³	N/A	<0.7	<0.7
Propanone	N	3760	µg/m³	N/A	<2.9	<2.9
Diethyl ether	N	3760	µg/m³	N/A	<0.7	<0.7
1,1-Dichloroethene	N	3760	µg/m³	N/A	<0.5	<0.5
Carbon disulfide	N	3760	µg/m³	N/A	<0.3	<0.3
Allyl chloride	N	3760	µg/m³	N/A	<0.8	<0.8
Dichloromethane	N	3760	µg/m³	N/A	<0.4	<0.4
trans-1,2-Dichloroethene	N	3760	µg/m³	N/A	<0.5	<0.5
Methyl-tertiary-butyl ether	N	3760	µg/m³	N/A	<0.4	<0.4
1,1-Dichloroethane	N	3760	µg/m³	N/A	<0.5	<0.5
2-Butanone	N	3760	µg/m³	N/A	<3.6	<3.6
cis-1,2-Dichloroethene	N	3760	µg/m³	N/A	<0.5	<0.5
Trichloromethane	N	3760	µg/m³	N/A	3	6
Tetrahydrofuran	N	3760	µg/m³	N/A	<7.3	<7.3
1,1,1-Trichloroethane	N	3760	µg/m³	N/A	<0.5	<0.5
1,2-Dichloroethane	N	3760	µg/m³	N/A	<0.5	<0.5
1-Chlorobutane	N	3760	µg/m³	N/A	<0.5	<0.5
1,1-Dichloropropene	N	3760	µg/m³	N/A	<0.6	<0.6
Benzene	N	3760	µg/m³	N/A	8	1
Tetrachloromethane	N	3760	µg/m³	N/A	<0.8	<0.8
2-Nitropropane	N	3760	µg/m³	N/A	<0.9	<0.9
Methyl methacrylate	N	3760	µg/m³	N/A	<1	<1
2-Hexanone	N	3760	µg/m³	N/A	<1.5	<1.5
4-Methyl-2-pentanone	N	3760	µg/m³	N/A	<2.5	<2.5
Trichloroethene	N	3760	µg/m³	N/A	<0.7	<0.7
Dibromomethane	N	3760	µg/m³	N/A	<0.9	<0.9
Bromodichloromethane	N	3760	µg/m³	N/A	<0.8	<0.8
trans-1,3-Dichloropropene	N	3760	µg/m³	N/A	<0.6	<0.6
cis-1,3-Dichloropropene	N	3760	µg/m³	N/A	<0.6	<0.6
Toluene	N	3760	µg/m³	N/A	21	5
1,1,2-Trichloroethane	N	3760	µg/m³	N/A	<0.7	<0.7

Project: 0578/2 Sutton Bridge

Client: Goldfinch Environmental Ltd	Chemtest Job No.:			19-10189	19-10189	
Quotation No.: Q18-14030	Chemtest Sample ID.:			798515	798516	
	Sample Location:			A (BH1)	B (BH3)	
	Sample Type:			GAS	GAS	
	Date Sampled:			21-Mar-2019	21-Mar-2019	
Determinand	Accred.	SOP	Units	LOD		
1,3-Dichloropropane	N	3760	µg/m³	N/A	<0.6	<0.6
Ethyl methacrylate	N	3760	µg/m³	N/A	<1.1	<1.1
Dibromochloromethane	N	3760	µg/m³	N/A	<1	<1
1,2-Dibromoethane	N	3760	µg/m³	N/A	<0.9	<0.9
Tetrachloroethene	N	3760	µg/m³	N/A	<0.8	<0.8
Chlorobenzene	N	3760	µg/m³	N/A	<0.5	<0.5
1,1,1,2-Tetrachloroethane	N	3760	µg/m³	N/A	<0.8	<0.8
Ethylbenzene	N	3760	µg/m³	N/A	2	2
m- & p-Xylene	N	3760	µg/m³	N/A	19	11
Styrene	N	3760	µg/m³	N/A	2	2
Bromoform	N	3760	µg/m³	N/A	<1.3	<1.3
o-Xylene	N	3760	µg/m³	N/A	20	4
1,1,2,2-Tetrachloroethane	N	3760	µg/m³	N/A	<0.8	<0.8
1,2,3-Trichloropropane	N	3760	µg/m³	N/A	<0.7	<0.7
Isopropylbenzene	N	3760	µg/m³	N/A	<0.6	<0.6
trans-1,4-Dichloro-2-butene	N	3760	µg/m³	N/A	<1.2	<1.2
Bromobenzene	N	3760	µg/m³	N/A	<0.8	<0.8
2-Chlorotoluene	N	3760	µg/m³	N/A	<0.6	<0.6
n-Propylbenzene	N	3760	µg/m³	N/A	<0.6	<0.6
4-Chlorotoluene	N	3760	µg/m³	N/A	<0.6	<0.6
1,3,5-Trimethylbenzene	N	3760	µg/m³	N/A	5	2
Pentachloroethane	N	3760	µg/m³	N/A	<2	<2
1,2,4-Trimethylbenzene	N	3760	µg/m³	N/A	2	3
tert-Butylbenzene	N	3760	µg/m³	N/A	<0.7	<0.7
1,3-Dichlorobenzene	N	3760	µg/m³	N/A	<0.7	<0.7
sec-Butylbenzene	N	3760	µg/m³	N/A	<0.7	<0.7
1,4-Dichlorobenzene	N	3760	µg/m³	N/A	<0.7	<0.7
4-Isopropyltoluene	N	3760	µg/m³	N/A	<0.7	<0.7
1,2-Dichlorobenzene	N	3760	µg/m³	N/A	<0.7	<0.7
n-Butylbenzene	N	3760	µg/m³	N/A	<0.7	<0.7
Hexachloroethane	N	3760	µg/m³	N/A	<2.4	<2.4
1,2-Dibromo-3-chloropropane	N	3760	µg/m³	N/A	<1.2	<1.2
1,2,4-Trichlorobenzene	N	3760	µg/m³	N/A	<0.9	<0.9
Naphthalene	N	3760	µg/m³	N/A	1	28
1,2,3-Trichlorobenzene	N	3760	µg/m³	N/A	<0.9	<0.9
Hexachlorobutadiene	N	3760	µg/m³	N/A	<1.3	<1.3

Tentatively identified compounds

1,3-Hexadien-5-yne	N	3760	µg/m³	N/A	5.6	<1.0
1-Hexanol, 2-ethyl-	N	3760	µg/m³	N/A	<1.0	1.4
1H-Indene, 1-methylene-	N	3760	µg/m³	N/A	11.1	<1.0

Project: 0578/2 Sutton Bridge

Client: Goldfinch Environmental Ltd	Chemtest Job No.:				19-10189	19-10189
Quotation No.: Q18-14030	Chemtest Sample ID.:				798515	798516
	Sample Location:				A (BH1)	B (BH3)
	Sample Type:				GAS	GAS
	Date Sampled:				21-Mar-2019	21-Mar-2019
Determinand	Accred.	SOP	Units	LOD		
2,6,10-Trimethyltridecane	N	3760	µg/m³	N/A	<1.0	2.0
2-Propenal, 3-phenyl-	N	3760	µg/m³	N/A	<1.0	1.1
7-Pentadecyne	N	3760	µg/m³	N/A	<1.0	1.2
Azulene	N	3760	µg/m³	N/A	<1.0	31.4
Benzene, 1,2,3-trimethyl-	N	3760	µg/m³	N/A	9.7	<1.0
Benzene, 1-butynyl-	N	3760	µg/m³	N/A	<1.0	1.6
Benzene, 1-ethyl-2-methyl-	N	3760	µg/m³	N/A	4.7	<1.0
Benzene, 2-propenyl-	N	3760	µg/m³	N/A	8.4	2.0
Benzo[b]thiophene, 2-methyl-	N	3760	µg/m³	N/A	<1.0	3.0
Benzo[c]thiophene	N	3760	µg/m³	N/A	<1.0	2.3
Benzofuran	N	3760	µg/m³	N/A	7.4	1.9
Benzo[thiazole	N	3760	µg/m³	N/A	<1.0	1.2
Biphenyl	N	3760	µg/m³	N/A	<1.0	26.3
Bis(2-chloroisopropyl) ether	N	3760	µg/m³	N/A	<1.0	4.9
Cyclodecene, 1-methyl-	N	3760	µg/m³	N/A	7.4	<1.0
Cyclohexane	N	3760	µg/m³	N/A	<1.0	3.9
Cyclohexane, 1,1,3-trimethyl-	N	3760	µg/m³	N/A	<1.0	4.4
Cyclohexane, 1,2-dimethyl-, trans-	N	3760	µg/m³	N/A	<1.0	1.8
Cyclohexane, 1,3-dimethyl-, cis-	N	3760	µg/m³	N/A	<1.0	4.1
Cyclohexane, 1,4-dimethyl-, cis-	N	3760	µg/m³	N/A	<1.0	1.7
Cyclohexane, 1-methyl-3-(1-methylethenyl)-, cis-	N	3760	µg/m³	N/A	13.4	<1.0
Cyclohexane, methyl-	N	3760	µg/m³	N/A	<1.0	10.9
Cyclohexanone, 5-methyl-2-(1-methylethenyl)-, trans-	N	3760	µg/m³	N/A	3.0	<1.0
Cyclohexanone, 5-methyl-2-(1-methylethylidene)-	N	3760	µg/m³	N/A	8.4	<1.0
Cyclohexene, 1,6-dimethyl-	N	3760	µg/m³	N/A	3.5	<1.0
Cyclohexene, 4-methyl-1-(1-methylethyl)-	N	3760	µg/m³	N/A	4.6	<1.0
Cyclopentane, 1,1,2-trimethyl-	N	3760	µg/m³	N/A	<1.0	1.1
Cyclopentane, 1,2,4-trimethyl-	N	3760	µg/m³	N/A	<1.0	1.1
Cyclopentane, 1,2-dimethyl-	N	3760	µg/m³	N/A	<1.0	2.3
Cyclopentane, methyl-	N	3760	µg/m³	N/A	<1.0	2.7
Cyclopentene	N	3760	µg/m³	N/A	1.6	<1.0
Dodecane	N	3760	µg/m³	N/A	<1.0	1.5
Heptanal	N	3760	µg/m³	N/A	<1.0	1.1
Indene	N	3760	µg/m³	N/A	15.4	6.8
Isopropenylcyclopropane	N	3760	µg/m³	N/A	1.4	<1.0
Naphthalene, 1-ethyl-	N	3760	µg/m³	N/A	<1.0	1.1
Naphthalene, 1-methyl-	N	3760	µg/m³	N/A	<1.0	50.9
Naphthalene, 2,3-dimethyl-	N	3760	µg/m³	N/A	<1.0	35.3
Naphthalene, 2,6-dimethyl-	N	3760	µg/m³	N/A	<1.0	32.1
Naphthalene, 2-ethyl-	N	3760	µg/m³	N/A	<1.0	6.7
Naphthalene, 2-methyl-	N	3760	µg/m³	N/A	<1.0	70.8

Project: 0578/2 Sutton Bridge

Client: Goldfinch Environmental Ltd	Chemtest Job No.:				19-10189	19-10189
Quotation No.: Q18-14030	Chemtest Sample ID.:				798515	798516
	Sample Location:				A (BH1)	B (BH3)
	Sample Type:				GAS	GAS
	Date Sampled:				21-Mar-2019	21-Mar-2019
Determinand	Accred.	SOP	Units	LOD		
Naphthalene, decahydro-2,6-dimethyl-	N	3760	µg/m³	N/A	6.1	<1.0
n-Hexane	N	3760	µg/m³	N/A	<1.0	1.8
Nonanal	N	3760	µg/m³	N/A	<1.0	3.2
Pentane	N	3760	µg/m³	N/A	1.2	1.3
Pentane, 2-methyl-	N	3760	µg/m³	N/A	<1.0	1.2
Pentane, 3-ethyl-2-methyl-	N	3760	µg/m³	N/A	<1.0	1.9
Tetradecane	N	3760	µg/m³	N/A	<1.0	4.5
Thiophene, 3,4-dimethyl-	N	3760	µg/m³	N/A	1.2	<1.0
trans,trans-1,6-Dimethylspiro[4.5]decane	N	3760	µg/m³	N/A	2.3	<1.0
trans-1,3-Diethylcyclopentane	N	3760	µg/m³	N/A	1.1	<1.0

Report Information

Key

- U UKAS accredited
- M MCERTS and UKAS accredited
- N Unaccredited
- S This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T This analysis has been subcontracted to an unaccredited laboratory
- I/S Insufficient Sample
- U/S Unsuitable Sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

APPENDIX 3

Ground Gas Monitoring Records

Summary Ground Gas and Groundwater Monitoring Results

Project Ref	0578-2a	Date :	07 Mar 2019
Site	Sutton Bridge	Visit	1/3

Borehole Ref	Methane		LEL (% Vol)	Oxygen		Carbon Dioxide		Flow Rate (l/hr)	Downhole Pressure (Pa)	Groundwater Depth (m bgl)
	peak	(% Vol) steady		peak	(% Vol) steady	peak	(% Vol) steady			
BH1	0.0	0.0	0.0	20.0	20.0	0.9	0.4	<0.1	-	-
BH2	0.0	0.0	0.0	20.1	20.1	0.0	0.0	<0.1	-	-
BH3	0.0	0.0	0.0	20.0	20.0	0.5	0.0	<0.1	-	-

Remarks	BP Regime - Gently Rising

Atmospheric Pressure: (mb)	985
Atmospheric Oxygen:	20.5%
Monitored by:	DS

Summary Ground Gas and Groundwater Monitoring Results

Project Ref	0578-2a	Date :	21 Mar 2019
Site	Sutton Bridge	Visit	2/3

Borehole Ref	Methane		LEL (% Vol)	Oxygen		Carbon Dioxide		Flow Rate (l/hr)	Downhole Pressure (Pa)	Groundwater Depth (m bgl)
	peak	(% Vol) steady		peak	(% Vol) steady	peak	(% Vol) steady			
BH1	0.0	0.0	0.0	19.8	20.5	0.5	0.0	<0.1	-	-
BH2	4.3	0.0	0.0	5.7	20.9	0.7	0.0	<0.1	-	-
BH3	0.0	0.0	0.0	19.6	20.4	0.2	0.0	<0.1	-	-

Remarks	Barometric Regime - Peak

Atmospheric Pressure: (mb)	1032
Atmospheric Oxygen:	20.2%
Monitored by:	DS

Summary Ground Gas and Groundwater Monitoring Results

Project Ref	0578-2a	Date :	04 Apr 2019
Site	Sutton Bridge	Visit	3/3

Borehole Ref	Methane		LEL (% Vol)	Oxygen		Carbon Dioxide		Flow Rate (l/hr)	Downhole Pressure (Pa)	Groundwater Depth (m bgl)
	peak	(% Vol) steady		peak	(% Vol) steady	peak	(% Vol) steady			
BH1	0.0	0.0	0.0	19.7	20.4	0.4	0.0	<0.1	-	-
BH2	0.0	0.0	0.0	2.7	20.5	0.5	0.0	<0.1	-	-
BH3	0.0	0.0	0.0	19.6	20.4	0.1	0.0	<0.1	-	-

Remarks	Barometric Regime - Trough (min.)

Atmospheric Pressure: (mb)	995
Atmospheric Oxygen:	20.8%
Monitored by:	DS