Phase II Site Investigation Report, Generic Quantitative Risk Assessment (GQRA) and Gas Risk Assessment

at Land Off Cheney Row, Walthamstow, London, E17 5ED

for We Made That LLP

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EXECUTIVE SUMMARY

The site is located off Cheney Row, Walthamstow and comprises a large open area approximately 1.6Ha, which is used for dog walking and BMX bike riding. The site was previously a landfill and is underlain by the London Clay Formation. It is proposed to redevelop the site to be used as Public Open Space including children's play area with a small café building and refurbished BMX track.

The preliminary searches identified a number of potential sources of contamination associated with the site's former use, including soil contamination from Heavy Metals, Polyaromatic Hydrocarbons (PAH) and asbestos. In addition, landfill gas was considered. The site is not affected by natural radon gas. UXO risk has been assessed as high.

An intrusive investigation was carried out on 2nd August 2017 which included 3 No. Windowless Sampler Boreholes with gas monitoring well installations and 20 shallow Hand Pits. Soil samples were collected for environmental testing and the soils were logged. The ground conditions comprised a thin layer of capping soil to around 0.1m below ground level (BGL) over the landfilled material which was found to be approximately 2.5m thick. The landfill materials were found to comprise a grey and black, fine to coarse gravelly SAND with fine to coarse gravels of clinker, ash, glass, metal, flint, crumbly chalk, wood, concrete and brick with occasional concrete cobbles. The natural clay soils were encountered beneath the Made Ground. Groundwater was not encountered during the investigation.

The Capping Layer, Made Ground and Natural Soils beneath the landfill were tested for pH, heavy metals, Polyaromatic hydrocarbons (PAH), Total Organic Carbon (TOC) and asbestos. A geo-environmental risk assessment has been carried out which identified hotspots of elevated concentrations of various contaminants, of which Lead, the PAH compound Benzo(a)Pyrene and asbestos were found to exceed the selected assessment criteria within the Landfilled Material. The overlying capping layer and underlying natural soils were not found to contain any elevations of contaminants.

The contamination risk assessment indicates that there is a potentially significant risk to human health from the Made Ground soils beneath the site. At this stage, due to the variability of the soils found within the landfill, the remediation proposals would involve removal of the landfilled material in its entirety and placement of clean soil, or placement of clean soil and geomembrane over the current site levels.

It is considered that with further targeted investigation, it may be possible to determine the extent of hotspots at the site and thereby refine the remediation strategy. It is suggested that the further site investigation could entail the use of portable X-Ray Fluorescence Spectrometer (XRF) testing on a closely spaced, accurately surveyed, grid in order to determine the horizontal and vertical extent of each hotspot.

Additional investigation has the potential to produce a remediation strategy that would reduce the volume of soil requiring to be removed from site or amount of clean cover required to be imported and placed.

Gas monitoring was undertaken from the three ground gas monitoring boreholes over 6 weekly visits between August and September 2017 and this identified concentrations of carbon dioxide up to 8.3% and low levels of Volatile Organic Compounds. The derived Gas Screening Values indicate that the site sits within Characteristic Situation 3 (CS3). Considering the proposed development as a Type B building in accordance with BS8485, gas protection measures are required to produce a gas protection score of 4 or more. One combination of protective measures which would achieve this comprises a monolithic floor slab, passive dispersal layer and gas resistant membrane. Alternative protective measures in accordance with BS8485 would be equally acceptable.

As with any redevelopment site, there is always the risk of hitherto undetected contamination. This is particularly important with historic landfill sites due to the variability and nature of the waste. At this stage, if soils were to be removed from site, much of the Made Ground soils could be expected to be classified as Hazardous Waste.

Signed :	 Charlie Bruinvels BSc MSc FGS PIEMA
Countersigned :	 Helen Smith, Director
Date :	2 October 2017
Revision:	Issue 1

A INTRODUCTION

1 Authority

Leap Environmental Ltd (hereafter referred to as LEAP) has been appointed by We Made That LLP to undertake a Phase II Intrusive Site Investigation, Generic Quantitative Risk Assessment (GQRA) and Gas Risk Assessment of a site referred to as the land off Cheney Row located in Walthamstow, London, E17 5ED as per Figure 1, Appendix B. The instruction was given in an email dated 17 July 2017 and signed by Oliver Goodhall of We Made That LLP.

2 Objective

LEAP understands that the site is currently owned by London Borough of Waltham Forest and it is proposed to redevelop the site into an area of Public Open Space (POS) with regenerated BMX cycling track and walking area with a small building to be used as a cafe as per the attached layout in Figure 2, Appendix B.

The proposed development is currently at a preplanning stage and the café building has been assessed in accordance with BS EN 1997[1], as being a Geotechnical Category 1 structure.

The objectives of this report are to:

- Provide information on the environmental quality of the ground present on the site;
- Assess the potential health and other environmental risks posed by the site to the proposed development and to other specifically identified receptors;
- Assess the potential for offsite contamination to adversely affect the proposed development; and
- To complete a Gas Risk Assessment on the area of the proposed cafe.

3 Previous Studies

The site has been the subject of previous investigations by others. The following site investigation reports have been supplied by the Client and the reader is referred to these earlier reports which should be read in conjunction with this report.

[1] BS EN 1997-1(2004) Eurocode 7: Geotechnical Design - Part 1: General Rules

- AMEC 2007, Ground Investigation Report for Cheney Row, Walthamstow. Prepared for London Borough of Waltham Forest by AMEC E&E (UK) Limited, Ref: K6102/R2801, August 2007.
- AMEC 2007, Desk Study and First Stage Risk Assessment for Cheney Row, Walthamstow. Prepared for London Borough of Waltham Forest by AMEC E&E (UK) Limited, Ref: K6101/R2763, July 2007.
- Carpenter and Lowe Limited 1990, Site Investigation at Cheney Row.

4 Scope of Works

This report describes a two stage process whereby the site is investigated and risks are assessed. The terms geotechnical and geoenvironmental are referred to throughout the report.

Geoenvironmental refers principally to the chemical nature of the ground and the degree of soil, water and/or land gas contamination and the impact that contamination may have on current or future development and also on the wider environment.

Geotechnical refers to all other aspects of the ground conditions and the impact they may have on the physical construction of existing or future development, principally foundations, slope stability, drainage, pavement and road design and groundwater control.

4.1 Intrusive Investigation Scope

The Phase II work comprises intrusive investigation, onsite monitoring and laboratory analysis. This phase of site investigation comprised the following tasks:

- 3 No. 4m deep windowless boreholes drilled with a tracked rig;
- 20 No. max 1m deep boreholes drilled using hand auger boring apparatus;
- In-situ geotechnical testing including Standard Penetrometer Tests in the boreholes;
- Land Gas monitoring from the boreholes; and
- Chemical Laboratory testing.

The intrusive works were completed by contractors who have been scrutinised and are on LEAP's approved contractor list. The windowless sampling was carried out by Oakland Site Investigation Limited and supervised by LEAP.

Selected samples of soil were scheduled for laboratory testing for a wide range of potential contaminants including metals, non-metals, polyaromatic hydrocarbons and asbestos. The

laboratory testing has been carried out by The Environmental Laboratory Ltd at its laboratories in East Sussex.

The final stage in the geoenvironmental assessment comprises a quantitative risk assessment and revision of the preliminary Conceptual Site Model. Preliminary recommendations for remediation have been provided, based on various development assumptions which are detailed in the following section and in the text of this report. The risk assessment has been carried out in accordance with UK industry standards and in particular in accordance with CLR11[2] and BS10175:2011.

5 Limitations

This report has been prepared by Leap Environmental Ltd on the basis of information received from a variety of sources which Leap Environmental Ltd believes to be accurate. Nevertheless, Leap Environmental Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

Leap Environmental Ltd has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed.

The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk.

Full details of the limitations are provided in Appendix A.

[2] Environment Agency, 2004. Model Procedures for the management of land contamination. Contaminated Land Report 11.

B ENVIRONMENTAL SETTING

The scope of the works did not include a full Phase I Desk Study. The following brief summary is based upon readily available information from online sources and from the AMEC 2007 Ground Investigation Report.

6 Site Location and Description

The site is located north of Cheney Row, Walthamstow, London, E17 5ED and the current site layout is shown in Figure 1, Appendix A. The approximate National Grid Reference of the site is TQ366910 and photographs of the site are presented in Appendix C.

The site is approximately 2.6Ha and comprised an area of Public Open Space (POS) with the main site being covered with thick grass with mown paths used for dog walking, a BMX cycle track surrounded by metal fencing in the southeast corner of the site, and a small car park south of the BMX track. The site is generally flat with hardstanding in the car park and parts of the BMX track are tarmac. There are no buildings onsite and the site is surrounded by mature trees.

The site is bounded by residential properties to the south and west of the site, Banbury Reservoir to the west, Waltham Forest Muslim Cemetery to the north of the site and Walthamstow Academy to the east.

During the site walkover areas of fly-tipping were encountered in the dense vegetation in the southwest corner of the site. In addition, a mound of soil was found north of the BMX cycle track. It is understood that this mound stays onsite as part of the development.

6.1 Site History

The history of the site has been ascertained from the AMEC 2007 Ground Investigation Report which identified that the site was previously used as a landfill between 1865 and 1952. Further information on the Environment Agency's What's in Your Backyard? Website (http://apps.environment-agency.gov.uk/wiyby/) stated that the site received inert waste between 1939 and1972. The site operator and licence number were not available. Before this the site was used for agricultural purposes.

6.2 Geology and Hydrogeology

The geology of the site has been ascertained by reference to the BGS website (www.bgs.ac.uk). The site is mapped as being directly underlain by the London Clay Formation. There are no surface water features mapped on site and the closest is the Banbury Reservoir to the west of the site. The AMEC report (2007) states the site is not part of a groundwater Source

Protection Zone (SPZ) and the closest groundwater abstraction for public potable supply is from Waterhall approximately 700m west of the site.

The northwest part of the site was found to be within a Flood Zone 1 according to the Flood Risk Mapping (https://flood-map-for-planning.service.gov.uk).

6.3 Unexploded Ordnance (UXO)

The risks from unexploded ordnance have been assessed in accordance with CIRIA guidance[3]. A non-UXO specialist preliminary screening assessment has been carried out. The risks have been assessed by considering firstly the likelihood of military activities on, or in the vicinity of the site as determined from the desk study and historical review. Secondly the risk of UXO has been assessed by reference to the unexploded WWII aerial delivered bomb (UXB) regional risk maps produced by Zetica. In addition, the website http://bombsight.org has been used to identify nearest bomb location.

The Zetica risk maps indicate a high risk and three bombs were located on Bomb Sight close to the site. The overall risk of UXO is rated as high.

6.4 Radon

According to the http://www.ukradon.org/information/ukmaps the site is not within a radon affected area (less than 1% of homes are above the action level for radon). Therefore, no special protective measures are required in the construction of buildings on this site, in respect of radon gas.

7 Previous Investigations

7.1 AMEC 2007 Desk Study and subsequent Ground Investigation Report

The site has been the subject of a Ground Investigation Report by AMEC 2007[4]. The report describes an investigation which completed 16 exploratory holes with the installation of eight gas monitoring wells. Soil samples were collected for chemical testing which identified

[3] CIRIA C681 2009. Unexploded ordnance (UXO) - A guide for the construction industry

[4] AMEC 2007, Ground Investigation Report for Cheney Row, Walthamstow. Prepared for London Borough of Waltham Forest by AMEC E&E (UK) Limited, Ref: K6102/R2801, August 2007.

elevated levels of lead, zinc, arsenic, copper, total PAH, TPH, nickel, selenium and benzo(a)pyrene. No testing for asbestos was carried out.

The results from the chemical testing were compared to a set of inhouse Risk Assessment Values produced by AMEC based on the assessment methodology relevant at the time of the report. The risk assessment suggested that there may be a risk to current and future users of the site and construction workers.

The report recommended that the contaminated materials were to be excavated to a minimum depth of 0.5mbgl in proposed grass areas and replaced with clean imported soils. In addition, gas monitoring identified a potential human health risk from carbon dioxide following maximum readings of 6.2% and recommended that gas protection measures should be installed in any proposed buildings at the site. It was also recommended that a Remediation Method Statement should be prepared.

7.2 Carpenter and Lowe 1990 Site Investigation

The report prepared by Carpenter and Lowe in 1990 was not available to LEAP at the time of writing, however a summary of this was presented within the AMEC Ground Investigation Report[5]. The summary states that this initial site investigation identified elevated levels of cadmium, lead, TPH, and PAH in the northernmost part of the site. It is not known how this relates to the current site layout and where these exceedance locations were positioned.

8 Environmental Risk Assessment

8.1 Conceptual Site Model (CSM)

A risk based approach is used to assess contaminated or potentially contaminated land within the UK. For a potential risk to exist, there must be a pollutant linkage in place, i.e. there must be a source of contamination, a potential receptor, and a pathway linking the two.

In order to quantify the magnitude of the risk, it is necessary to first calculate the potential exposure of the receptor as a result of all the individual active pollutant linkages affecting that receptor. Secondly it is necessary to ascertain "what is an acceptable exposure level for each of the identified receptors and contaminants?".

The purpose of the Conceptual Site Model, in this instance, is to identify all of the potential pollutant linkages by considering, in turn, the potential sources, receptors and pathways.

[5] AMEC 2007, Desk Study and First Stage Risk Assessment for Cheney Row, Walthamstow. Prepared for London Borough of Waltham Forest by AMEC E&E (UK) Limited, Ref: K6101/R2763, July 2007.

A CSM was produced within the AMEC 2007 report and the information has been used to complete the following sections.

8.2 Sources

The identified potential onsite sources of contamination are outlined in Table 1. This includes contaminants within the Landfilled Material and land gasses.

Table 1: Onsite sources of contamination

Source	Contaminants of Concern
Landfill – Made Ground	Heavy metals, Polyaromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbons (TPH) and Asbestos
Landfill – Gas	Methane, Carbon Dioxide, Hydrogen Sulphide, Carbon Monoxide

8.3 Receptors

Potential receptors are those which may be impacted by any of the contaminants of concern identified above, and include the following:

- Current users of the site
- Future users of the site
- Construction workers

Groundwater has not been considered as a receptor due to the limited permeability of the London Clay soils beneath the site.

8.4 Pathways and Potential Pollutant Linkages

The development will include Public Open Space (POS) Park. The potential pollutant linkages involving future users of the site and construction workers and soil contaminants include dermal contact, direct ingestion of soil, and inhalation of indoor and outdoor vapour and of dust. The potential for tracked back dust is considered to be low due to the fact that to get back to any residential properties requires walking along the public highway.

In addition, the pathways for gas include the migration of gas through the ground and accumulation within buildings.

9 Recommendations for Intrusive Ground Investigation

The results from the AMEC Ground Investigation Report and historic use of the site as a landfill determined that further intrusive investigation was necessary to determine the risks to future users of the site. The recommendations for further investigation included:

1. Supplementary intrusive investigation work to refine the contamination dataset and establish current ground gas conditions at the site;
2. Generic quantitative risk assessment using current assessment methodologies to establish where contamination risk was unacceptable for the proposed development; and
3. Production of an options appraisal and remediation method statement to determine and define the optimum remedial solution for the site.

The Generic Quantitative Risk Assessment (GQRA) was to be carried out using the data from both the previous investigations and the supplementary site work to determine potential risk from concentrations of contaminants in the soil and a ground gas risk assessment. Given the nature of the geology underlying the site, the perceived risk to controlled waters is low and hence, no controlled waters investigation or assessment work was proposed.

Based on the results of the GQRA, an options appraisal was to be carried out to determine the most appropriate potential remedial solution for the site. This would then be supported with a Remediation Method Statement (RMS) setting out the detail of the remediation required and how it was to be validated.

C PHASE II - INTRUSIVE INVESTIGATION

10 Investigation Rationale

A total of 23 trial holes were excavated across the site. These included 3 No. Windowless sampler boreholes to depths of 4m and 20 Hand Pits to a depth of 1m. The site investigation locations are shown on Figure 3, Appendix B. This Figure also shows positions drilled by AMEC in 2007.

The Windowless Sampler Boreholes were located in the area of the proposed café to install gas monitoring wells and complete gas monitoring. The Hand Pits were located to give general coverage, taking into consideration the proposed development and the potential geoenvironmental risks. The investigation rationale for the trial holes is summarised below:

Table 2 Rationale for Investigation Locations

Trial Hole/Test Location	Rationale	Depth (mbGL)	Notes
Windowless Sampler Boreholes 1-3	Provide information on ground conditions and to install gas monitoring wells.	4	Gas monitoring well installed.
Hand Pits 1-20	Provide information on the ground conditions and provide samples for contamination testing	1	Hand Pits were backfilled upon completion.

11 Site Work

The intrusive investigations were undertaken in a single phase on 2nd August 2017. At the time of the investigations, the weather was cloudy with heavy rain.

The Boreholes were drilled using a Windowless Sampler Rig and the Hand pits were excavated using hand tools. Soil samples were recovered from the excavations for field screening, logging and sampling. Boreholes were logged in general accordance with the requirements of BS 5930: 2015 and BS EN ISO 14688 Pt 1&2. Borehole logs are presented in Appendix D.

In addition, visual and olfactory evidence of contamination was noted if encountered. These observations were used to aid scheduling of samples for chemical laboratory analyses, and are included on the borehole logs in Appendix D.

Samples were collected with a clean sampling trowel or by hand (using dedicated nitrile gloves for each sampling location). Samples were placed into laboratory supplied sampling containers, specific to the type of analyses required. All sample containers were sealed and labelled with a unique location identity, depth and date of sampling.

11.1.1 Monitoring Well Installation

Three monitoring wells were installed within the Windowless Sampler Boreholes using 38mm diameter HDPE pipe. The response zone was typically targeted to intercept the Made Ground and was surrounded by washed filter gravel. The plain zone was surrounded with bentonite to provide a seal. The monitoring wells were finished with bungs with gas taps and flush steel covers. Monitoring well installations are shown on the borehole logs.

11.2 Field Tests

11.2.1 Standard Penetration Tests

Standard penetration tests were undertaken in the boreholes at 1m intervals in granular soils. Uncorrected blow counts, 'N values', are recorded on the borehole logs in Appendix D.

11.3 Ground Gas

11.3.1 Ground gas monitoring

6 No. rounds of ground gas monitoring were undertaken during this investigation. The final visit was completed on 13th September 2017. The wells were monitored for methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide using a GFM463 Infra-Red and Electrochemical gas analyser. The wells were also monitored for volatile organic compounds using a PhoCheck+ Portable Ionisation Detector (PID). The details of the Ground Gas Risk Assessment are outlined in Section E.

11.4 Laboratory Analysis

Selected samples of soil were subjected to laboratory testing. Sampling techniques and storage have been undertaken as per BS 10175:2011 Code of Practice for Investigation of Potentially Contaminated Sites. The laboratory testing has been carried out by The Environmental Laboratory Ltd at its laboratories in East Sussex. Where available, the test procedures are UKAS and MCERTS accredited.

The following analyses were completed on selected samples:

- LEAP Extended Soil suite (pH, metals, speciated PAHs, asbestos, Phenols, Cyanide, Sulphate, TOC)
- Asbestos Quantification

No Total Petroleum Hydrocarbon (TPH) testing was carried out on any of the samples obtained during this investigation as no visual or olfactory evidence of this being present was observed.

The full laboratory test results are presented in Appendix E.

12 Ground Conditions

The ground conditions are described in detail in the logs attached in Appendix D and summarised in Table 3.

The soils encountered onsite included a thin capping layer of Topsoil/Made Ground which was found to be a dark brown Sand with some glass, brick and clinker.

The Capping Layer was found to be over Landfilled Material. This Landfill was found to be highly variable comprising a sandy or gravelly matrix with ash, metal, brick, and wood. Due to the common presence of degradable material landfill soils can also be a potential source of landfill gas, though the materials encountered during the investigation of this site found no evidence of putrescible materials, paper or other readily degradable materials which is consistent the stated age of the landfill.

The Natural soils were encountered within the Windowless Sampler Boreholes at a minimum depth of 2.1m. The natural soils were found to be stiff, orange, brown and blue silty Clay with selenite crystals.

Table 3: Summary of soils encountered

Depth From (m)	Depth To (m)	Soil Type	Description
GL	0.05 / 0.1	TOPSOIL / MADE GROUND COVER	Made Ground Topsoil Capping Layer. Grass over dark brown slightly clayey, slightly silty, medium-grained sandy TOPSOIL, with medium gravel of angular clinker, flint, brick abundant roots and occasional glass.
0.05 / 0.1	2.1 / 2.6	LANDFILL	Highly Variable Made Ground "landfill". Grey and black, fine to coarse gravelly SAND with fine to coarse gravels of clinker, ash, glass, metal, flint, crumbly chalk, wood, concrete and brick. Occasional concrete cobbles.
2.1 / 2.6	4	CLAY	Natural Soil (London Clay Formation) Firm to stiff orange, brown and blue silty CLAY with selenite crystals.

12.1.1 Visual Evidence of Contamination

Visual and olfactory evidence of contamination noted during the investigation works is summarised in Table 4. Suspected Asbestos fragments and ash were identified within the Made Ground landfill in areas across the site.

Table 4: Summary of Visual Evidence of Contamination

Hole ID	Depth (m)	Visual Evidence
WS1	0.5	Suspected Asbestos Containing Material (ACM)
HP2	0.2	Suspected ACM
HP2	0.4 – 0.6	Ash
HP3	0.3 – 0.5	Ash
HP6	0.05 – 0.3	Ash
HP6	0.4	Ash
HP8	0.5	Suspected ACM
HP12	0.15 – 0.65	Ash
HP15	0.65	Suspected ACM

D GEO-ENVIRONMENTAL APPRAISAL

13 Conceptual Site Model

The preliminary conceptual site model has identified a number of potential pollutant linkages relating to the contaminants identified within the AMEC report. This related to the risks from elevated heavy metal concentrations within the Made Ground and future users on the site.

On-site sources of contamination likely to impact the site are related to the historic use as a landfill. Contaminants may include heavy metals, PAH and asbestos and potential land gases. These sources are considered to pose a moderate to high risk to human receptors and a low to moderate risk to controlled waters.

14 Testing Strategy

14.1 Soil Sampling

Trial hole locations were spread evenly across the site to provide even, non-targeted coverage, with the exception of the windowless boreholes which were located at the proposed café's position. Samples were tested for the presence of the identified contaminants of concern (heavy metals, PAH compounds, and asbestos). As no visual or olfactory evidence of hydrocarbon contamination was noted no Total Petroleum Hydrocarbon (TPH) testing was carried out.

15 Assessment Criteria

15.1 Human Health Assessment Criteria

Pollutant linkages containing human health have been risk assessed by comparing the soil laboratory test results to Tier 1 Generic Assessment Criteria. These are based on published Suitable for Use Levels (S4UL[6]) and Category Four Screening Levels (C4SL[7]) assuming a Public Open Space (POS) Park land use.

[6] The LQM/CIEH S4ULs for Human Health Risk Assessment, Nathaniel P et al, 2015. Copyright Land Quality Management Ltd, reproduced with permission: Publication Number S4UL3509

[7] CL:AIRE Final Project Report. SP1010 – Development of Category 4 Screening Levels for assessment of land affected by contamination. CL:AIRE, December 2013

The assessment of seven genotoxic PAH compounds have been compared to the ratio reported from coal tars by Culp et al, 1999. The ratios have been found to typically be within an order of magnitude and thus the concentrations of benzo(a)pyrene have been used a proxy for the genotoxic PAH compounds in accordance with current HPA guidance. The remaining non-genotoxic PAH compounds have been screened individually against S4ULs.

Cyanide has not been modelled using CLEA. Assuming an acute risk and based on a single dose of 3g of soil, an assessment criterion of 33mg/kg free inorganic cyanide and 544mg/kg complex cyanide may be derived. At this stage we have adopted a conservative Tier 1 screening level of 20mg/kg for total cyanide (essentially the sum of free and complex cyanides) in order to highlight any potential risks to human health and to be reflective of potential risk to controlled waters.

15.1.1 Statistical Assessment

In assessing soil test results and comparing them to any threshold or screening value, an assessment must first be made as to how accurately the test results reflect the true mean of the contaminant level within the ground. In this assessment for each parameter the test data have been subjected to statistical assessment based on the methodology set out in *CIEH report 2008: Guidance on comparing Soil Contamination Data with a Critical Concentration*. The Upper Confidence Level or U_{95} value is thereby calculated as being the level at which we would be 95% confident that the true mean is **less** than this value. For the purposes of this assessment, a conservative approach has been adopted in the statistics. All non-detect values have been treated as being equal to half the limit of detection.

Statistical analysis has been carried out on populations of greater than 6. Where the population is less than 6 statistical analysis has been deemed inappropriate and therefore the maximum concentration of each contaminant has been recorded.

Where outliers have been identified they have been separated from the main population of test results and are discussed separately.

16 Analytical Test Results

The analytical test results have been summarised within the following sections and the laboratory certificates are presented in Appendix E. The soil samples have been subdivided into three populations representing the Topsoil, the Landfill and the Natural Soil. The test results for each population have been subject to statistical analysis where appropriate and the results tabulated.

In addition to the results from this investigation, the results from the AMEC 2007 report and Carpenter and Lowe 1990 report have been added to the data set and been subject to statistical analysis and re-screening against modern criteria. The AMEC investigation included samples of the Made Ground Fill and the Carpenter and Lowe investigation included samples throughout the capping layer and Made Ground Fill.

16.1 Topsoil / Capping Material

The results from the chemical analysis of soils recovered from the Topsoil / Capping Material are presented in Table 5. These results were compared to the assessment criteria for POS Park and no exceedances were identified.

In addition, no asbestos was found within the samples recovered from the capping material.

No test outliers were identified within the Topsoil /Capping material.

Table 5: Summary of soil contamination test results within the Topsoil / Upper Capping Material

Determinant	Arithmetic Mean (mg/kg)	Number of samples	UCL U_{95} (mg/kg)	Evidence Level (%)	Assessment Criteria POS Park (mg/kg)	Outliers Identified?	Samples which exceed GAC
Arsenic	15.6	13	27.4	100	168	No	None
Cadmium	2.2	13	2.7	100	880	No	None
Hexavalent Chromium	0.4	7	0.4	100	250	No	None
Copper	345.7	7	1062.9	100	44000	No	None
Lead	589.7	13	716.4	100	1300	No	None
Mercury	0.8	7	1.6	100	240[1]	No	None
Nickel	65.3	7	163.9	100	800	No	None
Selenium	1.5	7	1.8	100	1800	No	None
Zinc	1518	7	5149.6	100	170000	No	None
Cyanide	1.65	13	3.3	100	20	No	None
Benzo(a)Pyrene	2.8	7	7.3	100	21	No	None
Naphthalene	0.1	7	0.2	100	1200	No	None
Acenaphthylene	0.3	7	1.0	100	29000	No	None
Acenaphthene	0.1	7	0.2	100	150000	No	None
Fluorene	0.1	7	0.4	100	20000	No	None
Phenanthrene	2.0	7	5.7	100	6200	No	None
Anthracene	0.6	7	2.1	100	150000	No	None
Fluoranthene	5.3	7	15.8	100	6300	No	None
Pyrene	4.6	7	13.2	100	15000	No	None
Asbestos	-	7	-	-	-	-	None

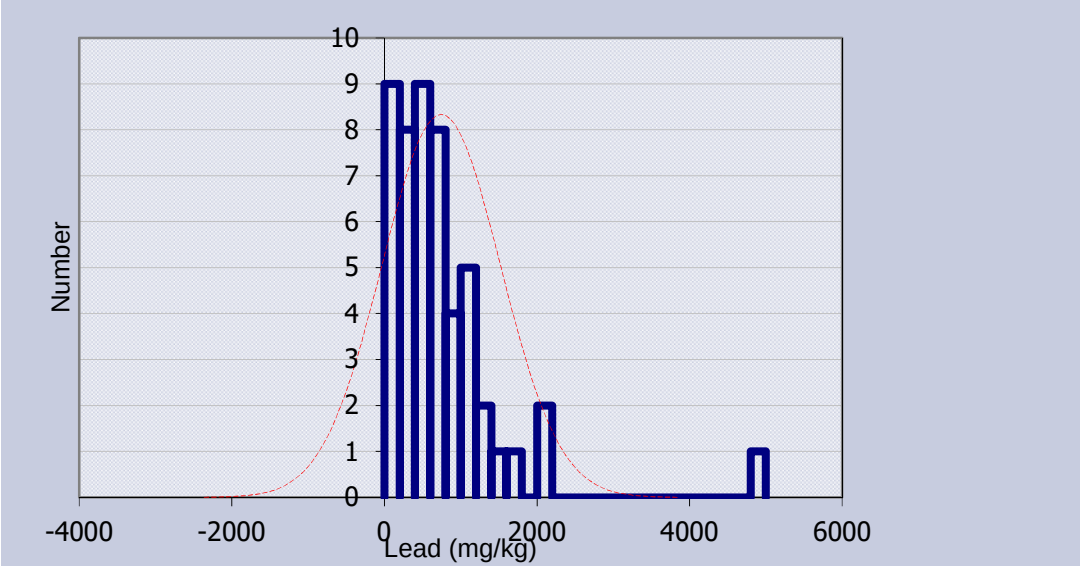
Notes to table

1. *Assessment criterion based on inorganic Mercury*
2. *Data from AMEC 2007 assumes all chromium is hexavalent chromium.*
3. *NA = Not Applicable*

16.2 Landfill Material

The results from the chemical analysis of soils recovered from the Landfill were subject to statistical analysis. The results identified a number of outliers within the dataset and as such the population of outliers has been assessed separately. Graph 1 below shows the histogram plot for lead at the site, clearly showing the outliers outside the normal distribution of the remaining results. The statistical analysis excluding outliers is presented in Table 6.

Graph 1: Histogram showing measured lead concentrations within the landfill material



The dataset shows that once outliers were excluded there were no exceedances of the GAC for the Landfill material.

Table 6: Summary of soil contamination test results within the Made Ground (Excluding Outliers)

Determinant	Arithmetic Mean (mg/kg)	Number of samples (Number of Outliers)	UCL U_{95} (mg/kg)	Evidence Level (%)	Assessment Criteria POS Park (mg/kg)	Outliers Identified?	Samples which exceed GAC (Excluding Outliers)
Arsenic	18.4	49 (1)	25.8	100	168	Yes	None
Cadmium	1.5	50 (2)	2.3	100	880	Yes	None
Hexavalent Chromium	11.9	38[2] (1)	22.8	100	250	Yes	None
Copper	164.2	38 (7)	48.3	100	44000	Yes	None
Lead	595.9	50 (3)	856.8	99	1300	Yes	None
Mercury	0.5	38 (5)	0.6	100	240[1]	Yes	None
Nickel	41.9	38 (1)	59.2	100	800	Yes	None
Selenium	1.0	38 (1)	1.4	100	1800	Yes	None
Zinc	689.2	38 (1)	1207.9	100	170000	Yes	None
Cyanide	1.1	50 (5)	1.5	100	20	Yes	None
Benzo(a)Pyrene	2.8	38 (6)	4.4	100	21	Yes	None
Naphthalene	0.2	38 (9)	0.2	100	1200	Yes	None
Acenaphthylene	0.3	38 (6)	0.5	100	29000	Yes	None
Acenaphthene	0.2	38 (7)	0.4	100	150000	Yes	None
Fluorene	0.3	38 (7)	0.5	100	20000	Yes	None
Phenanthrene	3.8	38 (7)	6.2	100	6200	Yes	None
Anthracene	2.8	38 (3)	4.9	100	150000	Yes	None
Fluoranthene	8.5	38 (4)	13.5	100	6300	Yes	None
Pyrene	8.6	38 (3)	14.1	100	15000	Yes	None
Asbestos	-	20 (4)	-	-	-	Yes	None

Notes to table

1. *Assessment criterion based on inorganic Mercury*
2. *Data from AMEC 2007 assumes all chromium is hexavalent chromium.*
3. *NA = Not Applicable*

16.2.1 Outliers Within the Landfill material

The statistical analysis identified outliers within the dataset for all contaminants. The concentrations of contaminants were compared to relevant GAC and exceedances were identified for Lead, Benzo(a)Pyrene and Asbestos. Table 7 shows the statistical dataset for the outliers.

Exceedances for Lead were found at various depths within the Made Ground, with the maximum concentration of 4830mg/kg reported within WS2 at 0.5m. The results for Benzo(a)Pyrene followed a similar trend although no exceedances were identified within the AMEC and Carpenter and Lowe investigations. The maximum concentration of Benzo(a)Pyrene reported was found in HP9 at 68mg/kg.

In addition, asbestos cement was identified within four samples of the Made Ground collected as part of this investigation. No free fibres were identified.

Table 7: Summary of Outliers within the Made Ground

Determinant	Number of Outliers	Assessment Criteria POS Park (mg/kg)	Samples which exceed GAC (Excluding Outliers)
Arsenic	1	168	None
Cadmium	2	880	None
Hexavalent Chromium	1	250	None
Copper	7	44000	None
Lead	3	1300	WS2 at 0.5m = 4830mg/kg HP9 at 0.6m = 1780mg/kg HP13 at 0.5m = 2170mg/kg WS16 at 0.2-0.3 = 2174mg/kg 10B at 0.3 = 1480mg/kg 10C at 1m = 1300mg/kg 11C at 1m = 1320mg/kg
Mercury	5	240[1]	None
Nickel	1	800	None
Selenium	1	1800	None
Zinc	1	170000	None
Cyanide	5	20	None
Benzo(a)Pyrene	6	21	WS2 at 0.5m = 24.5mg/kg HP9 at 0.6m = 68mg/kg HP13 at 0.5m = 65.2mg/kg
Naphthalene	9	1200	None
Acenaphthylene	6	29000	None
Acenaphthene	7	150000	None
Fluorene	7	20000	None
Phenanthrene	7	6200	None
Anthracene	3	150000	None
Fluoranthene	4	6300	None
Pyrene	3	15000	None
Asbestos	4	NA	WS1 0.4m = Chrysotile Cement (1.29%) HP2 0.2m, = Chrysotile Cement (2.23%) HP8 0.5m = Chrysotile Cement (13.4%) HP15 0.65m = Chrysotile Cement (1.31%)

Notes to table

1. *Assessment criterion based on inorganic Mercury*
2. *Data from AMEC 2007 assumes all chromium is hexavalent chromium.*
3. *NA = Not Applicable*

16.3 Natural Soils

The results from the chemical analysis of a single soil sample recovered from the Natural Soil beneath the Made Ground are presented in Table 7. These results were compared to the assessment criteria for POS Park and no exceedances were identified.

Table 8: Summary of soil contamination test results within the Natural Soils (1 sample)

Determinant	Maximum (mg/kg)	Assessment Criteria POS Park (mg/kg)	Samples which exceed GAC (Including outliers)
Arsenic	20.4	168	None
Cadmium	<0.5	880	None
Hexavalent Chromium	<0.8	250	None
Copper	67.2	44000	None
Lead	326	1300	None
Mercury	1	240[1]	None
Nickel	25.4	800	None
Selenium	<1.0	1800	None
Zinc	176	170000	None
Benzo(a)Pyrene	0.2	21	None
Naphthalene	<0.1	1200	None
Acenaphthylene	<0.1	29000	None
Acenaphthene	<0.1	150000	None
Fluorene	<0.1	20000	None
Phenanthrene	0.1	6200	None
Anthracene	<0.1	150000	None
Fluoranthene	0.3	6300	None
Pyrene	0.2	15000	None
Asbestos	NAD	-	None

Notes to table

1. *Assessment criterion based on inorganic Mercury*
2. *NA = Not Applicable*

17 Risk Assessment

17.1 Human Health

The works carried out to date have indicated that the Made Ground beneath the site contains hotspots of elevated contaminant concentrations. Of these hotspots there are some which contain lead, the PAH compound Benzo(a)Pyrene and asbestos above the relevant assessment criteria. The contamination identified poses a significant potential risk to human health through the direct ingestion, inhalation and skin contact pathways that would be present in a Public Open Space (Park) setting. The contaminated ground is considered to pose an unacceptable risk if it is to be retained in the near surface of soft covered areas where direct human contact is feasible.

Some remediation to mitigate risk to human health from impacted Made Ground soils will be required and it is recommended that a remediation strategy for the site is prepared following further investigations. Due to the inherently variable nature of the Made Ground within the landfill it is difficult to determine the extent of each hotspot both vertically and horizontally within the ground.

Three Figures (Appendix B) have been prepared to show the location of each exceedance of the GAC within the LEAP and AMEC investigations. It should be noted that LEAP did not have access to a site plan showing the locations of the exceedances within the Carpenter and Lowe investigation.

Figure 4 shows the four asbestos detections were found in the northern part of the site. Asbestos was found as a fragment in each of these four locations and was not found as free fibres. There are no set GAC for asbestos and therefore presence of asbestos is considered to be a potential risk to human health.

Figure 5 shows a heat map for Lead. The concentrations of lead determine whether the colour is light or dark, with light being the lowest and dark being the highest. The size of the 'halo' is not representative of the physical size or footprint of the hotspot. The darkest colours show the exceedances of the GAC which were found in WS2, HP9, HP13 from this investigation and WS16 from the AMEC investigation. The spatial variability shows that there are multiple hotspots onsite and remediation would be necessary in these areas to lower the risk to human health.

Figure 6 shows a heat map for Benzo(a)Pyrene. Much like the heat map for Lead, the light colours represent a concentration and the dark colours represent a high concentration. The size of the 'halo' does not represent the physical size or footprint of the hotspot. The highest concentrations were found in positions WS2, HP13 and HP9 from the LEAP investigation. These positions were also found to contain an elevated Lead concentration. It is therefore considered that there is a potential relationship between Lead and Benzo(a)Pyrene in the material encountered at the sample depths. The contaminated areas pose a high risk to human health and require remediation to lower the risk.

17.2 Recommendations for Remediation

The risk assessment has highlighted that there is a potential human health risk from Lead, Benzo(a)Pyrene and Asbestos hotspots within the Landfilled Made Ground. Currently the material is beneath a capping layer of a maximum thickness of 0.1m which is not likely to considered sufficient for providing protection from these identified risks. In particular the use of part of the site as a BMX track raises potential additional risk due to the potential for dust generation arising from the activity.

At this stage it is considered that potential options for remediation could include:

- Removal of the landfilled material in its entirety and replacement with clean imported soil i.e. Cut and Fill; or
- Importation of clean soil to be placed over a geotextile across the entire site as a cover system.
- A combination of the two, with partial excavation and then placement of clean cover to raise the levels back up.

Any of these options is likely to have significant cost implications if it was to be carried out across the site in its entirety. Unfortunately, the nature of the contamination source – i.e. landfilled material – means that there is the potential that hotspots could be present anywhere across the site and could vary significantly in size from <1m to >10m diameter.

One potential option to attempt to delineate the spatial extent of the hotspots would be to carry out a highly detailed investigation based on a statistical sampling methodology with sample locations derived using specialist software. This would be at a much closer spacing than has currently been carried out.

This could include using a handheld X-Ray Fluorescence (XRF) Spectrometer on a closely spaced grid across the site at a range of ground depths required for a detailed profile of the soils to be determined. Real time GPS positioning (using a smart pole/total station) would be used to map the site accurately and compile a 3D contamination concentration model.

This would allow for a detailed Remediation Method Statement to be prepared whereby the specific location onsite and the depth of the contamination within the landfill was identified and a potential alternative remedial option where only the contamination hotspots were removed/covered.

17.3 Validation of Remediation

A final Remediation Method Statement will be required to be prepared once the final site designs are complete. This method statement should be submitted to the appropriate regulatory authorities and it is recommended that the local authority is advised of the intended build programme in order that they can phase the sign off of planning conditions as required.

Where any remediation strategy requires the importation of clean soil these will need to meet the criteria for Public Open Space (Park) and these imported soils should be tested at source by the supplier. The validation engineers should then make spot checks as and when necessary once material has been imported.

Provision should also be made for dealing with further localised hotspots of contamination which may come to light during construction. Any such soils should be inspected by the validation engineers and appropriate remedial action taken as necessary.

18 Waste Disposal

It is anticipated that the proposed development will generate waste soils and materials will need to be removed from site as part of the construction process. Where soils are to be disposed off-site, it is the duty of the waste producer, in this case We Made That LLP, to ensure that all waste is disposed of appropriately and that any that is sent to landfill is sent to an appropriately licensed one. All waste sent to landfill must be classified and must be pre-treated. The form of pre-treatment should be documented in the Site Waste Management Plan. There are various forms of pre-treatment that are acceptable. In this case it could include "reduction in volume", which could be achieved by segregating the Made Ground and re-using part of it on site.

Where made ground soil is to be re-used on site then it is recommended that this is carried out under the CL:AiRE Definition of Waste Industry Code of Practice (DoWCoP) for re-use of soils[8].

No samples were tested for Waste Classification Purposes (WAC), however due to the concentration of contaminants identified and the presence of asbestos and the high concentrations of metals identified it is likely that the soils would be classified as hazardous waste for disposal purposes. However, it is recommended that this is confirmed with a haulier/receiving site. Further testing and inspection of soils will be required to confirm waste classification of material leaving the site.

It is strongly advised that detailed discussions be held with remediation/groundworks contractors and that receiving landfill sites are identified in advance of commencing any waste removal.

[8] The Definition of Waste: Development Industry Code of Practice. Version 2 2011. CL:AiRE

E LAND GAS RISK ASSESSMENT

19 Introduction to Land Gas Risk Assessment

Landfill gas generation and emissions will change throughout the lifetime of a landfill site due to accumulation of the wastes deposited during the operational period, the variation in decomposition rates and any changes in the gas management system. The landfill at Cheney Row has no known gas management system and gas generation will be dependent on the operational period and the decomposition rates for the landfilled waste.

Potential contaminant linkages associated with landfill gases have been identified as risk drivers at the site. The history of the site has been suggested by AMEC 2007 as being used between 1865 and 1952. Before this the site was in agricultural use. This Gas Risk Assessment considers the risks to receptors associated with the proposed users of the site and the café building that is to be constructed.

The methodology set out in CIRIA 665[9] has been used to assess the risks to human health and structures. The gassing potential for this site has been assessed as Low to Moderate due to the age and composition of the potential source material. The sensitivity of this development would be classified as Low and hence the minimum number of monitoring visits as recommended by CIRIA would be six visits over two months including a visit under falling atmospheric pressure to capture the "worst-case" scenario.

The aim of the gas risk assessment was to determine whether there is a risk to future users of the site. This has been carried out by completing a number of objectives:

- Collate and review available data pertaining to the former landfill;
- Utilise the above information to inform the development of a Gas Risk Assessment; and
- Identify, describe and justify what mitigation measures, if any, are required to manage the identified pollutant linkages with respect to gas / vapour risks.

The assessment process is based on the empirical method set out within CIRIA C665. Gas Screening Values (GSVs) were to be calculated for the site and Total Organic Carbon (TOC) values have been reviewed as a separate line of evidence, although it is noted that this method would not be suitable for site characterisation in isolation.

[9] CIRIA 665 Assessing risks posed by hazardous ground gases to buildings 2007

The assessment concludes by suggesting a Characteristic Situation (CS) for the site. This is then used in conjunction with the proposed development proposals to determine what level of gas protection measures may be required

20 Ground Conditions

The ground conditions found within the Windowless Sample Boreholes (WS1, WS2 and WS3) have been summarised to typically contain a thin capping layer over the landfilled material, over the natural London Clay. These boreholes were drilled in the location of the proposed café to understand the waste types beneath the proposed development.

The thickness of the capping layer ranged between 0.05m and 0.1m and comprised grass over dark brown slightly clayey, slightly silty, medium-grained sandy Topsoil, with medium gravel of angular clinker, flint, brick abundant roots and occasional glass.

Beneath the Topsoil layer was Made Ground containing landfilled waste. Generally, the predominant waste type identified was inert commercial waste, which included reworked flint gravel, sand, brick, glass, concrete and occasional clinker in a sand, clay or gravelly matrix. Degradable material was predominantly wood and some plastic.

The London Clay beneath the landfill was encountered at a minimum depth of 2.1m and a maximum depth of 2.6m.

The groundwater was not encountered during the excavation of each borehole but was identified throughout the monitoring period. The groundwater level was typically encountered at around 3.11 – 4.10m bgl.

21 Gas Risk Assessment Methodology

Carbon Dioxide (CO_2), Methane (CH_4), Carbon Monoxide (CO), Hydrogen sulphide (H_2S) and Volatile Organic Compounds (VOCs) occur from the degradation of organic wastes within a landfill. These gases pose a significant risk to structures when the following three factors occur:

- An accumulation of large volumes of gas occurs in the ground near buildings
- A pathway exists that allows gas to migrate through the ground into a building
- A confined space within the building is present where gas can build up to unacceptable levels

These three factors combined create a source, pathway and receptor.

21.1 Gas Screening Values

An initial assessment has been made using the method outlined in CIRIA 665. Gas concentrations and borehole flow rates are combined to provide GSVs for both Carbon Dioxide and Methane. In this assessment, the highest recorded concentrations have been combined with the highest recorded flow rates to provide a worst-case assessment.

GSVs are considered in conjunction with the conceptual site model and typical gassing levels associated with the identified source to characterise the gassing regime. The source is assigned a Characteristic Situation in accordance with CIRIA 665.

21.2 Total Organic Content (TOC)

The review of TOC results from across the site provides a line of evidence and allows the gas generating potential of the source material to be assessed. This approach considers the TOC of the Made Ground as well as the age and depth of the fill. The TOC is then compared with the Table set out by Card et al. 2012[10] and determined the Characteristic Situation of the site.

Samples from the Made Ground within the capping layer and the landfill material were collected from boreholes and hand auger pits in order to carry out TOC analyses as part of the gas risk assessment. In total, 22 No. TOC analyses were undertaken and the results are presented in Appendix E and summarised in Table 8.

Table 9. Summary of TOC Analyses

Depth	Nr. of TOC tests	TOC Range (%)	TOC Mean (%)
Made Ground	22	0.45 – 32	6.9

Table 8 shows a range of TOC results from samples collected from the landfill. The TOC is useful in determining the gas generation potential of the landfill mass as landfill waste with a high content of degradable organic material can produce gas which will create a migration network within landfill soil.

Based on BS8485 and CIRIA C665 alone, the TOC results conform to criteria in category Characteristic Situation 3 (CS3). However, it is known from the exploratory works undertaken that the waste material includes discreet areas of organic material such as wood. In line with CIRIA Research Bulleting RB17, confirmatory ground gas monitoring is required and was therefore subsequently carried out.

[10] Card G., Wilson S, Mortimer S. 2012. A pragmatic approach to ground gas risk assessment. CI:AIRE Research Bulletin RB17.

22 Land Gas Monitoring Results

The land gas investigation strategy has been designed generally in accordance with CIRIA[11] and NHBC[12] guidance and monitoring wells were placed in the footprint of the proposed café building to determine whether there is a risk of land gas onsite. Ground gas monitoring has been undertaken on a weekly basis for 6 weeks.

The wells were monitored during six site visits over a period of two months between 9th August and 13th September 2017. The atmospheric pressures were typically high during these monitoring visits, recorded between 999hPa and 1020hPa. The first five visits were undertaken when the atmospheric was above 1000hPa and the final visit was undertaken when the atmospheric pressure was below 1000hPa. Three of the monitoring visits were carried during periods of falling pressure, as seen on the pressure graph from Weather Underground in Graph 1, Appendix B.

The results from each borehole have been summarised in the following Tables.

Table 10: Summary of land gas monitoring results in WS1

Monitoring Date	WS1							
	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (%)	H_2S (%)	Flow rate (l/hr)	VOC	Atmospheric Pressure (hPa)
9 August 2017	0	5.6	14.6	0	0	0	0.2	1015
17 August 2017	0	5.6	14.4	0	0	0	0.5	1011
23 August 2017	0	5.7	14.7	0	0	0	0.6	1013
30 August 2017	0	5.7	14.5	0	0	0	1.7	1013
6 September 2017	0	5.6	14.7	0	0	0	0.7	1020
13 September 2017	0	5.5	15.1	0	0	0	0.5	999

Notes to table

1. *Carbon Dioxide, Methane and Carbon Monoxide shown as maximum result*
2. *Oxygen shown as lowest result*
3. *VOC = Volatile Organic Compounds*

[11] Wilson S, Oliver s, Mallett H, Hutchings H and Card G. 2007. Assessing risks posed by hazardous ground gases to buildings. CIRIA Report 665.

[12] Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights", Report 10627-R01-(02) for NHBC 2006 Boyle, R and Witherington, P

Table 11: Summary of land gas monitoring results in WS2

Monitoring Date	WS2							
	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (%)	H_2S (%)	Flow rate (l/hr)	VOC	Atmospheric Pressure (hPa)
9 August 2017	0	7.9	11.4	0	0	0	0	1015
17 August 2017	0	8.2	10.9	0	0	0	0	1011
23 August 2017	0	7.9	11.6	0	0	0	0.1	1013
30 August 2017	0	7.9	11.5	0	0	0	0	1013
6 September 2017	0	8.1	11.2	0	0	0	0.3	1020
13 September 2017	0	8.3	10.8	0	0	0	0.1	999

Notes to table

1. *Carbon Dioxide, Methane and Carbon Monoxide shown as maximum result*
2. *Oxygen shown as lowest result*
3. *VOC = Volatile Organic Compounds (Peak Result Recorded)*

Table 12: Summary of land gas monitoring results in WS3

Monitoring Date	WS3							
	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (%)	H_2S (%)	Flow rate (l/hr)	VOC	Atmospheric Pressure (hPa)
9 August 2017	0	6.0	13.9	0	0	0	0	1015
17 August 2017	0	5.7	14.1	0	0	0	0.3	1011
23 August 2017	0	6.0	14.2	0	0	0	0.3	1013
30 August 2017	0	6.0	14.2	0	0	0	0.2	1013
6 September 2017	0	5.6	14.5	0	0	0	0.3	1020
13 September 2017	0	6.1	13.9	0	0	0	0.2	999

Notes to table

1. *Carbon Dioxide, Methane and Carbon Monoxide shown as maximum result*
2. *Oxygen shown as lowest result*
3. *VOC = Volatile Organic Compounds*

22.1 Summary of Gas Conditions Within Landfill

The gas monitoring data indicates that the concentrations of methane, carbon monoxide and hydrogen sulphide were all below the limit of detection. The highest concentrations of carbon dioxide were identified in WS2 at 8.3%. Concentrations of oxygen were low within each borehole and the lowest recorded concentration was 10.8%.

Flow rates within the landfill have been below detection and no significant changes were noted across the differing atmospheric pressure differences. In addition, the concentrations of gases were broadly consistent over the monitoring rounds. Some minor fluctuations were noted within the groundwater levels.

23 Gas Risk Assessment

The gas screening value is calculated using the measured ground gas concentration expressed as a percentage by volume of each hazardous ground gas being considered i.e. methane and carbon dioxide, and the measured borehole flow rate i.e. the volume of total gas flow (of all gases present) being emitted from the monitoring point (q) expressed in litres per hour.

The maximum concentrations should be used unless the use of lower values can be justified together with the steady state values of gas flows.

The borehole gas flow rate Q_{hg} (in L/hr) can be calculated for each monitoring location using the following equation:

$$Q_{hg} = \mathrm{q}\left(\frac{C_{hg}}{100}\right)$$

Where:

q is the measured flow rate (in litres per hour) of combined gases from the monitoring standpipe.

C_{hg} is the measured hazardous gas concentration (in percentage volume/volume)

Adopting this method and assuming a gas flow rate of 0.1l/hr (the detection limit of the monitoring equipment) and the maximum recorded concentrations of gases (8.3% for CO_2 and 0.3% the limit of detection for methane), GSVs have been calculated for a worst-case scenario for both methane and carbon dioxide for the site. These are presented in Table 12.

Table 13: Calculated Gas Screening Values

	Carbon Dioxide (l/hr)	Methane (l/hr)
Gas Screening Value	0.83	0.03

Note to Table:

In calculating these gas screening values, a maximum flow rate of 0.1l/hr has been assumed (the detection limit of the equipment used by LEAP).

23.1 Characteristic Situation (CS)

The Gas Screening Values can then be compared to those presented in BS8485. The following table outlines the Characteristic Situation different GSVs fall into.

Table 14. CS by Site Characteristic GSV

Characteristic Situation (CS)	Hazard Potential	Site Characteristic GSV (Methane or Carbon Dioxide)	Additional Factors
CS1	Very low	<0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	0.07 to <0.7	Typical measured flow rate <70 L/hr (otherwise consider an increase to CS3)
CS3	Moderate	0.7 to <3.5	-
CS4	Moderate to high	3.5 to <15	-
CS5	High	15 to <70	-
CS6	Very high	>70	-

Note to table:

- *Table is based on Table 2 BS8485:2015.*

Adopting the modified Card and Wilson classification system as set out in CIRIA 665 then the gas regime would be classified as Characteristic Situation 3 based on the GSV for Carbon Dioxide.

TOC analysis has shown the fill material to have a range of levels of organic carbon. The logs indicate that some waste included ash, which would result in an elevated TOC but is not readily degradable.

24 Recommendations for Gas Protection Measures

The results of the assessment suggest that the area of the proposed café falls within a CS3. BS8485 sets out various categories of building type which need to be selected in order to determine appropriate gas protection measures. This is because potential risks posed by ground gases are strongly influenced by the construction of the building, control of future structural changes and the buildings management.

The approach in BS8485 outlines four building types (A-D). The café development at Cheney Row is considered likely to be classed as a Type B development – private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management of the maintenance of the building, including the gas protection measures. Single occupancy of ground floor and basement areas. Small to medium size rooms with passive ventilation of rooms and other internal spaces. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings. The Type B development is considered the most suitable for

the Café at Cheney Row as it is a retail unit with small rooms, that is likely to remain in the control of the Local Authority.

The building type is then allocated a Gas Protection Score based on the Characteristic Situation identified in the previous step. A building type B at a CS3 site requires a Gas Protection Score of 4 points.

BS8485 sets out various mechanisms to gain point using a combination of floor slab detail, gas membrane, sub floor ventilation and other mechanisms. In accordance with this standard one combination of measures which would likely be considered suitable to obtain a score of 4 points would be to install a cast in situ monolithic floor slab, a passive dispersal layer, and a gas resistant membrane:

- Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (Score of 1)
- Passive Dispersal Layer with a good performance (Score of 1.5)
- Gas Resistant Membrane (Score of 2)

25 Summary and Recommendations

Preliminary intrusive investigations at Cheney Row have excavated boreholes and installed monitoring wells to facilitate the construction of a café on the historic landfill. As such a Gas Risk Assessment was required to characterise the waste within the landfill and to carry out gas monitoring to determine the risk to the proposed development and future users of the site.

Gas monitoring to date has identified moderate concentrations of carbon dioxide up to 8.3%, although flow rates are low. The results of this monitoring showed that the soils are producing ground gases and that the area of the site where these soils are present should be classified as being Characteristic Situation 3 (CS3).

The proposed development would be considered a Type B building in accordance with BS8485 and therefore requires gas protection measures providing a gas protection score of 4 or more. One combination of protective measures which would achieve this comprises a monolithic floor slab, passive dispersal layer and gas resistant membrane. Alternative protective measures in accordance with BS8485 would be equally acceptable.

F CONCLUSIONS AND RECOMMENDATIONS

An investigation was carried out on the land off Cheney Row, Walthamstow to determine the risks from the site to the proposed development and future site users. This report summarises findings from both this investigation and the previous 2 site investigations from AMEC 2007 and Carpenter and Lowe 1990.

LEAP carried out an intrusive investigation with 23 positions across the site. 3 boreholes were excavated using a windowless sampler rig to install gas monitoring wells within the landfilled material in order to carry out a gas risk assessment, and 20 pits were excavated by hand to log soils within the capping soils and landfill and collect samples for geochemical testing.

The geochemical testing identified hotspots of elevated concentrations of various contaminants, of which Lead, the PAH compound Benzo(a)Pyrene and asbestos were found to exceed the selected assessment criteria within the Landfilled Material. The soils tested from the capping layer and natural soils beneath the landfill were free from contamination.

The contamination risk assessment indicates that there is a potentially significant risk to human health from the Made Ground soils beneath the site and suggests additional investigation could be carried out to determine the extent of hotspots at the site and suggest an appropriate remediation strategy. At this stage remediation could involve removal of the landfilled material and placement of clean soil, or placement of clean soil and geomembrane over the current site levels.

Gas monitoring was undertaken in the Windowless Sampler Boreholes (WS1, WS2 and WS3) over 6 visits between August and September 2017. The results identified concentrations of carbon dioxide up to 8.3% and low levels of Volatile Organic Compounds. The concentration of methane, hydrogen sulphide and carbon monoxide were below the limit of detection. The Total Organic Carbon and Gas Screening Values were used to determine the Characteristic Situation of the development. Due to the elevated carbon dioxide results the site sits within Characteristic Situation 3 (CS3). Considering the proposed development as a Type B building in accordance with BS8485, gas protection measures are required to produce a gas protection score of 4 or more. One combination of protective measures which would achieve this comprises a monolithic floor slab, passive dispersal layer and gas resistant membrane. Alternative protective measures in accordance with BS8485 would be equally acceptable.

APPENDIX A – LIMITATIONS

Limitations

LIMITATIONS

This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk. Unless explicitly agreed otherwise in writing, this report has been prepared under LEAP's standard terms and conditions, as included in the quotation for this works.

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The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted, and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

The extent of the exploratory holes, laboratory testing and monitoring undertaken may have been restricted due to a number of factors including accessibility, the presence of buried or overhead services, current development and site usage, timescales or clients specification. The exploratory holes only assess a small proportion of the site area with respect to the site as a whole, and as such may only provide an overall assessment of ground conditions on site. The presence of hotspots of undisclosed contamination or exceptional and unforeseen ground conditions cannot be discounted.

The presence of asbestos may be noted during the site walkover survey, intrusive investigations and/or from the results of contamination testing. However, this report does not constitute an asbestos survey. On this basis, the presence of asbestos on site cannot be discounted and a full asbestos survey should be undertaken.

APPENDIX B – FIGURES

Figures

N

Legend

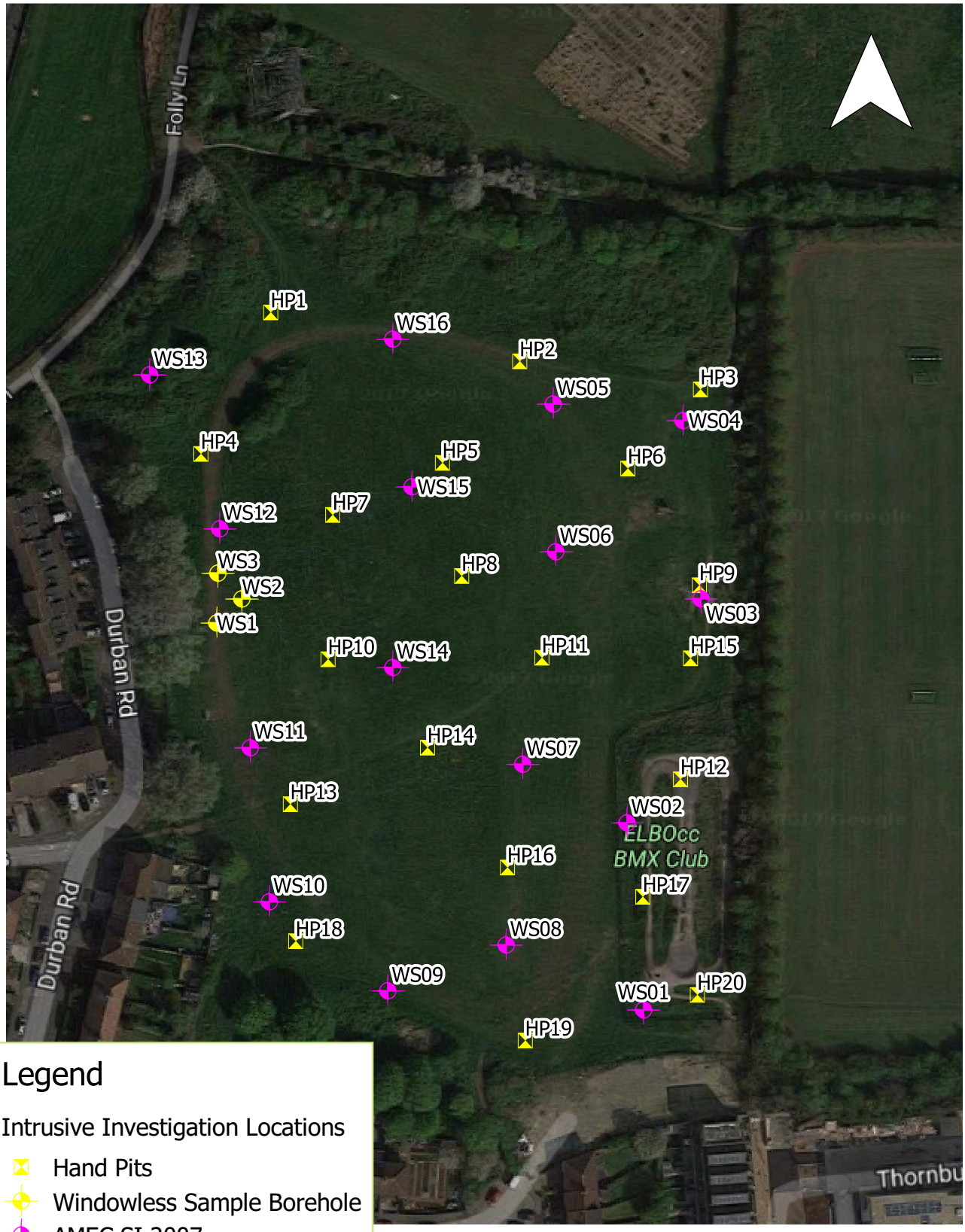
Site Boundary

Google Imagery 2017, Google Map data 2017.

leap environmental	**Client:**	We Made That LLP	**Date:**	12/09/2017	**Project ID:**	LP1428
	Project:	Cheney Row	**Title:**	Site Location Plan	**Fig. No.**	1

Proposed Development Drawing for Cheney Row produced by We Made That, Drawing Number 126 GA 1001, Dated 12/07/2017.

leap environmental	**Client:**	We Made That LLP	**Date:**	12/09/2017	**Project ID:**	LP1428
	Project:	Cheney Row	**Title:**	Proposed Site Layout	**Fig. No.**	2



Legend

Intrusive Investigation Locations

- Hand Pits
- Windowless Sample Borehole
- AMEC SI 2007

Google Imagery 2017, Google Map data 2017.

leap environmental	Client:	We Made That LLP	Title:	Intrusive Investigation Location Plan	Project ID: LP1428
	Project:	Cheney Row	Date:	12/09/2017	Figure No. 3

Legend

- Asbestos in Made Ground
- Sample Location

50m

Google Imagery 2017, Google Map data 2017.

leap environmental

Client:	We Made That LLP	Title:	Asbestos Hotspot	Project ID:	LP1428
Project:	Cheney Row	Date:	12/09/2017	Figure No.	4

Legend

Lead Heatmap

- Sample Location

50m

Google Imagery 2017, Google Map data 2017.

leap environmental	Client:	We Made That LLP	Title:	Lead Hotspot	Project ID:	LP1428
	Project:	Cheney Row	Date:	12/09/2017	Figure No.	5

Legend

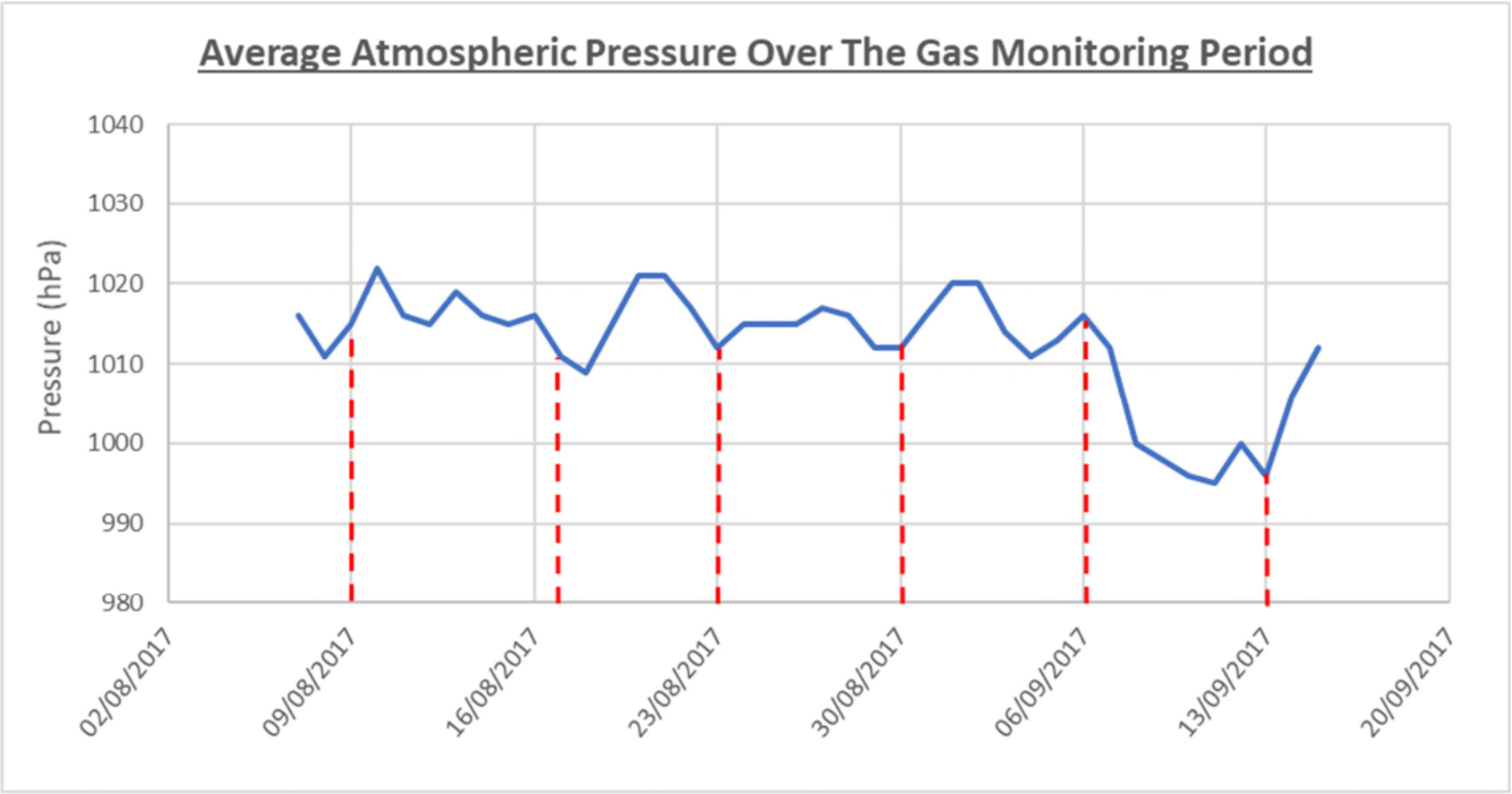
Benzo(a)Pyrene Heatmap

- Sample Location

50m

Google Imagery 2017, Google Map data 2017.

leap environmental	Client:	We Made That LLP	Title:	Benzo(a)Pyrene Hotspot	Project ID: LP1428
	Project:	Cheney Row	Date:	12/09/2017	Figure No. 6



Graph 1 – Record of the average daily measured atmospheric pressure from the closest weather station to the site: 'Walthamstow ILONDON866' (TheWeatherCompanyLLC, 2017). The blue line indicates the measured atmospheric pressure and the red dashed line indicates the site visit date.

APPENDIX C – SITE PHOTOGRAPHS

Site Photographs

Photo 1 – Gated site entrance and fly tipped material offsite.

Photo 2 – General site overview from the pedestrian gate (facing east).

Photo 3 – General site overview (facing southeast).

Photo 4 – View of site access area (facing south).

Photo 5 – Car Park south of the BMX Cycle Track.

Photo 6 – Material stockpiled in the Car Park.

Photo 7 – Photograph of the existing BMX track (facing north)

Photo 8 – Photograph of the arisings from WS1.

Photo 9 – Photograph of the arisings from WS2.

Photo 10 – Suspected Asbestos Cement.

Photo 11 – Photograph of the arisings from WS3.

Photo 12 – Photograph of the Clay beneath the Fill.

Photo 13 – Photograph of the arisings from HP1.

Photo 14 – Photograph of the arisings from HP2.

Photo 15 – Photograph of the arisings from HP3.

Photo 16 – Photograph of the arisings from HP5.

Photo 17 – Photograph of the arisings from HP13.

Photo 18 – Photograph of the arisings from HP15.

Photo 19 – Photograph of the arisings from HP17.

Photo – Photograph of the arisings from HP20.

APPENDIX D – TRIAL HOLE AND BOREHOLE LOGS

Trial Hole and
Borehole Logs

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Borehole Log

Borehole No.
WS1
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: -	Hole Type WS
Location: Walthon Forest		Level:	Scale 1:20
Client: We Made That		Dates: 22/08/2017 - 22/08/2017	Logged By CB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.05	ES		0.10			Grass over dark brown slightly clayey, slightly silty, medium-grained sandy TOPSOIL, with medium gravel angular clinker, abundant roots, and occasional glass.
		0.40	ES					MADE GROUND. Grey and black, fine to coarse, gravelly SAND with fine to coarse gravels of clinker, concrete and brick.
								ACM encountered at 0.5m.
					0.60			MADE GROUND. Brown and grey gravelly coarse SAND, with gravels of rounded to sub-rounded flint, angular brick and concrete and some glass.
		1.00		N=3 (1,1/1,0,1,1)				1
		1.50	ES					
		2.00		N=11 (1,1/2,2,3,4)				2
					2.10			Stiff orange, brown and blue silty CLAY, wth selenite crystals.
		2.60	ES					
		3.00		N=10 (1,2/2,2,3,3)				3
		4.00		N=9 (1,2/2,2,2,3)	4.00			End of borehole at 4.00 m 4

Remarks
Dry and stable, no groundwater encountered

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Borehole Log

Borehole No.
WS2
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: -	Hole Type WS
Location: Walthon Forest		Level:	Scale 1:20
Client: We Made That		Dates: 22/08/2017 - 22/08/2017	Logged By CB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.05	ES		0.10			Grass over dark brown slightly clayey, slightly silty medium-grained sandy TOPSOIL.
		0.50	ES					MADE GROUND. Black sandy gravel with wood, metal, clinker, glass and concrete cobbles.
								Brick encountered at 0.8m.
								Becoming Sandy from 0.9 to 1.3m.
		1.00		N=4 (1,1/1,1,1,1)				
		1.20	ES					
								Brick encountered at 1.5m.
		2.00		N=12 (2,3/3,3,3,3)				
					2.30			Firm to stiff dark brown slightly silty CLAY.
		3.00		N=10 (1,1/2,2,3,3)				
		4.00		N=11 (1,1/2,3,3,3)	4.00			End of borehole at 4.00 m

Remarks
Dry and stable, no groundwater encountered

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Borehole Log

Borehole No.
WS3
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: -	Hole Type WS
Location: Walthon Forest		Level:	Scale 1:20
Client: We Made That		Dates: 22/08/2017 - 22/08/2017	Logged By CB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.05	ES		0.10			Grass over dark brown slightly clayey, slightly silty medium-grained sandy TOPSOIL.
		0.30	ES					MADE GROUND. Sandy gravel, crumbly chalk powder, with brick, glass, clinker and concrete cobbles.
		1.00		N=5 (2,1/2,1,1,1)				
		2.00		N=14 (1,1/2,3,4,5)	2.10			MADE GROUND. Very soft, black grey brown red mottled clayey slightly GRAVEL with brick, chalk, clinker and concrete.
		2.50	ES		2.60			Firm to stiff, orange, brown and blue silty CLAY.
		3.00		N=8 (1,1/2,2,2,2)				
		4.00		N=8 (1,1/2,2,2,2)	4.00			End of borehole at 4.00 m

Remarks
Dry and stable, no groundwater encountered

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Trial Pit Log

Trialpit No
HP1
Sheet 1 of 1

Project Name:	Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location:	Walthon Forest	Dimensions (m): Depth 0.60	0.3 / 0.3	Scale 1:10
Client:	We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.01	ES					Grass over, brown silty sandy clayey TOPSOIL with rootlets.
				0.10			MADE GROUND. Brown sandy coarse GRAVEL of angular brick and concrete, with occasional fine clinker.
				0.60			End of pit at 0.60 m

1
2

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP2
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.60 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			MADE GROUND. Brown silty sandy TOPSOIL with rootlets. Occasional gravel of fine to coarse rounded flint with some plastic.
	0.20	ES					MADE GROUND. Brown gravelly CLAY. Gravels comprise fine to coarse slate, angular brick and sub-rounded flint. *Cobbles of brick and mortar encountered at 0.20m.* *Suspected ACM encountered at 0.20m.*
	0.45	ES		0.40			MADE GROUND. Black and brown gravelly SAND. Gravels comprise is fine to coarse clinker. Sand is fine to medium. *Sand is ashy.* *Occasional medium sized chalk gravel encountered between 0.50m and 0.6m.*
				0.60			End of pit at 0.60 m

Remarks: Trial pit remained dry.

Stability: Stable.

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Trial Pit Log

Trialpit No **HP3**
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.55 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			MADE GROUND. Brown silty sandy TOPSOIL with rootlets. Occasional gravel of fine to coarse angular brick.
							MADE GROUND. Orange brown slightly gravelly sandy CLAY. Gravels comprise fine to coarse sub-rounded flint, angular brick and clinker and occasional plastic.
				0.30			MADE GROUND. Pale brown and dark black-brown fine to medium slightly gravelly SAND. Gravels comprise fine to coarse brick, clinker, ash and rare glass.
	0.40	ES					*Sand is ashy.*
				0.50			MADE GROUND. Orange brown silty CLAY with occasional gravel of fine to coarse angular brick.
				0.55			End of pit at 0.55 m

Remarks: Trial pit remained dry.

Stability: Stable.

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Trial Pit Log

Trialpit No
HP4
Sheet 1 of 1

Project Name:	Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location:	Walthon Forest	Dimensions (m): Depth 0.60	0.3 / 0.3	Scale 1:10
Client:	We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.05	ES					Grass over, brown silty sandy clayey TOPSOIL with rootlets.
				0.20			MADE GROUND. Brown clayey sandy GRAVEL of fine to coarse angular brick.
				0.60			End of pit at 0.60 m

1
2

Remarks: Trial pit remained dry. No further progress past 0.60m, tarmac obstruction.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP5
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): 0.3 × 0.3, Depth 0.60	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			MADE GROUND. Brown silty clayey TOPSOIL with rootlets and occasional fine to medium gravel of angular brick and glass.
	0.50	ES					MADE GROUND. Pale orange brown fine to medium gravelly silty SAND. Gravels comprise fine to coarse cement, angular brick, slate, charcoal and rare glass with occasional cobble of brick. Some ash present.
				0.60			End of pit at 0.60 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP6
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.50 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			Grass over, black clayey sandy TOPSOIL with rootlets.
	0.20	ES					MADE GROUND. Black-brown fine to medium gravelly SAND. Gravels comprise fine to coarse clinker, angular brick, and occasional glass. *Sand is ashy.*
	0.40	ES		0.30			MADE GROUND. Light grey and black fine to coarse cobbly gravelly SAND. Gravels comprise fine to coarse angular brick, clinker, cement. Cobbles of whole brick and concrete. *White and grey ash encountered between 0.40m and 0.5m.*
				0.50			End of pit at 0.50 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No **HP7**
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.50 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	ES		0.15			Grass over, brown silty sandy clayey TOPSOIL with rootlets.
	0.40	ES		0.50			MADE GROUND. Brown and red fine to coarse very gravelly SAND. Gravels comprise fine to coarse angular brick, clinker and rare cement.
							End of pit at 0.50 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP8
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.50 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			Grass over, brown silty sandy clayey TOPSOIL with rootlets.
							MADE GROUND. Brown sandy fine to coarse GRAVEL of fine to coarse, sub-rounded flint and angular brick.
	0.50	ES		0.50			*Suspected ACM encountered at 0.50m.* End of pit at 0.50 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP9
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.60 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass over, brown silty sandy clayey TOPSOIL with rootlets and occasional medium to coarse gravel of rounded to sub-rounded flint.
	0.20	ES					MADE GROUND. Black and red, medium to coarse, sandy GRAVEL of angular brick and clinker, sub-rounded flint with occasional ash and glass.
	0.40	ES					*Becoming brown below 0.50m.*
	0.60	ES		0.60			End of pit at 0.60 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP10
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): 0.3 × 0.3, Depth 0.60	Scale 1:10
Client: We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.05	ES		0.10			Grass over, brown silty sandy clayey TOPSOIL with rootlets.
				0.60			MADE GROUND. Dark brown slightly gravelly SAND. Gravels comprise fine to coarse angular brick and concrete, fine angular clinker, with occasional pieces of metal and plastic.
							End of pit at 0.60 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP11
Sheet 1 of 1

Project Name:	Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location:	Walthon Forest	Dimensions (m): Depth 0.60	0.3 / 0.3	Scale 1:10
Client:	We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.05	ES		0.10			Grass over, brown silty sandy clayey TOPSOIL with rootlets.
				0.60			MADE GROUND. Brown slightly sandy GRAVEL of fine to coarse sub-rounded flint, fine clinker and fine to coarse angular brick.
							End of pit at 0.60 m

1
2

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP12
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): 0.3 × 0.3, Depth 0.65	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Grass over, brown clayey sandy TOPSOIL with rootlets.
				0.10			MADE GROUND. Pale orange brown sandy gravelly SILT. Gravels comprise fine to coarse sub-rounded flint and occasional angular brick.
				0.15			MADE GROUND. Brown-black fine to medium gravelly silty slightly clayey SAND. Gravels comprise fine to coarse clinker, concrete, brick, glass, with occasional cobbles of clinker.
	0.35	ES					*Sand is ashy.*
				0.65			End of pit at 0.65 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP13
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.75 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			Grass over, brown clayey sandy TOPSOIL with rootlets.
	0.15	ES					MADE GROUND. Brown slightly gravelly sandy CLAY. Gravels comprise fine to coarse angular brick, flint, clinker and cement.
							Brick encountered at 0.20m.
				0.30			MADE GROUND. Dark orange and brown, very gravelly SAND. Gravels comprise fine to coarse angular brick, mortar, flint, clinker, chalk and slate.
	0.50	ES					*Two rusted nails encountered at 0.50m.*
				0.75			End of pit at 0.75 m

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP14
Sheet 1 of 1

Project Name:	Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location:	Walthon Forest	Dimensions (m): Depth 0.50	0.3 / 0.3	Scale 1:10
Client:	We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass over, brown silty sandy clayey TOPSOIL with rootlets.
				0.50			MADE GROUND. Brown slightly gravelly CLAY. Gravels comprise fine to coarse angular brick.
							End of pit at 0.50 m

1
2

Remarks: Trial pit remained dry.

Stability: Unstable.

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Trial Pit Log

Trialpit No
HP15
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.65 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			Grass over, brown clayey sandy TOPSOIL with rootlets.
				0.20			MADE GROUND. Brown sandy very gravelly CLAY. Gravels comprise fine to coarse sub-rounded flint, angular brick and occasional concrete cobbles.
	0.35	ES					MADE GROUND. Brown and red sandy, very gravelly CLAY. Gravels comprise fine to coarse angular brick, sub-rounded flint, cement, angular clinker and coal, with occasional cobbles of flint and brick. *Becoming less cobbly below 0.40m.*
	0.65	ES		0.60			MADE GROUND. Dark grey brown fine silty SAND.
				0.65			*Suspected ACM at 0.65m.* End of pit at 0.65 m

Remarks: Trial pit remained dry.

Stability: Stable.

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Trial Pit Log

Trialpit No
HP16
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): 0.3 × 0.3, Depth 0.50	Scale 1:10
Client: We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass over, brown silty sandy clayey TOPSOIL with rootlets.
	0.20	ES					MADE GROUND. Dark brown sandy gravelly CLAY of angular brick and concrete, with occasional fine chalk.
	0.30	ES					
				0.50			End of pit at 0.50 m

Remarks: Trial pit remained dry.

Stability: Unstable.

AGS

Leap Environmental Ltd
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Trial Pit Log

Trialpit No
HP17
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 0.75 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.05			Grass over, brown clayey sandy TOPSOIL with rootlets.
	0.20	ES					MADE GROUND. Brown very gravelly sandy CLAY. Gravels comprise fine to coarse sub-rounded flint, rare angular brick and rare glass.
				0.30			MADE GROUND. Orange brown fine to coarse clayey gravelly SAND. Gravels comprise fine to coarse flint, rare ash and fine brick.
				0.45			MADE GROUND. Orange brown very sandy gravelly CLAY. Gravels comprise fine to coarse flint, occasional brick and ash.
	0.65	ES					*Becoming pale brown below 0.60m.*
				0.75			End of pit at 0.75 m

Remarks: Trial pit remained dry.

Stability: Unstable.

AGS

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Trial Pit Log

Trialpit No
HP18
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): Depth 1.00 (0.3 × 0.3)	Scale 1:10
Client: We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Grass over, dark brown silty sandy clayey TOPSOIL with rootlets.
	0.20	ES		0.20			MADE GROUND: brown silty slightly gravelly CLAY. Gravels comprise medium angular brick.
	0.60	ES					
				1.00			End of pit at 1.00 m

Remarks: Trial pit remained dry.

Stability: Unstable.

AGS

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Trial Pit Log

Trialpit No
HP19
Sheet 1 of 1

Project Name:	Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location:	Walthon Forest	Dimensions (m): Depth 0.50	0.3 / 0.3	Scale 1:10
Client:	We Made That			Logged CB

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass over, dark brown silty sandy clayey TOPSOIL with rootlets.
	0.20	ES					MADE GROUND. Brown fine to coarse gravelly SAND. Gravels comprise fine to coarse angular concrete and brick, sub-rounded flint, with occasional clinker and metal.
				0.50			End of pit at 0.50 m

1
2

Remarks: Trial pit remained dry.

Stability: Unstable.

AGS

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Trial Pit Log

Trialpit No
HP20
Sheet 1 of 1

Project Name: Cheney Row, Waltham Forest	Project No. LP1428	Co-ords: - Level:	Date 02/08/2017
Location: Walthon Forest		Dimensions (m): 0.3 × 0.3, Depth 0.60	Scale 1:10
Client: We Made That			Logged SM

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.40	ES		0.60			MADE GROUND. Pink and grey, becoming brown, gravelly slightly clayey SAND. Gravels comprise fine to coarse angular concrete, sub-rounded flint, occasional angular brick, clinker, plastic, metal, with rare cobbles of concrete. *Becoming more cobbly below 0.40m.* End of pit at 0.60 m

Remarks: Trial pit remained dry.

Stability: Unstable.

AGS

APPENDIX E – CHEMICAL LABORATORY TEST RESULTS

Chemical Laboratory
Test Results

Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone: (01424) 718618
Facsimile: (01424) 729911
info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number:	17-13420
Issue:	2
Date of Issue:	14/09/2017
Contact:	Charlie Bruinvels
Customer Details:	Leap Environmental Ltd The Atrium Curtis Road Dorking SurreyRH4 1X4
Quotation No:	Q14-00063
Order No:	LPO6418
Customer Reference:	LP1428
Date Received:	04/08/2017
Date Approved:	14/09/2017
Details:	Cheney Row
Approved by:	

John Wilson, Operations Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683

Sample Summary

Report No.: 17-13420

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
108202	HP1 0.01	02/08/2017	07/08/2017	Silty loam	
108203	HP2 0.20	02/08/2017	13/09/2017	Silty loam	
108204	HP2 0.45	02/08/2017	07/08/2017		
108205	HP3 0.40	02/08/2017	07/08/2017	Sandy silty loam	
108206	HP4 0.05	02/08/2017	07/08/2017	Silty loam	
108207	HP5 0.50	02/08/2017	07/08/2017	Silty loam	
108208	HP6 0.20	02/08/2017	07/08/2017	Sandy silty loam	
108209	HP6 0.40	02/08/2017	07/08/2017		
108210	HP7 0.10	02/08/2017	07/08/2017	Silty loam	
108211	HP7 0.40	02/08/2017	07/08/2017		
108212	HP8 0.50	02/08/2017	13/09/2017	Silty loam	
108213	HP9 0.20	02/08/2017	07/08/2017	Sandy silty loam	
108214	HP9 0.40	02/08/2017	07/08/2017		
108215	HP9 0.60	02/08/2017	07/08/2017	Silty loam	
108216	HP10 0.05	02/08/2017	07/08/2017	Silty loam	
108217	HP11 0.05	02/08/2017	07/08/2017	Silty loam	
108218	HP12 0.35	02/08/2017	07/08/2017	Silty loam	
108219	HP13 0.15	02/08/2017	07/08/2017	Silty loam	
108220	HP13 0.50	02/08/2017	07/08/2017	Sandy silty loam	
108221	HP15 0.35	02/08/2017	07/08/2017	Silty loam	
108222	HP15 0.65	02/08/2017	13/09/2017		
108223	HP16 0.20	02/08/2017	07/08/2017	Silty loam	
108224	HP16 0.30	02/08/2017	07/08/2017		
108225	HP17 0.20	02/08/2017	07/08/2017	Silty loam	
108226	HP17 0.65	02/08/2017	07/08/2017		
108227	HP18 0.20	02/08/2017	07/08/2017		
108228	HP18 0.60	02/08/2017	07/08/2017	Silty loam	
108229	HP19 0.20	02/08/2017	07/08/2017	Silty loam	
108230	HP20 0.40	02/08/2017	07/08/2017	Sandy silty loam	
108231	WS1 0.05	02/08/2017	07/08/2017	Silty loam	
108232	WS1 0.40	02/08/2017	13/09/2017	Silty loam	
108233	WS1 1.50	02/08/2017	07/08/2017	Silty loam	
108234	WS1 2.60	02/08/2017	07/08/2017		
108235	WS2 0.05	02/08/2017	07/08/2017	Silty loam	
108236	WS2 0.50	02/08/2017	07/08/2017	Silty loam	
108237	WS2 1.20	02/08/2017	07/08/2017	Sandy silty loam	
108238	WS3 0.05	02/08/2017	07/08/2017	Silty loam	
108239	WS3 0.30	02/08/2017	07/08/2017	Silty loam	
108240	WS3 2.50	02/08/2017	07/08/2017	Silty loam	

Results Summary

Report No.: 17-13420

			ELAB Reference	108202	108203	108205	108206	108207	108208
			Customer Reference						
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	HP1	HP2	HP3	HP4	HP5	HP6
			Sample Depth (m)	0.01	0.20	0.40	0.05	0.50	0.20
			Sampling Date	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017
Determinand	**Codes**	**Units**	**LOD**						
Metals									
Arsenic	M	mg/kg	1	21.9	34.6	20.5	16.8	25.5	28.6
Cadmium	M	mg/kg	0.5	1.5	4.2	0.8	0.9	1.2	0.7
Chromium	M	mg/kg	5	59.0	66.4	23.6	55.5	41.0	24.6
Copper	M	mg/kg	5	114	1390	155	105	277	179
Lead	M	mg/kg	5	306	677	367	283	828	145
Mercury	M	mg/kg	0.5	1.8	2.6	< 0.5	0.5	0.6	< 0.5
Nickel	M	mg/kg	5	42.6	76.3	57.5	29.0	53.0	66.0
Selenium	M	mg/kg	1	2.1	2.1	1.1	1.7	1.1	2.0
Zinc	M	mg/kg	5	414	2010	283	290	1000	155
Anions									
Water Soluble Sulphate	M	g/l	0.02	0.05	0.05	0.16	0.08	0.06	0.05
Inorganics									
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Total Sulphide	N	mg/kg	2	< 2	< 2	< 2	< 2	< 2	< 2
Total Cyanide	M	mg/kg	1	< 1.0	2.0	3.8	2.4	9.0	4.8
Miscellaneous									
pH	M	pH units	0.1	7.6	7.7	9.3	6.9	9.4	7.5
Total Organic Carbon	N	%	0.01	17	4.1	9.7	6.3	2.8	32
Phenols									
Phenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
M,P-Cresol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
O-Cresol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
3,4-Dimethylphenol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
2,3-Dimethylphenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
2,3,5-trimethylphenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons									
Naphthalene	M	mg/kg	0.1	< 0.1	0.2	0.2	0.1	2.2	0.1
Acenaphthylene	M	mg/kg	0.1	0.1	0.3	< 0.1	0.7	0.9	< 0.1
Acenaphthene	M	mg/kg	0.1	0.2	0.4	0.2	0.2	2.6	0.2
Fluorene	M	mg/kg	0.1	< 0.1	0.3	0.1	0.4	1.9	0.2
Phenanthrene	M	mg/kg	0.1	1.2	4.1	2.3	6.5	18.6	0.8
Anthracene	M	mg/kg	0.1	0.3	1.0	0.6	1.6	3.3	0.2
Fluoranthene	M	mg/kg	0.1	3.2	8.1	4.5	12.2	23.4	1.5
Pyrene	M	mg/kg	0.1	2.9	7.2	4.0	10.3	19.5	1.4
Benzo(a)anthracene	M	mg/kg	0.1	1.8	4.1	2.4	6.2	10.9	0.8
Chrysene	M	mg/kg	0.1	2.1	4.7	2.9	6.5	12.6	1.1
Benzo (b) fluoranthene	M	mg/kg	0.1	2.0	4.1	2.5	5.4	9.8	1.0
Benzo(k)fluoranthene	M	mg/kg	0.1	2.2	4.2	2.7	5.5	10.3	1.0
Benzo (a) pyrene	M	mg/kg	0.1	2.1	4.5	2.7	6.1	11.2	1.0
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	1.9	3.5	2.3	4.3	8.1	0.8
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.5	0.9	0.6	1.2	2.2	0.3
Benzo[g,h,i]perylene	M	mg/kg	0.1	1.6	3.2	2.2	3.8	7.5	1.1
Total PAH(16)	M	mg/kg	0.4	22.4	50.7	30.3	70.9	145	11.6

Results Summary

Report No.: 17-13420

			ELAB Reference	108210	108212	108213	108215	108216	108217
			Customer Reference						
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	HP7	HP8	HP9	HP9	HP10	HP11
			Sample Depth (m)	0.10	0.50	0.20	0.60	0.05	0.05
			Sampling Date	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017
Determinand	**Codes**	**Units**	**LOD**						
Metals									
Arsenic	M	mg/kg	1	12.3	15.5	31.8	49.4	40.0	18.9
Cadmium	M	mg/kg	0.5	0.7	< 0.5	1.1	3.4	1.5	1.6
Chromium	M	mg/kg	5	23.1	33.5	41.1	108	113	48.5
Copper	M	mg/kg	5	56.6	86.0	419	6960	1270	532
Lead	M	mg/kg	5	215	196	311	1780	567	393
Mercury	M	mg/kg	0.5	< 0.5	< 0.5	0.9	1.7	0.7	0.6
Nickel	M	mg/kg	5	18.3	28.6	95.0	219	197	67.2
Selenium	M	mg/kg	1	1.2	1.0	2.0	< 1.0	1.7	1.7
Zinc	M	mg/kg	5	268	205	219	2290	469	1970
Anions									
Water Soluble Sulphate	M	g/l	0.02	0.05	0.07	0.06	0.04	0.07	0.04
Inorganics									
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Total Sulphide	N	mg/kg	2	< 2	< 2	< 2	< 2	< 2	< 2
Total Cyanide	M	mg/kg	1	2.0	1.3	2.5	2.7	2.4	2.3
Miscellaneous									
pH	M	pH units	0.1	6.2	8.3	7.9	8.2	6.2	6.8
Total Organic Carbon	N	%	0.01	3.8	1.5	12	6.2	6.1	4.9
Phenols									
Phenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
M,P-Cresol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
O-Cresol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
3,4-Dimethylphenol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
2,3-Dimethylphenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
2,3,5-trimethylphenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons									
Naphthalene	M	mg/kg	0.1	< 0.1	< 0.1	0.3	10.5	0.1	< 0.1
Acenaphthylene	M	mg/kg	0.1	< 0.1	< 0.1	0.3	1.4	1.3	0.1
Acenaphthene	M	mg/kg	0.1	0.1	< 0.1	0.1	15.3	0.2	< 0.1
Fluorene	M	mg/kg	0.1	< 0.1	< 0.1	< 0.1	12.5	0.5	< 0.1
Phenanthrene	M	mg/kg	0.1	1.5	1.2	1.4	166	6.9	0.5
Anthracene	M	mg/kg	0.1	0.4	0.3	0.4	30.5	2.6	0.1
Fluoranthene	M	mg/kg	0.1	4.0	2.9	4.5	174	19.6	2.1
Pyrene	M	mg/kg	0.1	3.6	2.6	4.0	151	16.3	1.8
Benzo(a)anthracene	M	mg/kg	0.1	2.1	1.5	3.2	67.5	8.2	1.2
Chrysene	M	mg/kg	0.1	2.5	2.0	4.2	76.9	9.6	1.7
Benzo (b) fluoranthene	M	mg/kg	0.1	2.2	1.6	4.1	63.8	7.7	1.5
Benzo(k)fluoranthene	M	mg/kg	0.1	3.0	1.7	3.7	49.6	8.0	2.0
Benzo (a) pyrene	M	mg/kg	0.1	2.4	1.6	4.0	68.0	8.9	1.7
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	1.8	1.4	3.3	54.0	7.5	2.5
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.7	0.5	0.9	12.4	3.1	0.8
Benzo[g,h,i]perylene	M	mg/kg	0.1	1.7	1.2	2.7	47.2	4.4	0.7
Total PAH(16)	M	mg/kg	0.4	26.1	18.8	37.4	1000	105	17.0

Results Summary

Report No.: 17-13420

	ELAB Reference	108218	108219	108220	108221	108223	108225
	Customer Reference						
	Sample ID						
	Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Sample Location	HP12	HP13	HP13	HP15	HP16	HP17
	Sample Depth (m)	0.35	0.15	0.50	0.35	0.20	0.20
	Sampling Date	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017
Determinand	**Codes** / **Units** / **LOD**						
Metals							
Arsenic	M / mg/kg / 1	43.9	24.6	34.6	19.1	27.3	12.9
Cadmium	M / mg/kg / 0.5	0.7	1.2	0.9	0.6	2.1	< 0.5
Chromium	M / mg/kg / 5	32.7	50.3	41.0	43.5	64.1	36.2
Copper	M / mg/kg / 5	224	157	424	106	747	36.8
Lead	M / mg/kg / 5	114	564	2170	510	704	77.2
Mercury	M / mg/kg / 0.5	< 0.5	0.8	0.9	0.5	2.0	< 0.5
Nickel	M / mg/kg / 5	71.9	38.6	60.5	32.4	54.5	22.6
Selenium	M / mg/kg / 1	2.3	1.4	1.1	< 1.0	1.4	< 1.0
Zinc	M / mg/kg / 5	214	507	980	376	1520	101
Anions							
Water Soluble Sulphate	M / g/l / 0.02	0.07	0.05	0.11	0.07	0.06	0.05
Inorganics							
Hexavalent Chromium	N / mg/kg / 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Total Sulphide	N / mg/kg / 2	< 2	< 2	< 2	< 2	< 2	< 2
Total Cyanide	M / mg/kg / 1	11.2	1.6	2.1	6.1	1.6	2.7
Miscellaneous							
pH	M / pH units / 0.1	7.1	7.1	8.0	8.0	7.5	7.8
Total Organic Carbon	N / % / 0.01	24	3.9	11	2.0	6.0	0.54
Phenols							
Phenol	M / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
M,P-Cresol	N / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
O-Cresol	N / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
3,4-Dimethylphenol	N / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
2,3-Dimethylphenol	M / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
2,3,5-trimethylphenol	M / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
Total Monohydric Phenols	N / mg/kg / 5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons							
Naphthalene	M / mg/kg / 0.1	0.3	0.2	7.8	7.9	< 0.1	< 0.1
Acenaphthylene	M / mg/kg / 0.1	0.4	0.2	2.1	0.3	< 0.1	0.2
Acenaphthene	M / mg/kg / 0.1	0.4	0.6	27.5	6.8	0.2	< 0.1
Fluorene	M / mg/kg / 0.1	0.3	0.4	21.7	4.7	0.1	< 0.1
Phenanthrene	M / mg/kg / 0.1	5.5	3.8	194	34.6	1.2	1.3
Anthracene	M / mg/kg / 0.1	1.5	0.7	48.2	6.8	0.2	0.3
Fluoranthene	M / mg/kg / 0.1	11.3	6.7	186	33.7	2.2	2.8
Pyrene	M / mg/kg / 0.1	9.2	5.8	152	27.9	1.8	2.2
Benzo(a)anthracene	M / mg/kg / 0.1	5.6	3.4	73.3	15.3	1.1	1.3
Chrysene	M / mg/kg / 0.1	6.3	4.0	74.5	17.8	1.8	1.7
Benzo (b) fluoranthene	M / mg/kg / 0.1	5.2	3.5	58.9	13.9	1.2	1.2
Benzo(k)fluoranthene	M / mg/kg / 0.1	5.2	3.5	50.3	13.3	1.2	1.3
Benzo (a) pyrene	M / mg/kg / 0.1	5.3	3.9	65.2	16.1	1.8	1.2
Indeno (1,2,3-cd) pyrene	M / mg/kg / 0.1	4.2	3.5	44.8	13.0	2.5	1.6
Dibenzo(a,h)anthracene	M / mg/kg / 0.1	1.2	1.0	11.3	4.5	1.2	0.6
Benzo[g,h,i]perylene	M / mg/kg / 0.1	2.8	2.1	36.5	8.5	1.2	0.8
Total PAH(16)	M / mg/kg / 0.4	64.4	43.1	1050	225	17.9	16.7

Tests marked N are not UKAS accredited.

Results Summary

Report No.: 17-13420

	ELAB Reference	108228	108229	108230	108231	108232	108233
	Customer Reference						
	Sample ID						
	Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Sample Location	HP18	HP19	HP20	WS1	WS1	WS1
	Sample Depth (m)	0.60	0.20	0.40	0.05	0.40	1.50
	Sampling Date	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017
Determinand	**Codes** / **Units** / **LOD**						
Metals							
Arsenic	M / mg/kg / 1	34.8	24.5	9.9	16.6	28.5	26.5
Cadmium	M / mg/kg / 0.5	9.8	1.2	0.6	1.2	1.8	0.6
Chromium	M / mg/kg / 5	73.3	55.6	21.9	45.3	54.9	30.7
Copper	M / mg/kg / 5	123	126	25.9	123	367	245
Lead	M / mg/kg / 5	692	354	123	387	1050	808
Mercury	M / mg/kg / 0.5	0.7	0.7	< 0.5	0.7	0.9	0.7
Nickel	M / mg/kg / 5	59.6	68.7	16.2	30.1	91.0	35.0
Selenium	M / mg/kg / 1	1.5	1.6	< 1.0	1.5	2.5	< 1.0
Zinc	M / mg/kg / 5	2250	384	143	388	820	654
Anions							
Water Soluble Sulphate	M / g/l / 0.02	0.08	0.04	0.46	0.15	0.14	1.44
Inorganics							
Hexavalent Chromium	N / mg/kg / 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Total Sulphide	N / mg/kg / 2	< 2	< 2	3	< 2	< 2	< 2
Total Cyanide	M / mg/kg / 1	1.4	1.0	< 1.0	3.4	1.4	1.1
Miscellaneous							
pH	M / pH units / 0.1	7.9	7.9	11.3	7.7	8.3	7.9
Total Organic Carbon	N / % / 0.01	1.2	2.7	0.45	7.2	13	3.1
Phenols							
Phenol	M / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
M,P-Cresol	N / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
O-Cresol	N / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
3,4-Dimethylphenol	N / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
2,3-Dimethylphenol	M / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
2,3,5-trimethylphenol	M / mg/kg / 1	< 1	< 1	< 1	< 1	< 1	< 1
Total Monohydric Phenols	N / mg/kg / 5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons							
Naphthalene	M / mg/kg / 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	0.2
Acenaphthylene	M / mg/kg / 0.1	< 0.1	0.1	0.1	< 0.1	0.1	0.2
Acenaphthene	M / mg/kg / 0.1	< 0.1	< 0.1	0.1	< 0.1	0.2	0.1
Fluorene	M / mg/kg / 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.1
Phenanthrene	M / mg/kg / 0.1	< 0.1	1.2	0.8	0.7	1.7	1.7
Anthracene	M / mg/kg / 0.1	< 0.1	0.3	0.3	0.2	0.3	0.3
Fluoranthene	M / mg/kg / 0.1	0.1	3.0	1.6	2.0	3.8	2.6
Pyrene	M / mg/kg / 0.1	0.1	2.5	1.8	1.9	3.1	2.2
Benzo(a)anthracene	M / mg/kg / 0.1	< 0.1	1.5	1.0	1.0	1.8	1.1
Chrysene	M / mg/kg / 0.1	0.5	2.1	1.4	1.3	2.1	1.4
Benzo (b) fluoranthene	M / mg/kg / 0.1	< 0.1	1.6	1.2	1.1	1.9	1.1
Benzo(k)fluoranthene	M / mg/kg / 0.1	< 0.1	1.6	1.4	1.3	2.4	1.5
Benzo (a) pyrene	M / mg/kg / 0.1	0.2	1.7	1.3	1.2	2.0	1.4
Indeno (1,2,3-cd) pyrene	M / mg/kg / 0.1	< 0.1	1.5	1.3	1.3	2.2	1.4
Dibenzo(a,h)anthracene	M / mg/kg / 0.1	< 0.1	0.4	0.5	0.5	0.6	0.5
Benzo[g,h,i]perylene	M / mg/kg / 0.1	< 0.1	1.0	1.0	0.7	1.6	0.8
Total PAH(16)	M / mg/kg / 0.4	0.7	18.7	13.9	13.4	24.3	16.7

Tests marked N are not UKAS accredited.

Results Summary

Report No.: 17-13420

			ELAB Reference	108235	108236	108237	108238	108239	108240
			Customer Reference						
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	WS2	WS2	WS2	WS3	WS3	WS3
			Sample Depth (m)	0.05	0.50	1.20	0.05	0.30	2.50
			Sampling Date	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017	02/08/2017
Determinand	**Codes**	**Units**	**LOD**						
Metals									
Arsenic	M	mg/kg	1	21.7	102	15.0	19.7	21.7	20.4
Cadmium	M	mg/kg	0.5	3.4	45.4	1.2	1.5	0.7	< 0.5
Chromium	M	mg/kg	5	43.2	127	29.1	38.8	30.5	32.6
Copper	M	mg/kg	5	106	729	63.8	120	326	67.2
Lead	M	mg/kg	5	479	4830	419	387	1150	326
Mercury	M	mg/kg	0.5	0.7	2.7	< 0.5	0.5	< 0.5	1.0
Nickel	M	mg/kg	5	28.3	84.6	25.1	34.4	46.9	25.4
Selenium	M	mg/kg	1	1.3	1.5	< 1.0	1.4	< 1.0	< 1.0
Zinc	M	mg/kg	5	6340	92000	2670	768	595	176
Anions									
Water Soluble Sulphate	M	g/l	0.02	0.12	1.43	1.68	0.56	0.06	0.46
Inorganics									
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Total Sulphide	N	mg/kg	2	3	< 2	< 2	< 2	< 2	9
Total Cyanide	M	mg/kg	1	3.7	3.6	1.2	2.4	1.9	1.1
Miscellaneous									
pH	M	pH units	0.1	6.5	6.9	8.5	7.2	11.9	8.4
Total Organic Carbon	N	%	0.01	4.9	8.0	0.81	7.3	6.3	1.9
Phenols									
Phenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
M,P-Cresol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
O-Cresol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
3,4-Dimethylphenol	N	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
2,3-Dimethylphenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
2,3,5-trimethylphenol	M	mg/kg	1	< 1	< 1	< 1	< 1	< 1	< 1
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons									
Naphthalene	M	mg/kg	0.1	< 0.1	0.4	< 0.1	< 0.1	0.1	< 0.1
Acenaphthylene	M	mg/kg	0.1	0.1	2.9	0.2	0.1	0.2	< 0.1
Acenaphthene	M	mg/kg	0.1	< 0.1	0.7	< 0.1	0.1	0.2	< 0.1
Fluorene	M	mg/kg	0.1	< 0.1	0.8	< 0.1	< 0.1	0.1	< 0.1
Phenanthrene	M	mg/kg	0.1	0.8	21.9	0.4	1.5	2.1	0.1
Anthracene	M	mg/kg	0.1	0.2	8.3	0.1	0.3	0.5	< 0.1
Fluoranthene	M	mg/kg	0.1	2.4	52.2	1.9	3.4	5.3	0.3
Pyrene	M	mg/kg	0.1	2.1	41.0	2.1	2.9	4.6	0.2
Benzo(a)anthracene	M	mg/kg	0.1	1.2	26.6	1.1	1.6	2.6	0.2
Chrysene	M	mg/kg	0.1	1.5	26.4	2.0	2.2	3.2	0.2
Benzo (b) fluoranthene	M	mg/kg	0.1	1.7	23.6	2.1	1.9	2.7	0.3
Benzo(k)fluoranthene	M	mg/kg	0.1	1.8	22.0	1.8	1.8	2.7	0.3
Benzo (a) pyrene	M	mg/kg	0.1	1.5	24.5	2.1	1.8	2.9	0.2
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	1.8	17.8	3.5	1.1	2.6	0.2
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.4	5.0	1.3	0.5	0.6	0.1
Benzo[g,h,i]perylene	M	mg/kg	0.1	0.9	12.9	1.7	1.6	2.7	0.1
Total PAH(16)	M	mg/kg	0.4	16.6	287	20.6	20.9	33.2	2.4

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2683

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Results Summary

Report No.: 17-13420

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #)
in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
108202	0.01	HP1	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
108203	0.20	HP2	Brown soil with stones and clinker	Chrysotile (Cement)	1.29	Cement (1.288)	< 0.001	1.29
108205	0.40	HP3	Brown soil with stones,clinker,glass	No asbestos detected	n/t	n/t	n/t	n/t
108206	0.05	HP4	Brown soil with stones,clinker,brick	No asbestos detected	n/t	n/t	n/t	n/t
108207	0.50	HP5	Brown soil with stones,brick,clinker,slate	No asbestos detected	n/t	n/t	n/t	n/t
108208	0.20	HP6	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108210	0.10	HP7	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108212	0.50	HP8	Brown soil with stones and brick	Chrysotile (Cement pieces)	2.23	Cement (2.234)	< 0.001	2.23
108213	0.20	HP9	Brown/black soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108215	0.60	HP9	Brown sandy soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
108216	0.05	HP10	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108217	0.05	HP11	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108218	0.35	HP12	Brown/black soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108219	0.15	HP13	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108220	0.50	HP13	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
108221	0.35	HP15	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
108222	0.65	HP15	Brown soil with stones	Chrysotile (Cement)	13.4	Cement (13.379)	< 0.001	13.4
108223	0.20	HP16	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
108225	0.20	HP17	Brown sandy soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
108228	0.60	HP18	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108229	0.20	HP19	Brown soil	No asbestos detected	n/t	n/t	n/t	n/t
108230	0.40	HP20	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t
108231	0.05	WS1	Brown soil with brick and stones	No asbestos detected	n/t	n/t	n/t	n/t
108232	0.40	WS1	Crushed clinker with stones	Chrysotile (Cement)	1.32	Cement Fragment (1.316)	< 0.001	1.32
108233	1.50	WS1	Brown sandy soil with slate,clinker,glass,concrete and stones	No asbestos detected	n/t	n/t	n/t	n/t
108235	0.05	WS2	Brown soil with pottery fragment	No asbestos detected	n/t	n/t	n/t	n/t
108236	0.50	WS2	Brown soil with stones and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108237	1.20	WS2	Brown sandy soil with brick and stones	No asbestos detected	n/t	n/t	n/t	n/t
108238	0.05	WS3	Brown soil and root	No asbestos detected	n/t	n/t	n/t	n/t
108239	0.30	WS3	Brown sandy soil with brick and clinker	No asbestos detected	n/t	n/t	n/t	n/t
108240	2.50	WS3	Brown soil with stones	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 17-13420

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Sulphide	N	As submitted sample	08/08/2017	109	Colorimetry
Hexavalent chromium	N	As submitted sample	08/08/2017	110	Colorimetry
pH	M	Air dried sample	09/08/2017	113	Electromeric
Aqua regia extractable metals	M	Air dried sample	08/08/2017	118	ICPMS
Phenols in solids	M	As submitted sample	08/08/2017	121	HPLC
PAH (GC-FID)	M	As submitted sample	08/08/2017	133	GC-FID
Water soluble anions	M	Air dried sample	09/08/2017	172	Ion Chromatography
Total cyanide	M	As submitted sample	09/08/2017	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	09/08/2017	210	IR
Asbestos identification	U	As submitted sample	09/08/2017	260	Microscopy

Tests marked N are not UKAS accredited

Report Information

Report No.: 17-13420

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C)
Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
PCB congener results may include any coeluting PCBs
Uncertainty of measurement for the determinands tested are available upon request

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

APPENDIX F – GAS MONITORING RESULTS

Gas Monitoring Results

Continuous Gas Monitoring Record

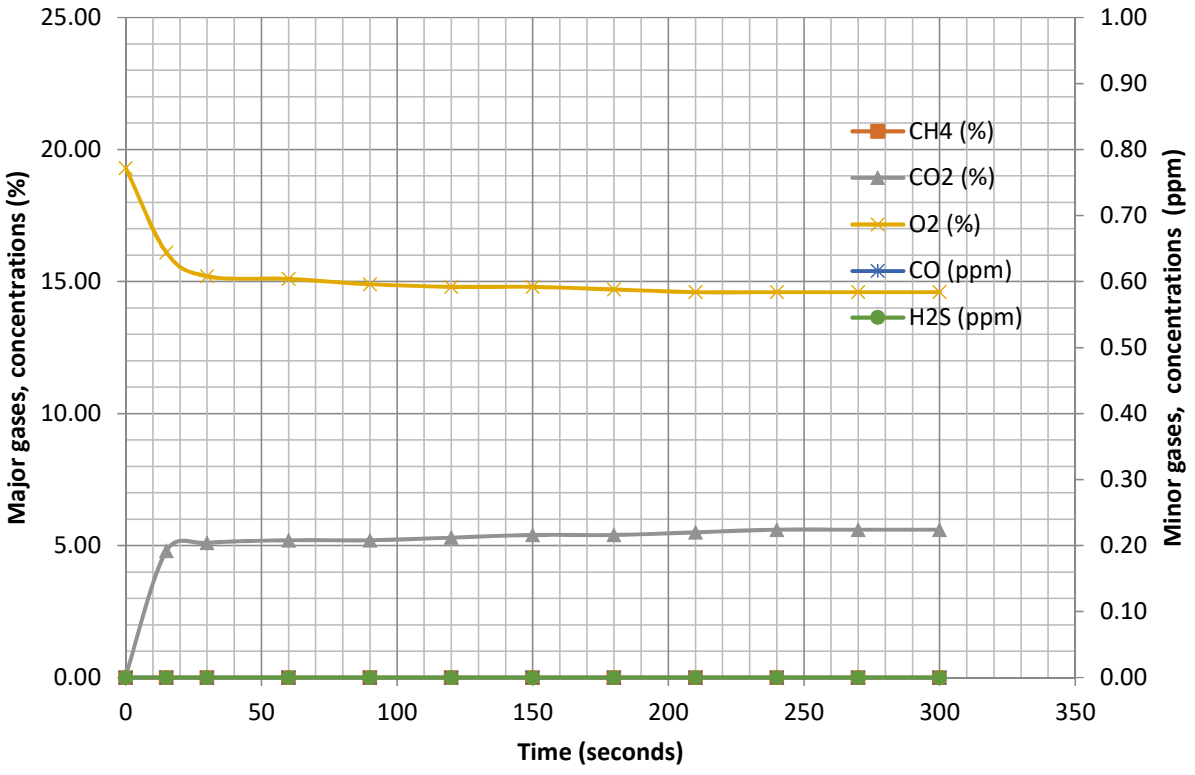
Date	09/08/2017	Engineer	SM
Project No	LP1428	Temp °C	
Site	Cheney Row	Ambient Pressure	1015

WS1

Hole ID

VOC peak (ppm)	0.20
VOC steady (ppm)	0.00
Borehole Depth (mbgl)	1.14
Water level (mbgl)	Dry
Borehole Pressure (mb)	0.00

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.00	0.00	0.10	19.30	0.00	0.00
00:15	0.00	0.00	4.80	16.10	0.00	0.00
00:30	0.00	0.00	5.10	15.20	0.00	0.00
01:00	0.00	0.00	5.20	15.10	0.00	0.00
01:30	0.00	0.00	5.20	14.90	0.00	0.00
02:00	0.00	0.00	5.30	14.80	0.00	0.00
02:30	0.00	0.00	5.40	14.80	0.00	0.00
03:00	0.00	0.00	5.40	14.70	0.00	0.00
03:30	0.00	0.00	5.50	14.60	0.00	0.00
04:00	0.00	0.00	5.60	14.60	0.00	0.00
04:30	0.00	0.00	5.60	14.60	0.00	0.00
05:00	0.00	0.00	5.60	14.60	0.00	0.00



Continuous Gas Monitoring Record

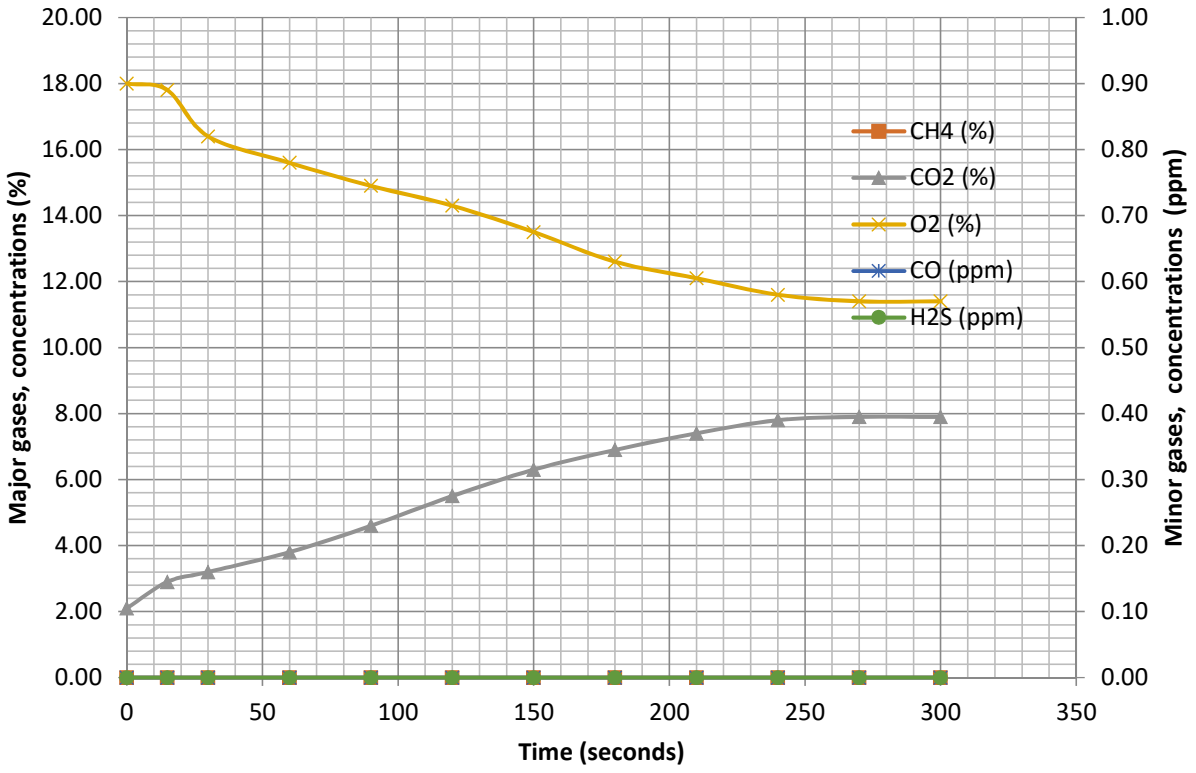
Date	09/08/2017	Engineer	SM
Project No	LP1428	Temp °C	
Site	Cheney Row	Ambient Pressure	1015

WS2

Hole ID

VOC peak (ppm)	0.00
VOC steady (ppm)	0.00
Borehole Depth (mbgl)	1.11
Water level (mbgl)	Dry
Borehole Pressure (mb)	0.00

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.00	0.00	2.10	18.00	0.00	0.00
00:15	0.00	0.00	2.90	17.80	0.00	0.00
00:30	0.00	0.00	3.20	16.40	0.00	0.00
01:00	0.00	0.00	3.80	15.60	0.00	0.00
01:30	0.00	0.00	4.60	14.90	0.00	0.00
02:00	0.00	0.00	5.50	14.30	0.00	0.00
02:30	0.00	0.00	6.30	13.50	0.00	0.00
03:00	0.00	0.00	6.90	12.60	0.00	0.00
03:30	0.00	0.00	7.40	12.10	0.00	0.00
04:00	0.00	0.00	7.80	11.60	0.00	0.00
04:30	0.00	0.00	7.90	11.40	0.00	0.00
05:00	0.00	0.00	7.90	11.40	0.00	0.00



Continuous Gas Monitoring Record

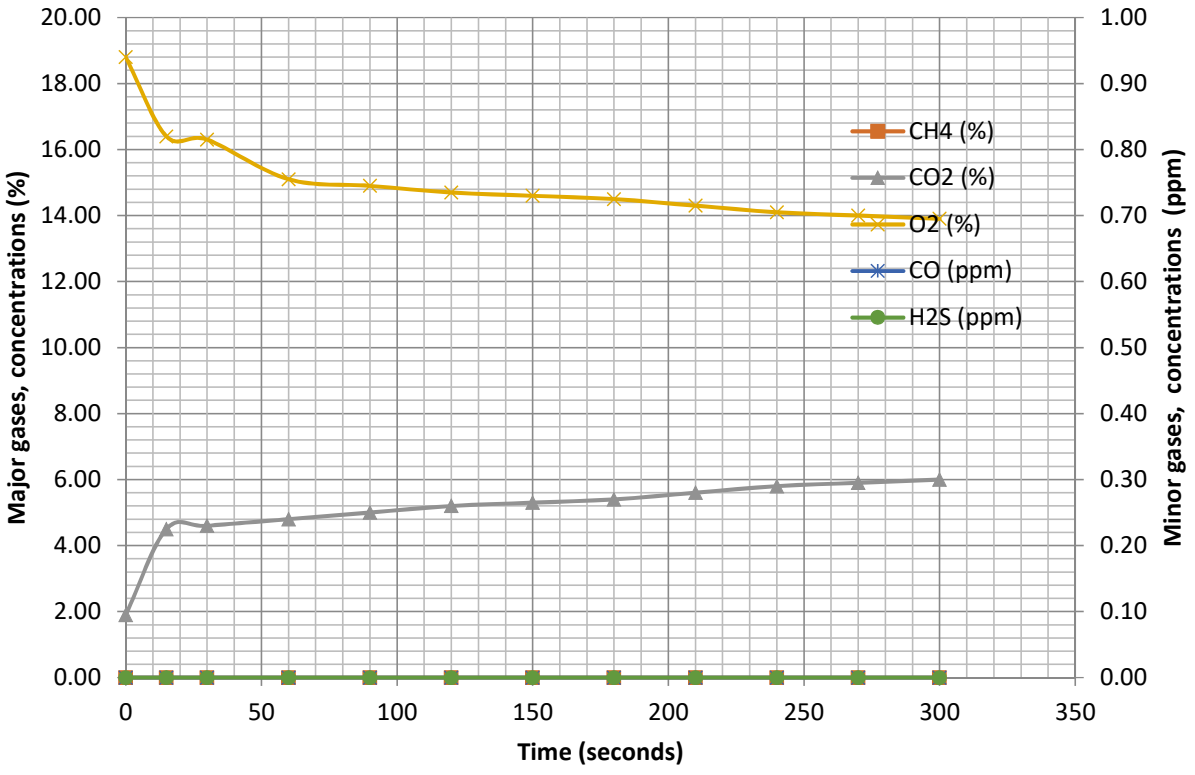
Date	09/08/2017	Engineer	SM	
Project No	LP1428	Temp °C		
Site	Cheney Row	Ambient Pressure	1015	

WS3

Hole ID

VOC peak (ppm)	0.00
VOC steady (ppm)	0.00
Borehole Depth (mbgl)	1.20
Water level (mbgl)	Dry
Borehole Pressure (mb)	0.00

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.00	0.00	1.90	18.80	0.00	0.00
00:15	0.00	0.00	4.50	16.40	0.00	0.00
00:30	0.00	0.00	4.60	16.30	0.00	0.00
01:00	0.00	0.00	4.80	15.10	0.00	0.00
01:30	0.00	0.00	5.00	14.90	0.00	0.00
02:00	0.00	0.00	5.20	14.70	0.00	0.00
02:30	0.00	0.00	5.30	14.60	0.00	0.00
03:00	0.00	0.00	5.40	14.50	0.00	0.00
03:30	0.00	0.00	5.60	14.30	0.00	0.00
04:00	0.00	0.00	5.80	14.10	0.00	0.00
04:30	0.00	0.00	5.90	14.00	0.00	0.00
05:00	0.00	0.00	6.00	13.90	0.00	0.00



Continuous Gas Monitoring Record

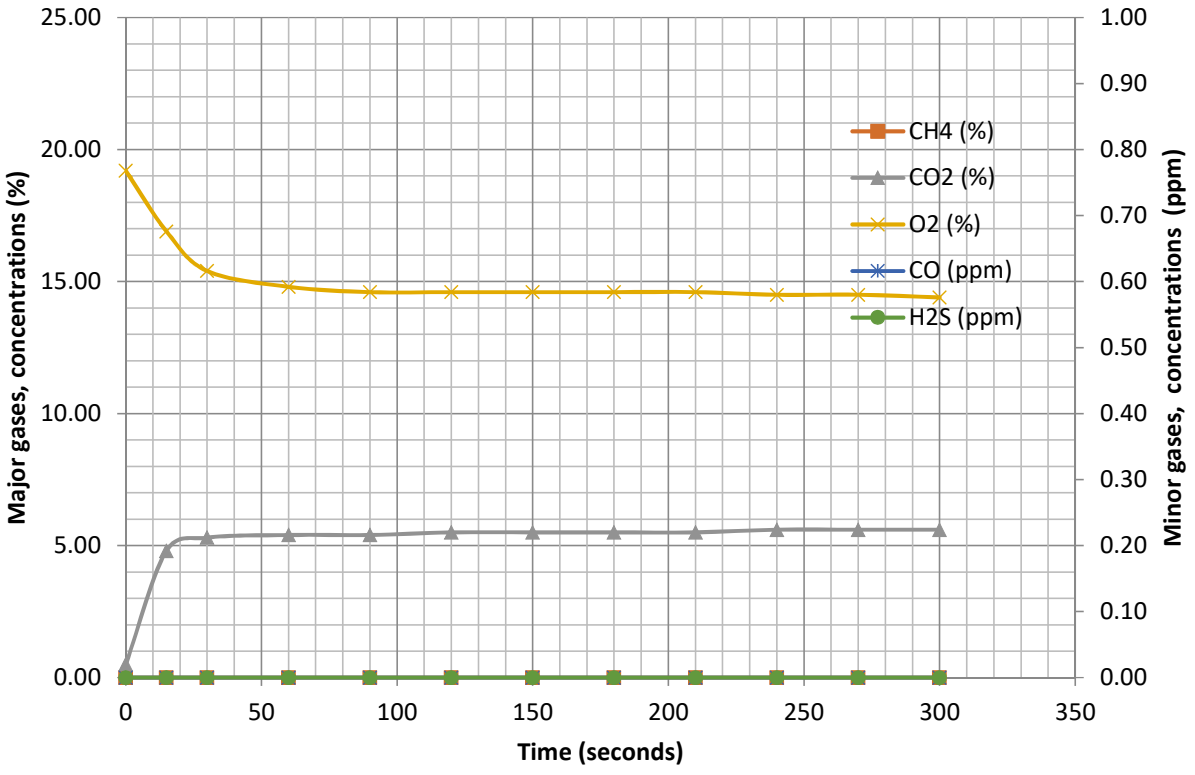
Date	17/08/2017	Engineer	SM
Project No	LP1428	Temp °C	21
Site	Cheney Row	Ambient Pressure	1011

WS1

Hole ID

VOC peak (ppm)	0.50
VOC steady (ppm)	0.10
Borehole Depth (mbgl)	4.13
Water level (mbgl)	3.59
Borehole Pressure (mb)	0.00

Time	Flow (∫/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.00	0.00	0.50	19.20	0.00	0.00
00:15	0.00	0.00	4.80	16.90	0.00	0.00
00:30	0.00	0.00	5.30	15.40	0.00	0.00
01:00	0.00	0.00	5.40	14.80	0.00	0.00
01:30	0.00	0.00	5.40	14.60	0.00	0.00
02:00	0.00	0.00	5.50	14.60	0.00	0.00
02:30	0.00	0.00	5.50	14.60	0.00	0.00
03:00	0.00	0.00	5.50	14.60	0.00	0.00
03:30	0.00	0.00	5.50	14.60	0.00	0.00
04:00	0.00	0.00	5.60	14.50	0.00	0.00
04:30	0.00	0.00	5.60	14.50	0.00	0.00
05:00	0.00	0.00	5.60	14.40	0.00	0.00



Continuous Gas Monitoring Record

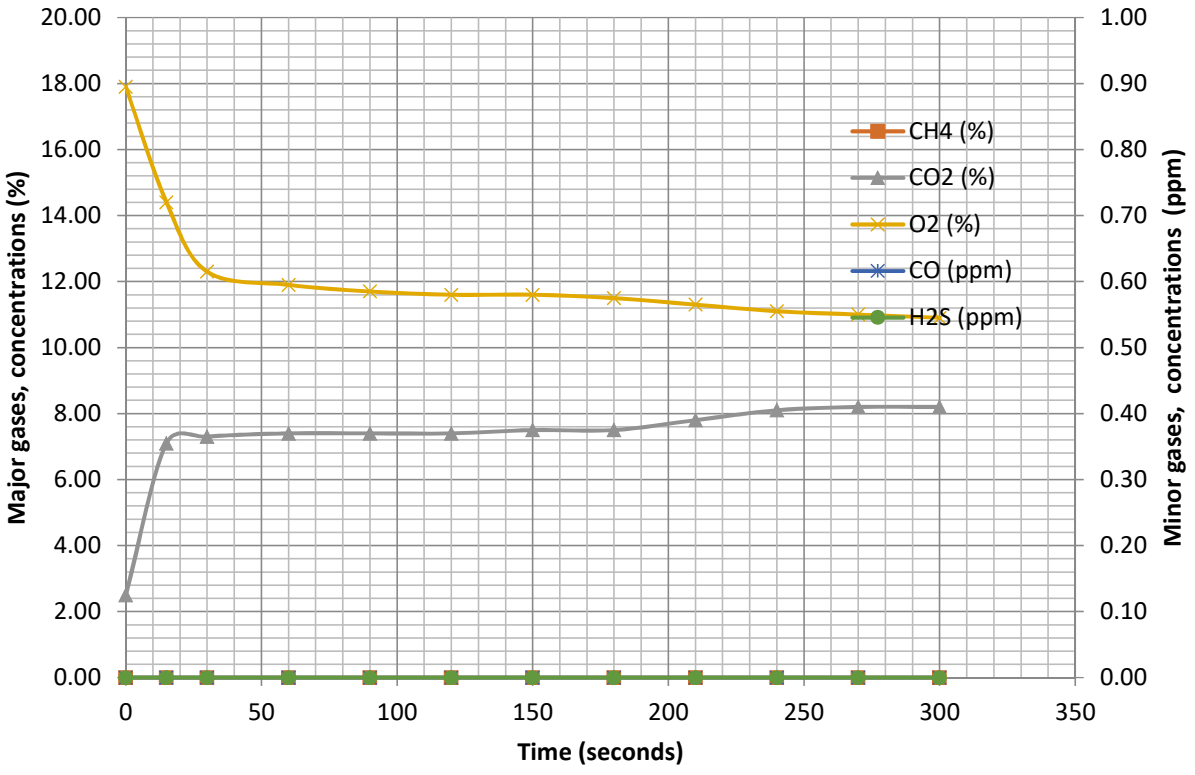
Date	17/08/2017	Engineer	SM
Project No	LP1428	Temp °C	21
Site	Cheney Row	Ambient Pressure	1011

WS2

Hole ID

VOC peak (ppm)	0.00
VOC steady (ppm)	0.00
Borehole Depth (mbgl)	4.05
Water level (mbgl)	3.41
Borehole Pressure (mb)	0.00

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.00	0.00	2.50	17.90	0.00	0.00
00:15	0.00	0.00	7.10	14.40	0.00	0.00
00:30	0.00	0.00	7.30	12.30	0.00	0.00
01:00	0.00	0.00	7.40	11.90	0.00	0.00
01:30	0.00	0.00	7.40	11.70	0.00	0.00
02:00	0.00	0.00	7.40	11.60	0.00	0.00
02:30	0.00	0.00	7.50	11.60	0.00	0.00
03:00	0.00	0.00	7.50	11.50	0.00	0.00
03:30	0.00	0.00	7.80	11.30	0.00	0.00
04:00	0.00	0.00	8.10	11.10	0.00	0.00
04:30	0.00	0.00	8.20	11.00	0.00	0.00
05:00	0.00	0.00	8.20	10.90	0.00	0.00



Continuous Gas Monitoring Record

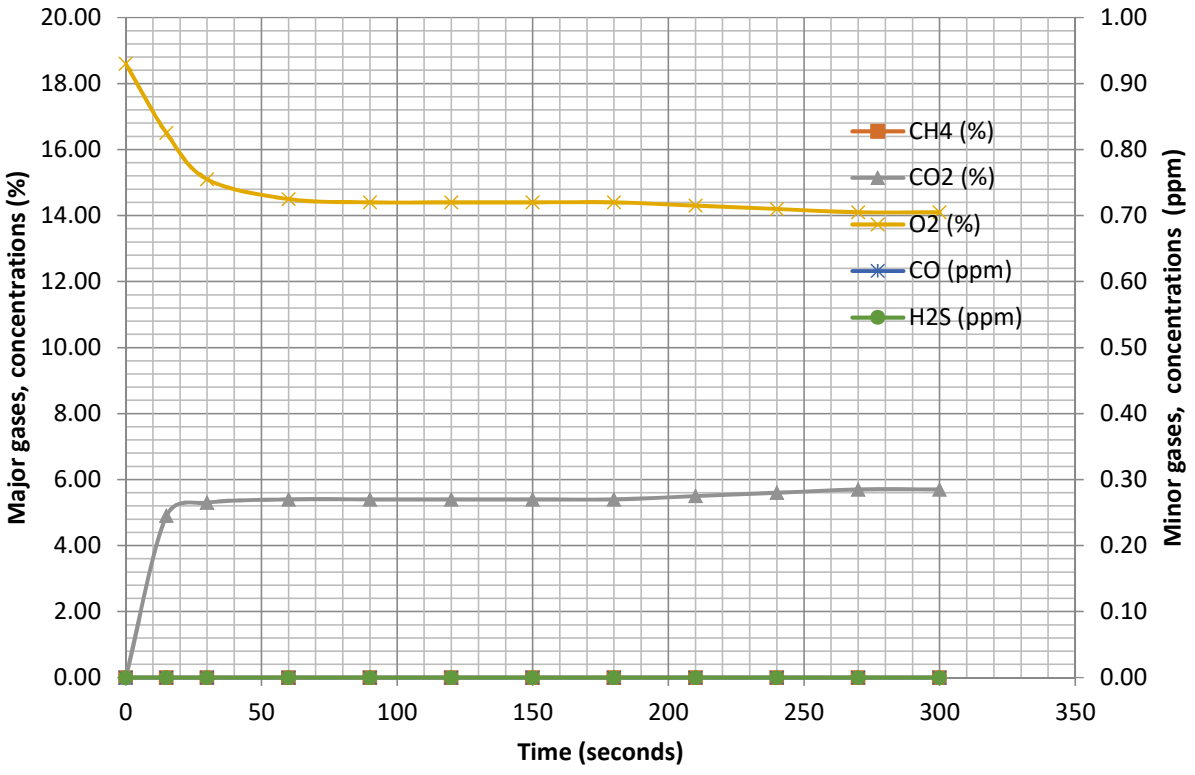
Date	17/08/2017	Engineer	SM	
Project No	LP1428	Temp °C	21	
Site	Cheney Row	Ambient Pressure	1011	

WS3

Hole ID

VOC peak (ppm)	0.30
VOC steady (ppm)	0.00
Borehole Depth (mbgl)	4.17
Water level (mbgl)	4.10
Borehole Pressure (mb)	0.00

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.00	0.00	0.00	18.60	0.00	0.00
00:15	0.00	0.00	4.90	16.50	0.00	0.00
00:30	0.00	0.00	5.30	15.10	0.00	0.00
01:00	0.00	0.00	5.40	14.50	0.00	0.00
01:30	0.00	0.00	5.40	14.40	0.00	0.00
02:00	0.00	0.00	5.40	14.40	0.00	0.00
02:30	0.00	0.00	5.40	14.40	0.00	0.00
03:00	0.00	0.00	5.40	14.40	0.00	0.00
03:30	0.00	0.00	5.50	14.30	0.00	0.00
04:00	0.00	0.00	5.60	14.20	0.00	0.00
04:30	0.00	0.00	5.70	14.10	0.00	0.00
05:00	0.00	0.00	5.70	14.10	0.00	0.00



Continuous Gas Monitoring Record

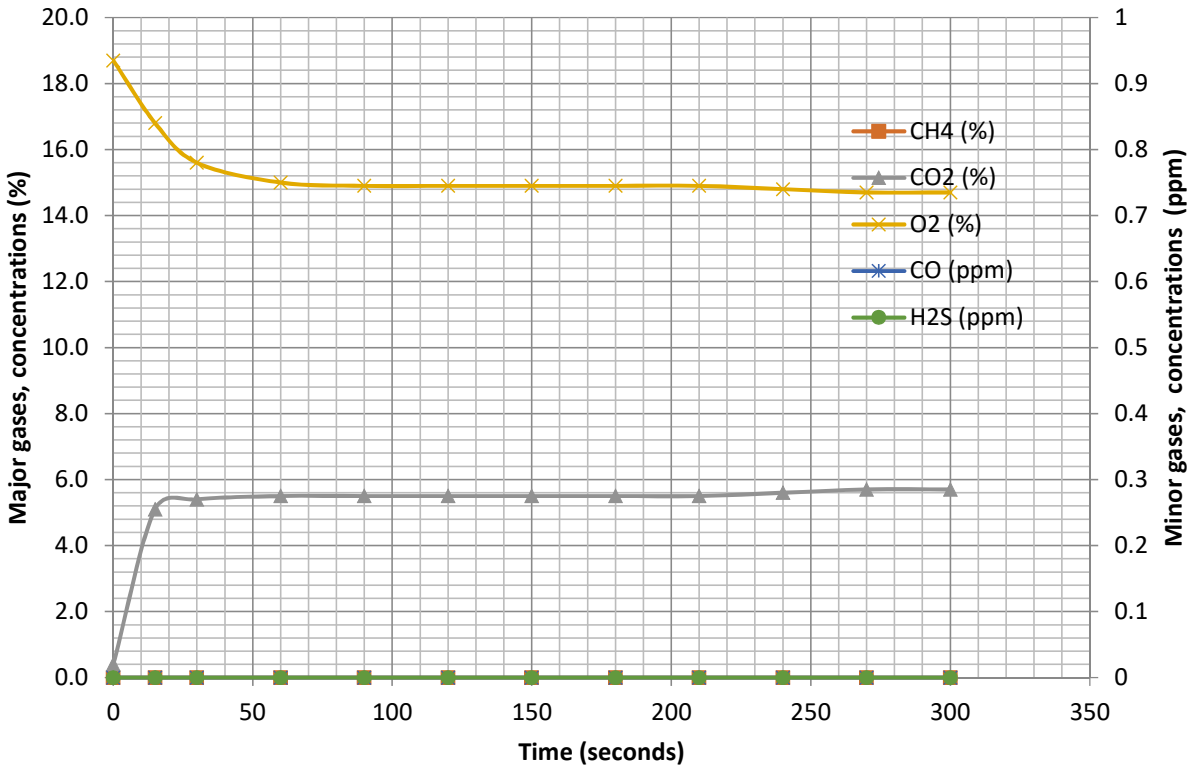
Date	23/08/2017	Engineer	SM
Project No	LP1428	Temp °C	22.8
Site	Cheney Row	Ambient Pressure	1013

WS1

Hole ID

VOC peak (ppm)	0.6
VOC steady (ppm)	0.1
Borehole Depth (mbgl)	4.1
Water level (mbgl)	3.49
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.4	18.7	0	0
00:15	0.0	0.0	5.1	16.8	0	0
00:30	0.0	0.0	5.4	15.6	0	0
01:00	0.0	0.0	5.5	15.0	0	0
01:30	0.0	0.0	5.5	14.9	0	0
02:00	0.0	0.0	5.5	14.9	0	0
02:30	0.0	0.0	5.5	14.9	0	0
03:00	0.0	0.0	5.5	14.9	0	0
03:30	0.0	0.0	5.5	14.9	0	0
04:00	0.0	0.0	5.6	14.8	0	0
04:30	0.0	0.0	5.7	14.7	0	0
05:00	0.0	0.0	5.7	14.7	0	0



Continuous Gas Monitoring Record

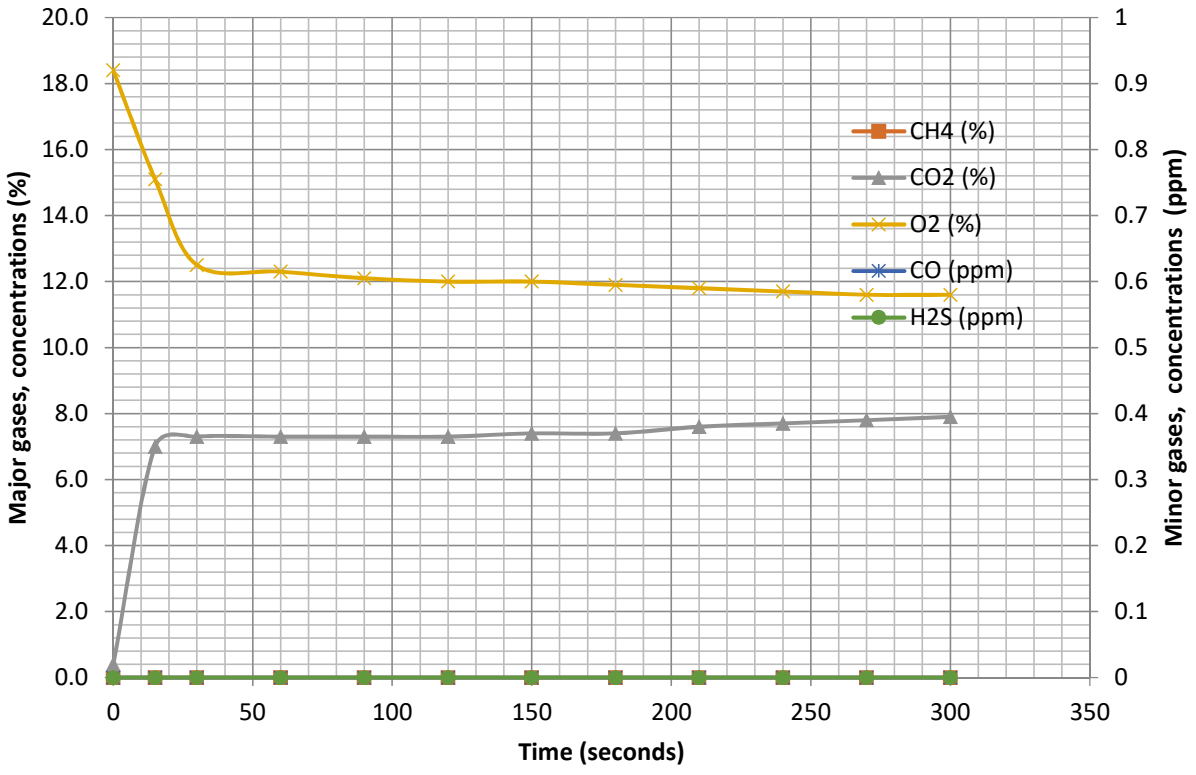
Date	23/08/2017	Engineer	SM
Project No	LP1428	Temp °C	22.8
Site	Cheney Row	Ambient Pressure	1013

WS2

Hole ID

VOC peak (ppm)	0.1
VOC steady (ppm)	0.1
Borehole Depth (mbgl)	4.04
Water level (mbgl)	3.49
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.4	18.4	0	0
00:15	0.0	0.0	7.0	15.1	0	0
00:30	0.0	0.0	7.3	12.5	0	0
01:00	0.0	0.0	7.3	12.3	0	0
01:30	0.0	0.0	7.3	12.1	0	0
02:00	0.0	0.0	7.3	12.0	0	0
02:30	0.0	0.0	7.4	12.0	0	0
03:00	0.0	0.0	7.4	11.9	0	0
03:30	0.0	0.0	7.6	11.8	0	0
04:00	0.0	0.0	7.7	11.7	0	0
04:30	0.0	0.0	7.8	11.6	0	0
05:00	0.0	0.0	7.9	11.6	0	0



Continuous Gas Monitoring Record

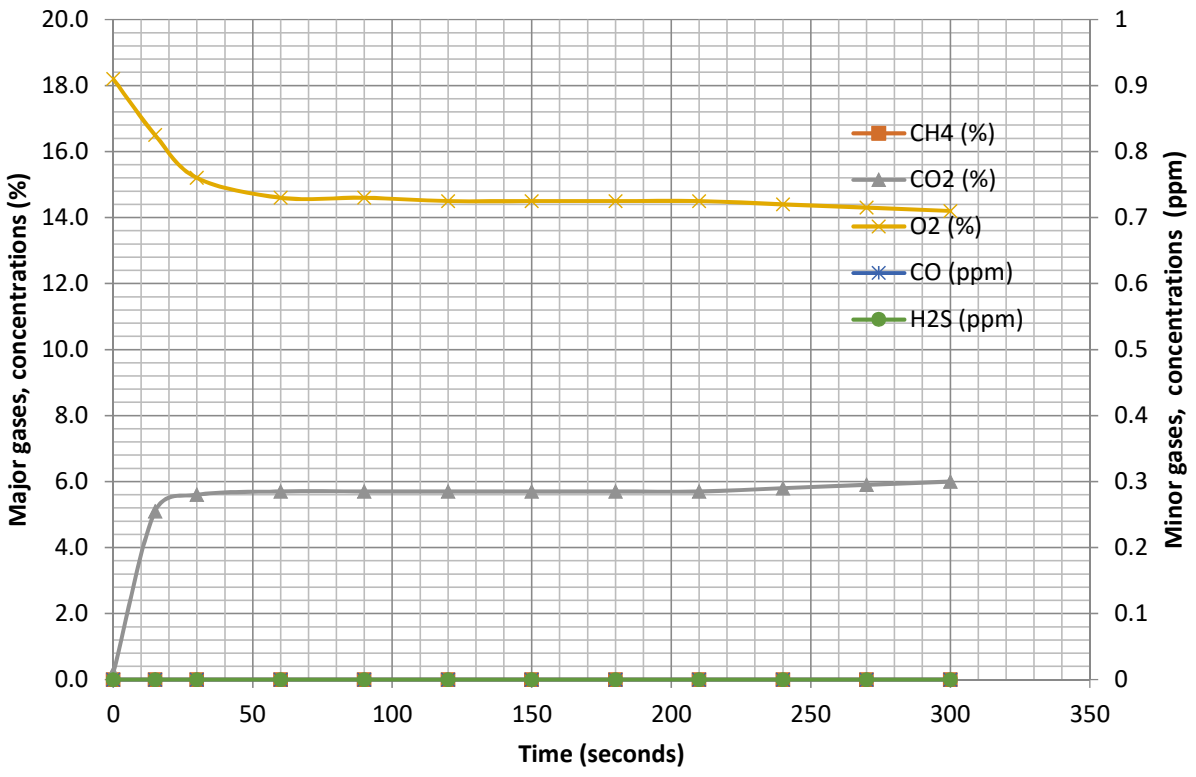
Date	23/08/2017	Engineer	SM
Project No	LP1428	Temp °C	22.8
Site	Cheney Row	Ambient Pressure	1013

WS3

Hole ID

VOC peak (ppm)	0.3
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.15
Water level (mbgl)	4.02
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.2	18.2	0	0
00:15	0.0	0.0	5.1	16.5	0	0
00:30	0.0	0.0	5.6	15.2	0	0
01:00	0.0	0.0	5.7	14.6	0	0
01:30	0.0	0.0	5.7	14.6	0	0
02:00	0.0	0.0	5.7	14.5	0	0
02:30	0.0	0.0	5.7	14.5	0	0
03:00	0.0	0.0	5.7	14.5	0	0
03:30	0.0	0.0	5.7	14.5	0	0
04:00	0.0	0.0	5.8	14.4	0	0
04:30	0.0	0.0	5.9	14.3	0	0
05:00	0.0	0.0	6.0	14.2	0	0



Continuous Gas Monitoring Record

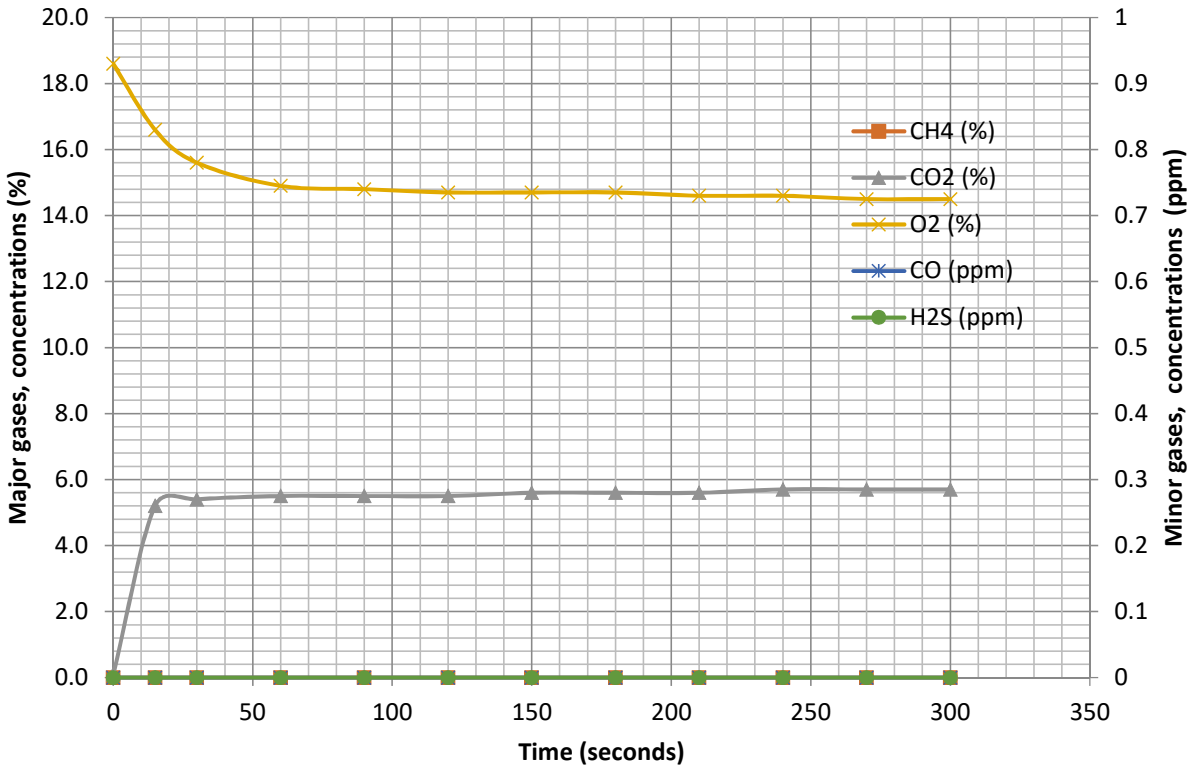
Date	30/08/2017	Engineer	SM
Project No	LP1428	Temp °C	22
Site	Cheney Row	Ambient Pressure	1013

WS1

Hole ID

VOC peak (ppm)	0.7
VOC steady (ppm)	0.1
Borehole Depth (mbgl)	4.09
Water level (mbgl)	3.37
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.1	18.6	0	0
00:15	0.0	0.0	5.2	16.6	0	0
00:30	0.0	0.0	5.4	15.6	0	0
01:00	0.0	0.0	5.5	14.9	0	0
01:30	0.0	0.0	5.5	14.8	0	0
02:00	0.0	0.0	5.5	14.7	0	0
02:30	0.0	0.0	5.6	14.7	0	0
03:00	0.0	0.0	5.6	14.7	0	0
03:30	0.0	0.0	5.6	14.6	0	0
04:00	0.0	0.0	5.7	14.6	0	0
04:30	0.0	0.0	5.7	14.5	0	0
05:00	0.0	0.0	5.7	14.5	0	0



Continuous Gas Monitoring Record

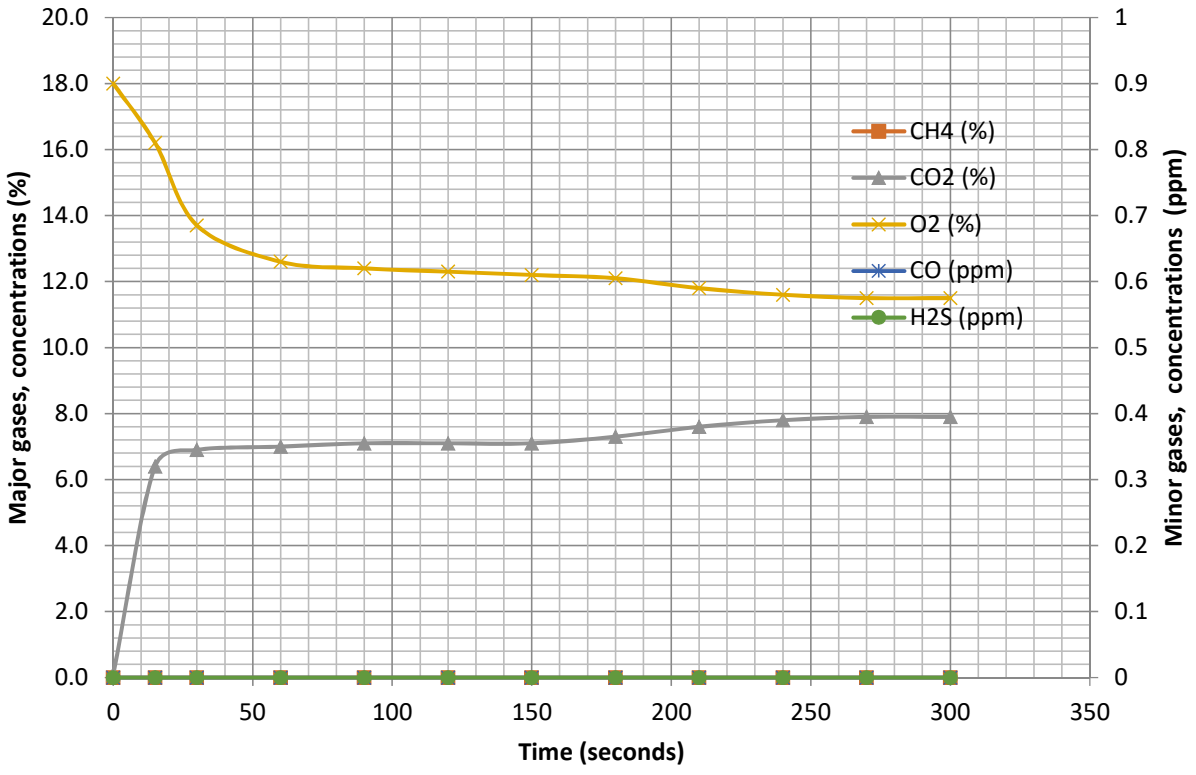
Date	30/08/2017	Engineer	SM
Project No	LP1428	Temp °C	22
Site	Cheney Row	Ambient Pressure	1013

WS2

Hole ID

VOC peak (ppm)	0
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.04
Water level (mbgl)	3.19
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.1	18.0	0	0
00:15	0.0	0.0	6.4	16.2	0	0
00:30	0.0	0.0	6.9	13.7	0	0
01:00	0.0	0.0	7.0	12.6	0	0
01:30	0.0	0.0	7.1	12.4	0	0
02:00	0.0	0.0	7.1	12.3	0	0
02:30	0.0	0.0	7.1	12.2	0	0
03:00	0.0	0.0	7.3	12.1	0	0
03:30	0.0	0.0	7.6	11.8	0	0
04:00	0.0	0.0	7.8	11.6	0	0
04:30	0.0	0.0	7.9	11.5	0	0
05:00	0.0	0.0	7.9	11.5	0	0



Continuous Gas Monitoring Record

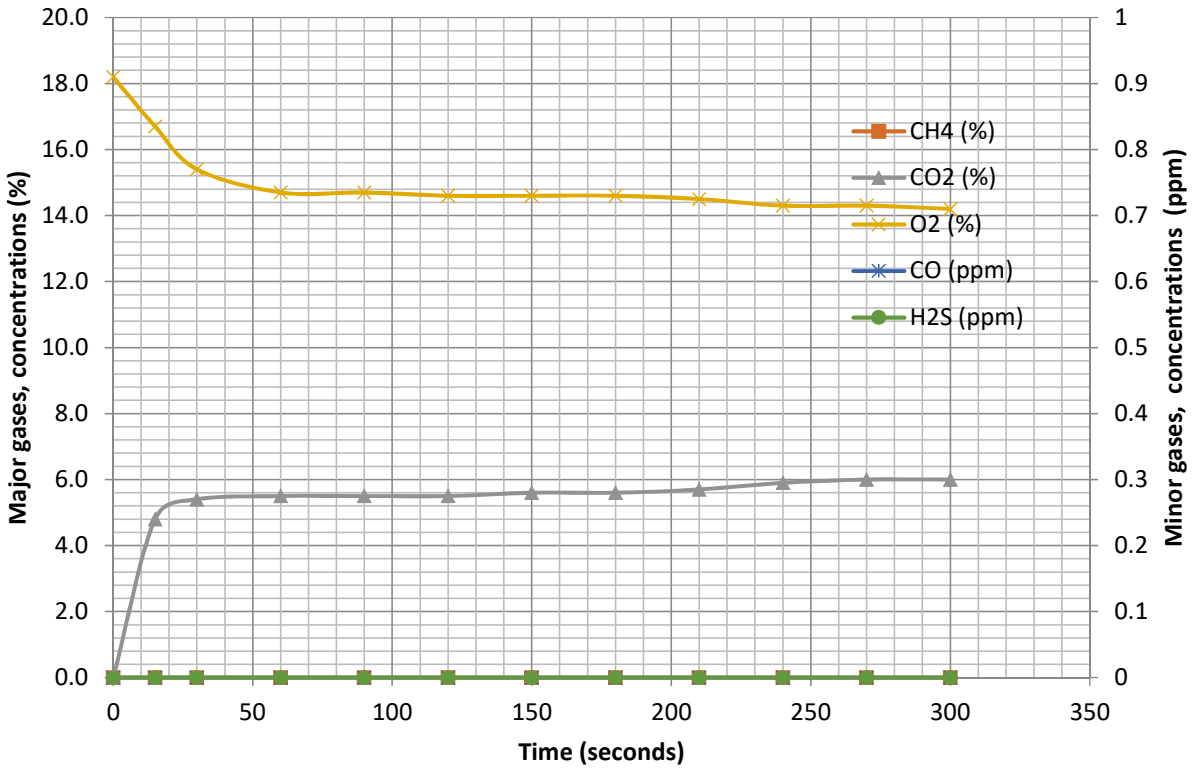
Date	30/08/2017	Engineer	SM
Project No	LP1428	Temp °C	22
Site	Cheney Row	Ambient Pressure	1013

WS3

Hole ID

VOC peak (ppm)	0.2
VOC steady (ppm)	0.1
Borehole Depth (mbgl)	4.16
Water level (mbgl)	3.95
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.0	18.2	0	0
00:15	0.0	0.0	4.8	16.7	0	0
00:30	0.0	0.0	5.4	15.4	0	0
01:00	0.0	0.0	5.5	14.7	0	0
01:30	0.0	0.0	5.5	14.7	0	0
02:00	0.0	0.0	5.5	14.6	0	0
02:30	0.0	0.0	5.6	14.6	0	0
03:00	0.0	0.0	5.6	14.6	0	0
03:30	0.0	0.0	5.7	14.5	0	0
04:00	0.0	0.0	5.9	14.3	0	0
04:30	0.0	0.0	6.0	14.3	0	0
05:00	0.0	0.0	6.0	14.2	0	0



Continuous Gas Monitoring Record

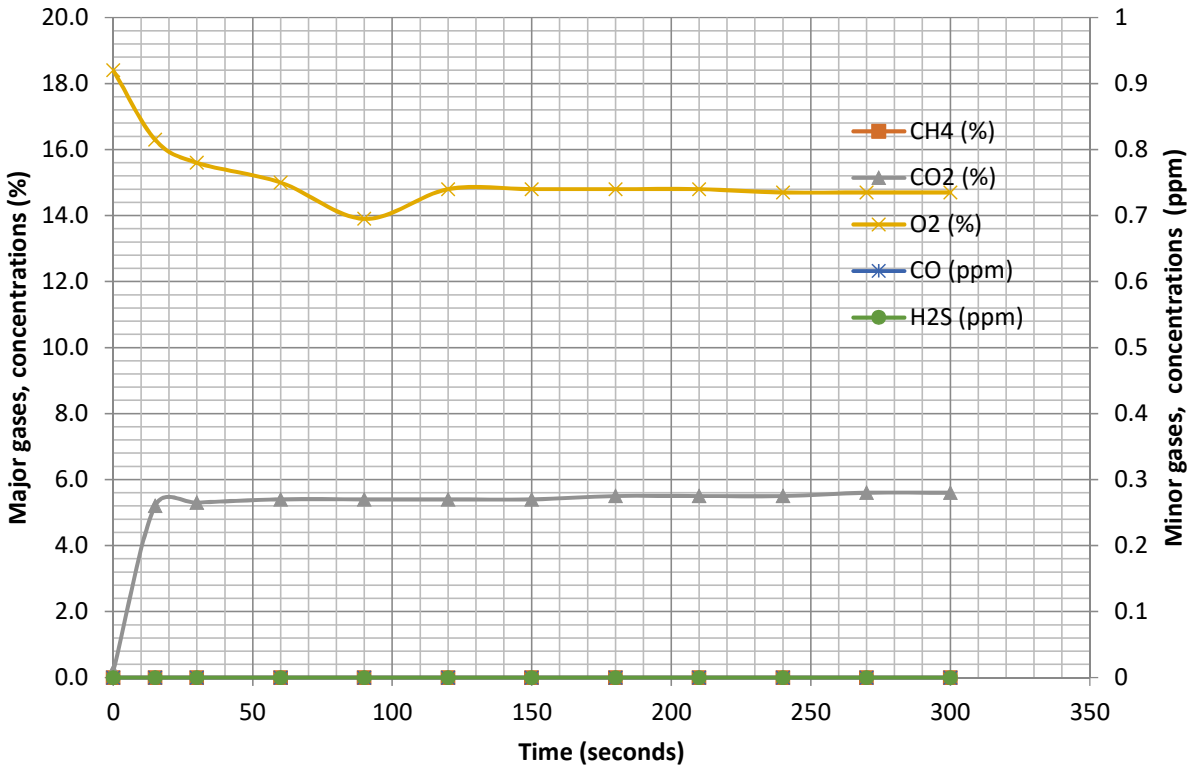
Date	06/09/2017	Engineer	SM, AH
Project No	LP1428	Temp °C	17°
Site	Cheney Row	Ambient Pressure (mbar)	1020

WS1

Hole ID

VOC peak (ppm)	0.7
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.09
Water level (mbgl)	3.18
Borehole Pressure (Pa)	0

Time	Flow (ʃ/h)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
00:00	0.0	0.0	0.2	18.4	0	0
00:15	0.0	0.0	5.2	16.3	0	0
00:30	0.0	0.0	5.3	15.6	0	0
01:00	0.0	0.0	5.4	15.0	0	0
01:30	0.0	0.0	5.4	13.9	0	0
02:00	0.0	0.0	5.4	14.8	0	0
02:30	0.0	0.0	5.4	14.8	0	0
03:00	0.0	0.0	5.5	14.8	0	0
03:30	0.0	0.0	5.5	14.8	0	0
04:00	0.0	0.0	5.5	14.7	0	0
04:30	0.0	0.0	5.6	14.7	0	0
05:00	0.0	0.0	5.6	14.7	0	0



Continuous Gas Monitoring Record

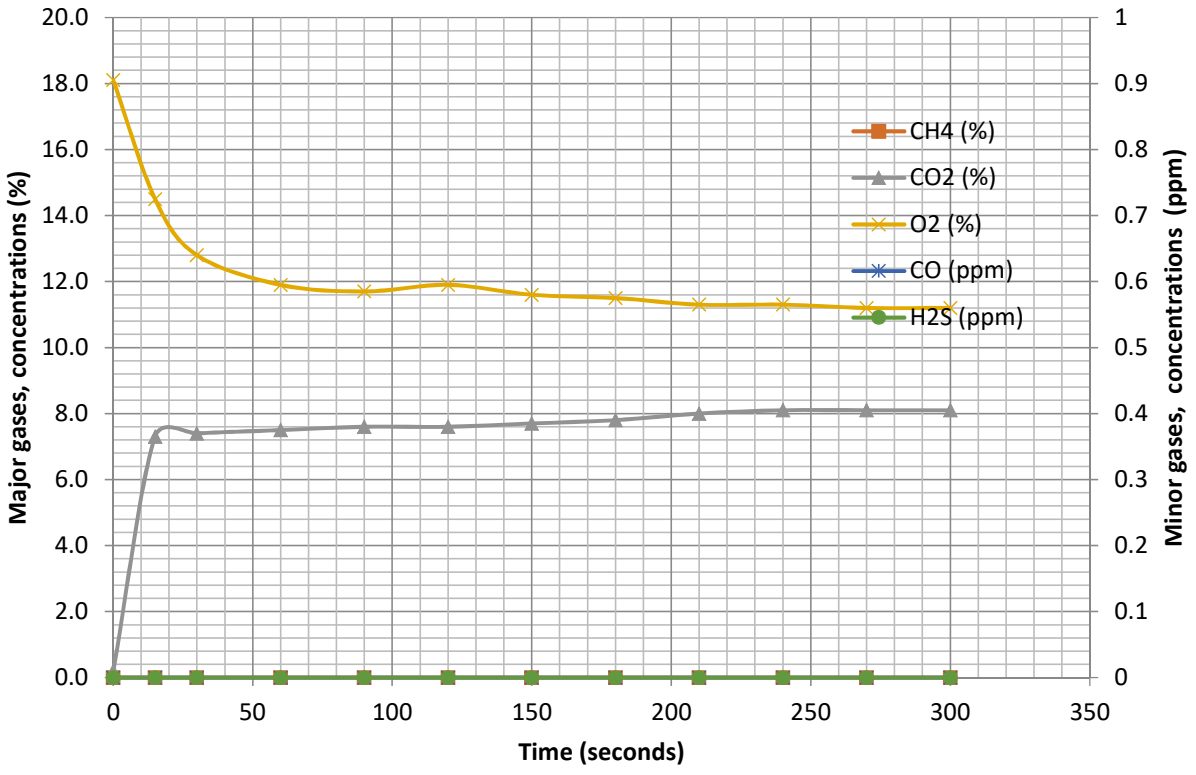
Date	06/09/2017	Engineer	SM, AH
Project No	LP1428	Temp °C	17°
Site	Cheney Row	Ambient Pressure (mbar)	1020

WS2

Hole ID

VOC peak (ppm)	0.3
VOC steady (ppm)	0.1
Borehole Depth (mbgl)	4.04
Water level (mbgl)	3.14
Borehole Pressure (Pa)	0

Time	Flow (ʃ/h)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
00:00	0.0	0.0	0.2	18.1	0	0
00:15	0.0	0.0	7.3	14.5	0	0
00:30	0.0	0.0	7.4	12.8	0	0
01:00	0.0	0.0	7.5	11.9	0	0
01:30	0.0	0.0	7.6	11.7	0	0
02:00	0.0	0.0	7.6	11.9	0	0
02:30	0.0	0.0	7.7	11.6	0	0
03:00	0.0	0.0	7.8	11.5	0	0
03:30	0.0	0.0	8.0	11.3	0	0
04:00	0.0	0.0	8.1	11.3	0	0
04:30	0.0	0.0	8.1	11.2	0	0
05:00	0.0	0.0	8.1	11.2	0	0



Continuous Gas Monitoring Record

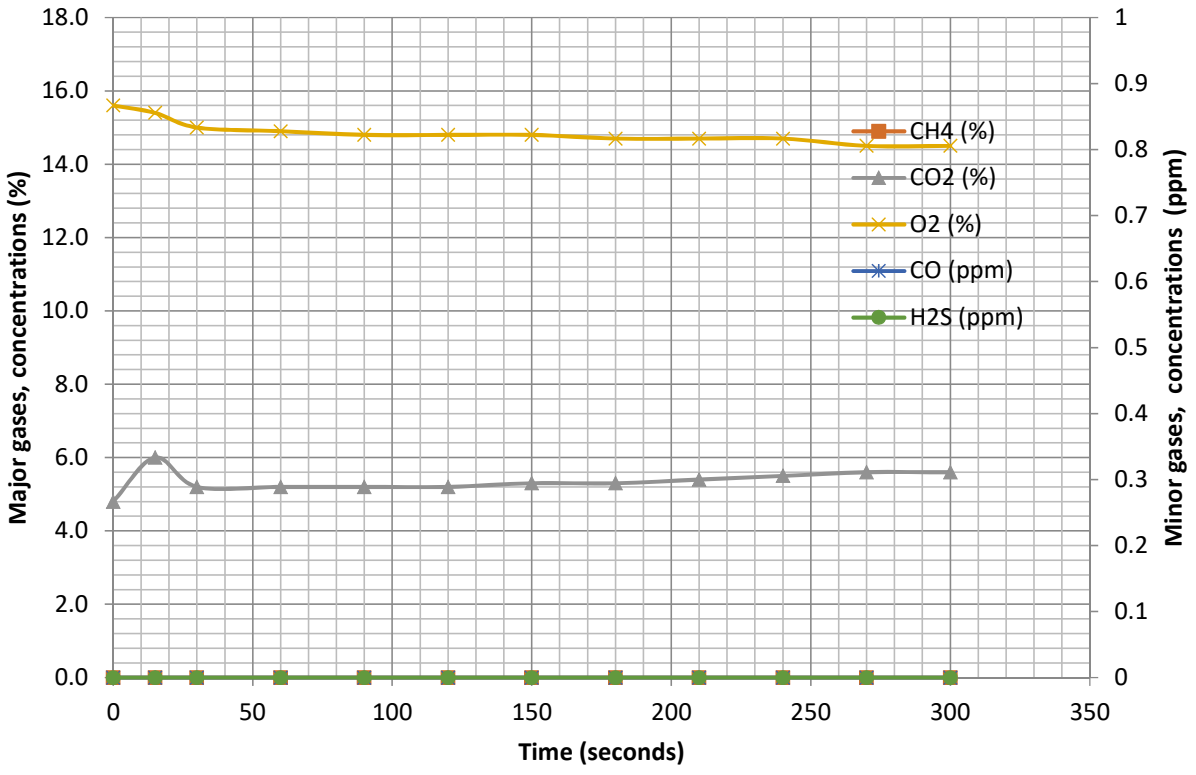
Date	06/09/2017	Engineer	SM, AH
Project No	LP1428	Temp °C	17°
Site	Cheney Row	Ambient Pressure (mbar)	1020

WS3

Hole ID

VOC peak (ppm)	0.3
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.16
Water level (mbgl)	3.86
Borehole Pressure (Pa)	0

Time	Flow (ʃ/h)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
00:00	0.0	0.0	4.8	15.6	0	0
00:15	0.0	0.0	6.0	15.4	0	0
00:30	0.0	0.0	5.2	15.0	0	0
01:00	0.0	0.0	5.2	14.9	0	0
01:30	0.0	0.0	5.2	14.8	0	0
02:00	0.0	0.0	5.2	14.8	0	0
02:30	0.0	0.0	5.3	14.8	0	0
03:00	0.0	0.0	5.3	14.7	0	0
03:30	0.0	0.0	5.4	14.7	0	0
04:00	0.0	0.0	5.5	14.7	0	0
04:30	0.0	0.0	5.6	14.5	0	0
05:00	0.0	0.0	5.6	14.5	0	0



Continuous Gas Monitoring Record

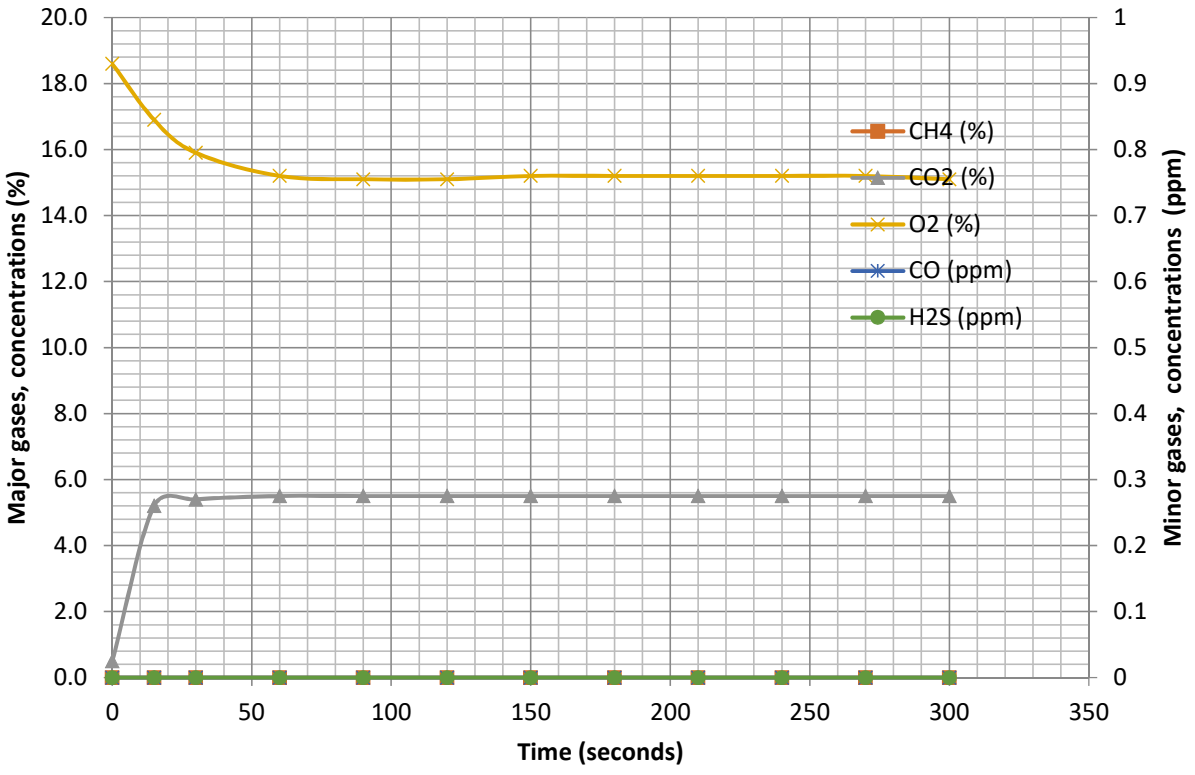
Date	13/09/2017	Engineer	SM/AH
Project No	LP1428	Temp °C	18°
Site	Cheney Row	Ambient Pressure	999

WS1

Hole ID

VOC peak (ppm)	0.5
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.09
Water level (mbgl)	3.11
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.5	18.6	0	0
00:15	0.0	0.0	5.2	16.9	0	0
00:30	0.0	0.0	5.4	15.9	0	0
01:00	0.0	0.0	5.5	15.2	0	0
01:30	0.0	0.0	5.5	15.1	0	0
02:00	0.0	0.0	5.5	15.1	0	0
02:30	0.0	0.0	5.5	15.2	0	0
03:00	0.0	0.0	5.5	15.2	0	0
03:30	0.0	0.0	5.5	15.2	0	0
04:00	0.0	0.0	5.5	15.2	0	0
04:30	0.0	0.0	5.5	15.2	0	0
05:00	0.0	0.0	5.5	15.1	0	0



Continuous Gas Monitoring Record

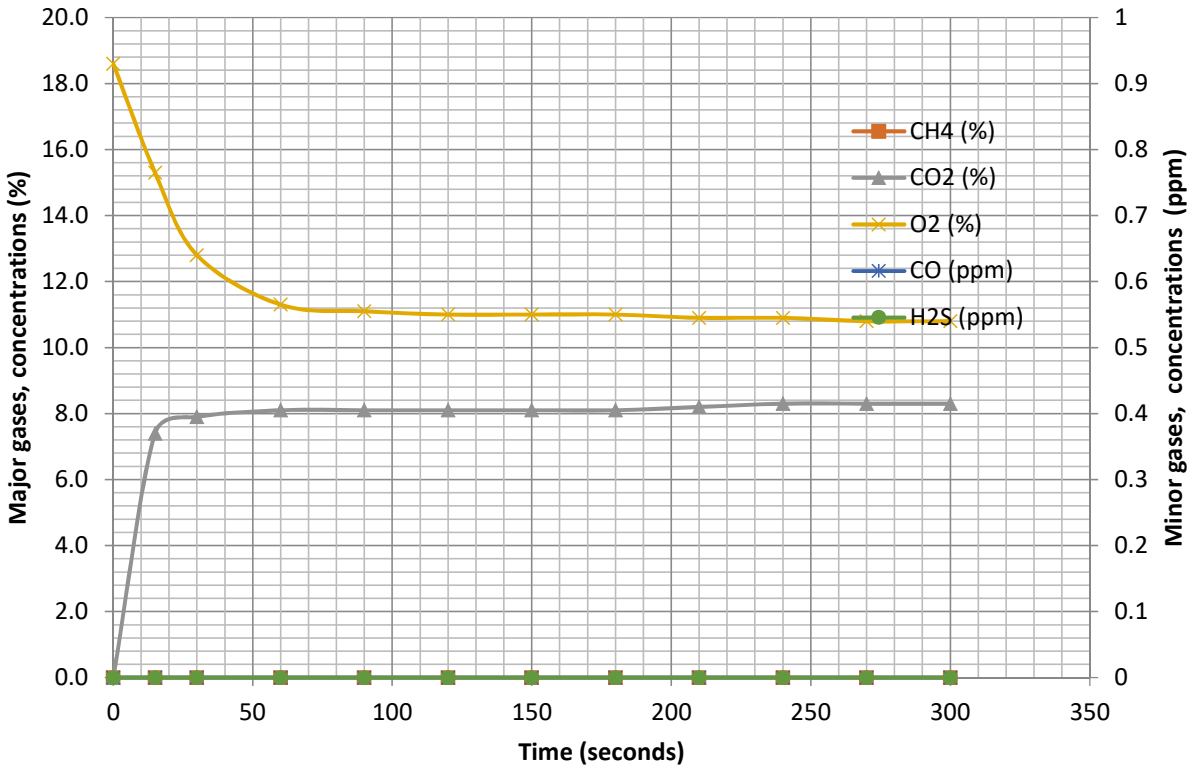
Date	13/09/2017	Engineer	SM/AH
Project No	LP1428	Temp °C	18°
Site	Cheney Row	Ambient Pressure	999

WS2

Hole ID

VOC peak (ppm)	0.1
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.05
Water level (mbgl)	3.13
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.0	18.6	0	0
00:15	0.0	0.0	7.4	15.3	0	0
00:30	0.0	0.0	7.9	12.8	0	0
01:00	0.0	0.0	8.1	11.3	0	0
01:30	0.0	0.0	8.1	11.1	0	0
02:00	0.0	0.0	8.1	11.0	0	0
02:30	0.0	0.0	8.1	11.0	0	0
03:00	0.0	0.0	8.1	11.0	0	0
03:30	0.0	0.0	8.2	10.9	0	0
04:00	0.0	0.0	8.3	10.9	0	0
04:30	0.0	0.0	8.3	10.8	0	0
05:00	0.0	0.0	8.3	10.8	0	0



Continuous Gas Monitoring Record

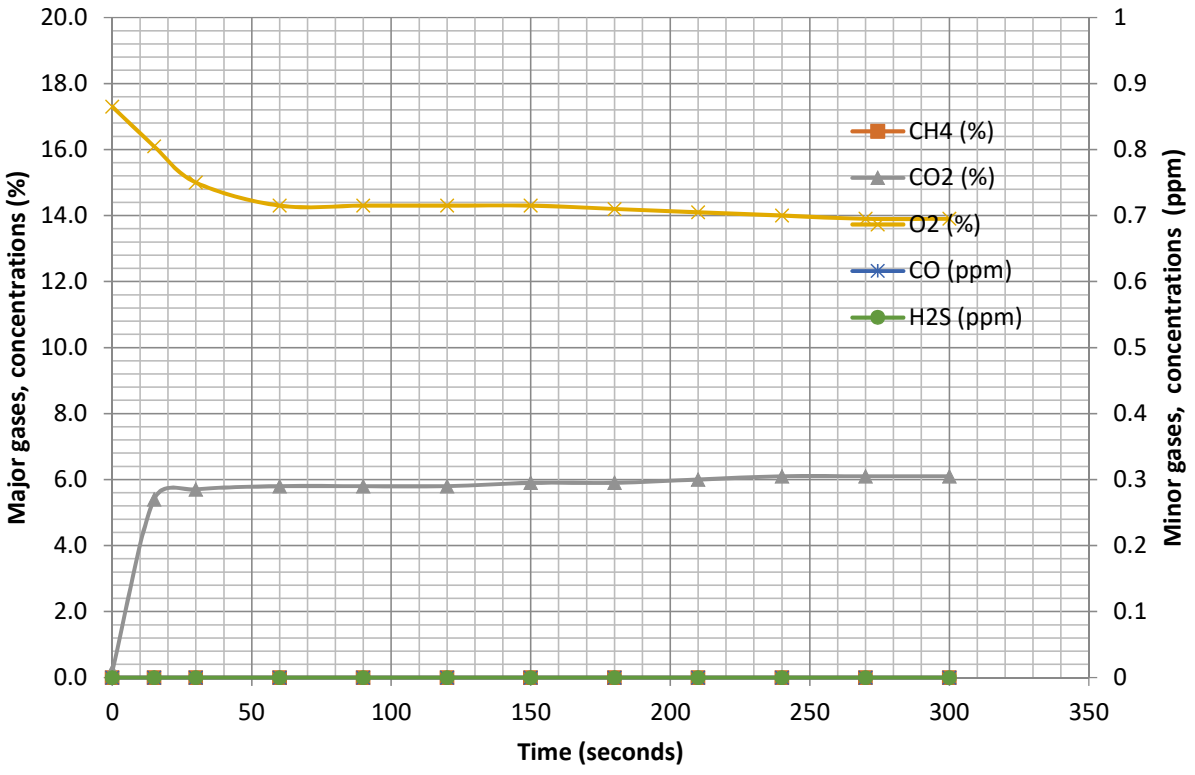
Date	13/09/2017	Engineer	SM/AH
Project No	LP1428	Temp °C	18°
Site	Cheney Row	Ambient Pressure	999

WS3

Hole ID

VOC peak (ppm)	0.2
VOC steady (ppm)	0
Borehole Depth (mbgl)	4.16
Water level (mbgl)	3.81
Borehole Pressure (mb)	0

Time	Flow (ʃ/h)	CH^4 (%)	CO^2 (%)	O^2 (%)	CO (ppm)	H^2S (ppm)
00:00	0.0	0.0	0.2	17.3	0	0
00:15	0.0	0.0	5.4	16.1	0	0
00:30	0.0	0.0	5.7	15.0	0	0
01:00	0.0	0.0	5.8	14.3	0	0
01:30	0.0	0.0	5.8	14.3	0	0
02:00	0.0	0.0	5.8	14.3	0	0
02:30	0.0	0.0	5.9	14.3	0	0
03:00	0.0	0.0	5.9	14.2	0	0
03:30	0.0	0.0	6.0	14.1	0	0
04:00	0.0	0.0	6.1	14.0	0	0
04:30	0.0	0.0	6.1	13.9	0	0
05:00	0.0	0.0	6.1	13.9	0	0



APPENDIX G – DETAILS OF FIELD MONITORING EQUIPMENT

Details of Field
Monitoring Equipment

GFM436 Infra-Red Gas Analyser

The GFM436 is an MCERTS accredited hand held gas analyser. It uses non-dispersive infra-red sensors and electro-chemical sensors to determine the relative proportions of the components in the sample gas.

The stated accuracy and detection limits of the instrument are as follows:

Measurement	Range	Typical Accuracy
Flow from borehole	-60 to +100 l/hr	± 0.1 l/hr
CH_4	0-100%	(see below)
CO_2	0-100%	(see below)
O_2	0-25%	(see below)
CO	5000ppm	20ppm
H2S	2000ppm	20ppm
LEL	0 to 100%	4% LEL

Concentration	Typical Accuracy		
	CH_4 % by volume	CO_2 % by volume	O_2 % by volume
0 - 5 %	± 0.3%	± 0.3%	± 0.2%
5 - 60%	± 3.0%	± 3.0%	
60 - 100%	± 3.0%	± 3.0%	

Operating Conditions	
Operating temperature range	-10°C to +40 °C
Barometric pressure	800 to 1200 mbar
Barometric pressure accuracy	5 mbar, 1mbar resolution

Photoionization Detector

A PhoCheck Tiger portable photoionization detector (PID) has been used in this investigation.

The PID measures the concentration of photoionizable chemicals in a gas stream. A 10.6eV ultraviolet lamp generates photons which ionize molecules with an ionization potential of 10.6eV or less in the gas stream. Many of the chemicals considered pollutants, including most hydrocarbons are ionized. It should be noted that substances with an ionization potential greater than 10.6eV (eg methane) pass through the detector without ionization. The ionized molecules generate an electric current which is proportional to the concentration of ionized molecules in the detector cell.

The PID is calibrated to isobutylene and the reading quoted is therefore in ppm isobutylene equivalent unless otherwise stated. Where the composition of the pollutant gas is known and is a single compound then the instrument may be directly calibrated to provide quantitative results. Alternatively the instrument's own library of calibration values may be used to provide semi quantitative results.

In general where the composition is unknown or is a mixture of compounds then the readings are regarded as qualitative only. The instrument is used primarily to highlight samples for laboratory testing. The instrument is also used effectively to highlight areas of relative contamination and thereby highlight hotspots or migration pathways.

In this investigation soil samples of about 0.5-1.0kg in weight have been placed in a plastic bag and agitated. The PID has then been used to monitor VOCs released within the bag using a dedicated probe which pierces the bag.

Each reading presented in this report represents the peak value recorded over a five minute period unless otherwise stated.