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Phase 2 Intrusive Site Investigation Report

LOCATION	Land adjacent to Ashtree Lodge, Lambert Bank, Gedney Hill PE12 0PR
ISSUE DATE	June 2019
FOR	Ms K Ling and Mr D Dillon
CLIENT REF.	
OUR REF.	G19175

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Table of Contents

Section	Content	Page
1	**Introduction**	**3**
1.1	Design of Investigation	3
2	**Scope of Phase 2 Investigation**	**3**
2.1	Scope of works	3
2.2	Sampling Rationale	4
3	**Phase 2 Investigation Findings**	**4**
3.1	Encountered ground conditions	4
3.1.1	Machine Excavated Trial Pits (TP1-TP5)	4
4	**Contamination Testing**	**5**
5	**Risk Assessment**	**5**
5.1	Method	5
5.2	Contamination Risk to Identified Receptors	6
5.2.1	Contamination Risk to Human Health	6
5.2.2	Contamination Risk to Controlled Waters	8
5.3	Review of Results	9
5.3.1	CGHM	9
6	**Hazardous Gas**	**11**
6.1	Gas Regime	11
6.2	Radon Gas	11
7	**Conclusions**	**11**
7.1	Contamination	11
7.2	Concrete Design	12
Appendix 1	**Site Plan and Trial Pit Logs**	
Appendix 2	**Chemtech Analytical Test Report**	

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1. Introduction

In accordance with your instruction, Geoinvestigate Ltd. has carried out an Intrusive Site investigation on Ashtree lodge, Lambert Bank, Gedney Hill PE12 0PR. The boundary of the study area is shown on the site plan presented in Appendix 1 of this report and access is from Lambert Bank west of the site.

A Phase 1 Desk Study of the site carried out by Geoinvestigate has been compiled for the site (report ref G19108 dated 5/4/19). Briefly, the potentially contaminative activities affecting the site primarily comprise former land uses including buildings and an above ground oil storage tank. The findings of the Phase 1 Desk Study have formed the basis for the design of the current investigation.

The proposed development at the site currently comprises a new residential dwelling, an outline development plan is shown on the site plan in Appendix 1.

The purpose of the Phase 2 investigation was to establish the true nature of the ground conditions at the site to assess the risks highlighted in the Phase 1 desk study with regard the potential for contamination to occur at the site.

1.1 Design of Investigation

The trial pits were positioned across the site to give an overview of the soil quality at the site with TP3 specifically placed to sample underneath the area which once housed the above ground storage.

Superficial geology is mapped as Tidal Flat Deposits 1 (Sand and Silt) with bedrock geology of the Oxford Clay Formation (Mudstone). Nearby BGS log records 80m northeast of site show made ground to 0.30m followed by natural silty clay to 1.22m underlain by clayey silty sand to 2.90m then silty sand to termination at 6.40m.

Given the findings of the desk study, and the anticipated ground conditions and potential sources of contamination and/or made ground, this investigation was designed to establish both the nature of the ground conditions across the site generally as well as specifically in the areas where made ground or contamination might be more likely to be present.

2. Scope of Phase 2 Investigation

2.1 Scope of Works

Given the above, the following investigation was carried out to assess the potential risks at the site:

- The excavation of five (5) hand-excavated trial pits, to depths of up to 1.00m to recover samples for contamination.
- Contamination analyses of five (5) samples of made ground recovered at depths of 0.20m to confirm that metals, asbestos, polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbons are absent or within acceptable limits. (Chemical analyses based on findings of the Phase 1 Desk Study Report, additional initial site assessment by Geoinvestigate, and on the attending engineer's assessment of encountered soils). Leachate from two (2) samples was also tested to check the mobility of the contaminants

- Provision of a factual and interpretative report including; site plan, trial pit logs, and contamination analysis results and, if required, remediation and validation.

The trial pit sample positions are shown on the plan provided in Appendix 1.

The excavations were sampled and logged at site by a geo-environmental engineer and the ground conditions encountered are described on the trial pit logs also provided in Appendix 1.

The results of the contamination testing are included in Appendix 4 in Chemtech Environmental Report 79104.

2.2 Sampling Rationale

As discussed in section 1.1, the trial pit locations (TP1 – TP5) were chosen to give maximum coverage of the site as a whole for both geo-environmental considerations with TP3 being located in the area beneath the over ground storage tank once on site.

Samples chosen for contamination were targeted samples of made ground deemed the most likely to contain contamination.

3. Phase 2 Investigation Findings

3.1 Encountered Ground Conditions

The trial pits were located principally within areas of soft landscaping where exposure to the soils by the end user would be greatest.

3.1.1 Machine Excavated Trial Pits (TP1-TP5)

In each case the trial pits encountered made ground overlying natural strata. Trial Pits TP1, TP3, TP4 and TP5 encountered made ground to between depths of 0.30m to 0.35m of soft/loose very sandy gravelly clay with brick and sandstone gravel though TP1 was underlain by further made ground of soft partially sandy gravelly clay, again with gravel of sandstone and brick. TP2 at the far west of the site encountered different made ground of mostly gravel then builders sand followed by sandy gravelly clay.

Each trial pit below the made ground then encountered clayey silty sand/sandy silty clay to termination.

The detailed results of these analyses are presented in Chemtech Environmental Ltd. report no. 79104 in Appendix 2 of this report.

All five of the trial pits remained stable and dry on completion and detailed logs are presented in Appendix 1 of this report.

4. Contamination Testing

The Phase 1 desk study had identified that most credible sources of made ground and/or possible contamination within the site would be the previous development of site and the over ground storage tank. In light of this, the risk of significant contamination being present at the site was deemed to be low to moderate.

It was considered that if former land uses within and near to the site had caused contamination the contaminants would most probably occur in the near surface or shallow made ground or topsoil horizons and perhaps in deeper made ground if present or potentially within the underlying natural soils if contaminants were found to be mobile.

Therefore five (5) samples of near-surface (0.20m) made ground recovered from across the site were tested for a range of substances. These included common contaminants such as Arsenic, Lead and Cadmium which are normally included in a general human health contamination suite together with analysis for Speciated PAHs and Asbestos. In addition, testing was also carried out for petroleum hydrocarbons where deemed appropriate. Leachate from two (2) of the samples was analysed also to check for potential contaminant mobility.

The results of the contamination testing are included in the Chemtech Environmental Ltd. Report (ref 79104) presented in Appendix 3 of this report and have been used in the contamination risk assessment set out in the following sections.

5. Risk Assessment

5.1 Method

Geoinvestigate Ltd. uses a combination of assessment criterion provided by the Environment Agency, DEFRA and by the Chartered Institute of Environmental Health in order to assess the presence of potentially harmful chemicals within soils and water. These include; Environment Agency Environmental Quality Standards (EQSs) and Soil Guideline Values (SGVs), Site Specific Assessment Criteria (SSAC) generated using CLEA software version 1.06 site specific risk assessment modelling, DEFRA Category 4 Screening Levels (C4SLs), and Land Quality Management / Chartered Institute of Environmental Health (LQM/CIEH) Safe for Use Levels (S4ULs).

As the site is to be developed as a dwelling it is considered appropriate to treat it as falling within the **Residential** end-use category with an allowance for plant uptake as it is possible that the site users will consume products grown at the site.

No site-specific assessment criteria (SSAC) have been created for the site as no unusual circumstances (i.e. occupation periods etc.) are considered to be present/likely at the site that would render the generic residential assessment criteria unsuitable.

The results of the contamination testing that has been carried out have been compared to the soil quality values from the above sources. Where they fall below these limit value, they have been deemed safe for a residential end-use category.

Where results are above the intervention values, an assessment of the available pathways and receptors has been carried out to determine whether further investigation or remediation is necessary.

An appraisal of the chemical results and relevant limits is set out in the Contamination Risk Assessment that follows.

5.2 Contamination Risk to Identified Receptors

5.2.1 Contamination Risk to Human Health

Made ground was encountered to depths of between 0.30m and 0.60m in each case. Samples from the made ground at 0.20m in each trial pit were taken and submitted for chemical analysis.

Therefore, based on the encountered depths of made ground at the site together with the favourable appearance of the encountered soils and limited sources of contamination there was considered to be a low risk of contamination at the site.

No hydrocarbon staining, odours, obvious chemical substances or signs of physical contamination such as glass or metal shards were noted in any of the material uncovered in the boreholes. Neither was there any visible evidence of Asbestos contamination such as roofing board. In light of this it was not anticipated that chemical or physical contamination would pose a significant hazard for the new development and its users but given the former land use, analysis would be required to confirm this.

As discussed earlier in the report, levels of determinands have been compared to the soil assessment criteria for **Residential** end-use with allowance for plant uptake, as published by the Environment Agency, DEFRA and LQM/CIEH.

The results of the analyses of five (5) samples of soil recovered from the site from depths of 0.20m returned concentrations of a range of substances falling below respective assessment criteria adopted from the sources named above with no exceptions. A summary of the returned soil concentrations together with the adopted assessment criteria is presented in Table 1 on the following page.

A mean Total Organic Carbon Content (TOC) of 1.72% and mean Soil Organic Matter Content (SOM) of 2.96% (estimated from the TOC) were returned from the soil analyses. Therefore, the LQM/CIEH GAC for PAHs and Hydrocarbons were chosen using the Soil Organic Matter (SOM) option of 2.5% as a conservative choice.

Table 2: Chemical Determinands in Soils

	Range of Returned concentrations (mg/kg)	Residential EA SGV or DEFRA C4SL (mg/kg)	LQM/CIEH S4UL* (mg/kg)
Asbestos	None detected (3 samples tested)	Any presence unacceptable	
Arsenic	13 – 14	32/37***	37
Boron	2.0 – 3.4		290
Cadmium	<0.2 – 0.2	10/26***	11
Chromium VI	<1	21***	6
Chromium III	36 – 50		910
Copper	10 – 23		2400
Lead	18 – 95	200***	200
Mercury (elemental)	<0.5	1	1.2
Nickel	17 – 30		180
Selenium	0.7 – 0.8	350	250
Zinc	58 – 120		3700
pH	7.9 – 8.0	See Report Section 7.2 "Concrete Design"	
Water Soluble SO_4	16 – 64		
Phenol	<0.5	420	550
Total PAH	<0.34 – 4.60		
PAH Naphthalene	<0.02 – 0.03		5.6
PAH Acenapthylene	<0.02		420
PAH Acenapthene	<0.02		510
PAH Fluorene	<0.02		400
PAH Phenanthrene	<0.02 – 0.22		220
PAH Anthracene	<0.02		5400
PAH Fluoranthene	<0.02 – 0.84		560
PAH Pyrene	<0.02 – 0.80		1200
PAH Benzo[a]anthracene	<0.02 – 0.37		11
PAH Chrysene	<0.03 – 0.43		22
PAH Benzo(b)fluoranthene	<0.02 – 0.64		3.3
PAH Benzo(k)fluoranthene	<0.03 – 0.21		93
PAH Benzo(a)pyrene	<0.02 – 0.44	5***	2.7
PAH Indeno(123-cd)pyrene	<0.02 – 0.31		36
PAH Dibenzo(a,h)anthracene	<0.02		0.28
PAH Benzo(ghi)perylene	<0.02 – 0.31		340
TPH Aromatic C5-C7	<0.01 (Two samples only)	0.87***(benzene)	140
TPH Aromatic C7-C8	<0.01 (Two samples only)		290
TPH Aromatic C8-C10	<0.01 (Two samples only)		83
TPH Aromatic C10-C12	<1 (Two samples only)		180
TPH Aromatic C12-C16	<1 (Two samples only)		330
TPH Aromatic C16-C21	<1 (Two samples only)		540
TPH Aromatic C21-C35	<1 – 1 (Two samples only)		1500
TPH Aromatic C35-C44	<1 (Two samples only)		1500
TPH Aliphatic C5-C6	<0.1 (Two samples only)		78
TPH Aliphatic C6-C8	<0.1 (Two samples only)		230
TPH Aliphatic C8-C10	<0.1 (Two samples only)		65
TPH Aliphatic C10-C12	<4 (Two samples only)		330 (118)**
TPH Aliphatic C12-C16	<4 – 15 (Two samples only)		2400 (59)**
TPH Aliphatic C16-C35	10 – 98 (Two samples only)		92000 (21)**
TPH Aliphatic C35-C44	<10 – 46 (Two samples only)		92000 (21)**

*For residential use with an allowance for plant uptake / consumption of homegrown produce and SOM of 2.5% where relevant.

**Value in parentheses denotes estimated soil saturation limit above which a possibility of free-phase contamination might exist in soil.

***DEFRA C4SL for residential use with allowance for plant uptake / consumption of homegrown produce.

As can be seen from the results in Table 1 and the detailed results presented in Chemtech Environmental Ltd. report 79104 (Appendix 2) the majority of the returned results are less than the adopted assessment criteria

Where slightly elevated levels of some fractions of aliphatic hydrocarbons were returned, these were within the adopted soil limits. However, these concentrations exceeded the estimated soil saturation limits for the soils. Where this is the case some risk of free-phase contamination might sometimes be inferred from the results (where hydrocarbons are not adsorbed onto the soil structure and are therefore 'free' to migrate or perhaps enter the vapour phase). Staining, residues and odours are often indicators that this may be the case however no soils showed such evidence, even where slightly elevated levels of heavier aliphatic hydrocarbon fractions have been noted, and therefore no soils at the site would be considered to contain free-phase contamination.

5.2.2 Contamination Risk to Controlled Waters

Leachate from samples of the investigation have been tested to investigate potential contaminant mobility. The screening of these returned generally negligible concentrations and concentrations below detectable limits and/or safe levels for domestic water supply or the protection of aquatic life levels as published by the Environment Agency which were used as the assessment criteria. The results of the testing and the assessment criteria are shown Table 3 below. The results from the previous investigation are also presented in Table 3 in a separate column.

Table 3: Chemical Determinands in Leachate

	Returned Concentrations (µg/l)	UK Standard for Surface Waters intended for Drinking Water Abstraction* (DW) and/or protection of Aquatic Life in surface waters* (Aq) (µg/l)
Inorganic Chemicals		
Arsenic	6.20 – 10.92	**50-100** (DW, range: 50-100) (No Aq standard)
Boron	23 – 24	**1000** (DW & Aq)
Cadmium	<0.07 (both)	**5** (DW & Aq)
Chromium	<0.2 (both)	**50** (DW) / **5-250** (Aq, range: 5-250)
Copper	1.6 – 3.7	**50** (DW) / **5-112** (Aq, range: 5-112)
Lead	<0.2 – 0.5	**50** (DW) / **4-250** (Aq, range: 4-250
Mercury (elemental Hg)	<0.008	**1** (DW & Aq)
Nickel	0.7 – 2.4	**20**** (DW) / **50-200** (Aq, range: 50-200)
Selenium	0.17 – 0.28	**10** (DW) (No Aq standard)
Zinc	<1	**3000** (DW, range: 3000-5000) / **30-2000** (Aq, range: 30-2000)
pH	8.2 – 8.5	**Range 5.5 to 10** (UK drinking water standards)
Organic Chemicals		
Phenols	<10 – 12	**50****(DW) / **300** (Aq)
PAHs (total)	<1.6 – 6.3	**0.2** (DW, range: 0.2-1.0) (No Aq standard)
Individual PAH species at detectable levels:		
Acenaphthene	<0.1 – 1.0	No applicable UK standard
Fluoranthene	<0.1 – **1.2**	**1** (surface water quality, max. allowable)
Fluorene	<0.1 – 1.2	No applicable UK standard
Phenanthrene	0.8 – 2.9	No applicable UK standard

*sourced from Environment Agency database at http://evidence.environment-agency.gov.uk/ChemicalStandards/home.aspx.
If more than one option is available (dependant on other water properties or environmental setting) the lowest value has been adopted.
**Standard for water supply as no standard available for surface water abstraction for drinking water.
*** Sum of USEPA 16, each at Lower Limit of Detection of <0.1
**** Sum of TPHs each at lower limit of detection of <0.1

Levels of potential contaminants in analysed leachates generally returned negligible concentrations and concentrations below detectable limits and/or adopted assessment criteria.

Concentrations of the individual PAHs have been compared to surface water quality standards in the absence of any viable alternative standards. These standards are however not strictly applicable to leachates.

The single very minor exceedance of the assessment criteria options for Fluoranthene 1.2(µg/l) (TP5 at 0.20m) is not considered to be of any significance. In addition, these elevated results in leachate might be considered unexpected given the consistently low PAH content of these same samples of made ground (by weight in soil).

As such, while the PAHs might be relatively mobile, the low total PAH content of the soil mass and small quantity of these soils (consistently ≤0.30m deep), would suggest that the overall potential for leaching will be relatively very low; i.e. the total quantity that *can* be leached from the made ground will be unlikely to cause any significant damage to local water quality in the wider context of the site setting.

Couple this consideration with the fact that some of the site will be under buildings or hardstanding in the proposed development where no water ingress into soils will be possible, and the overall risk from leaching PAHs must be concluded to be low.

5.3 Review of Results

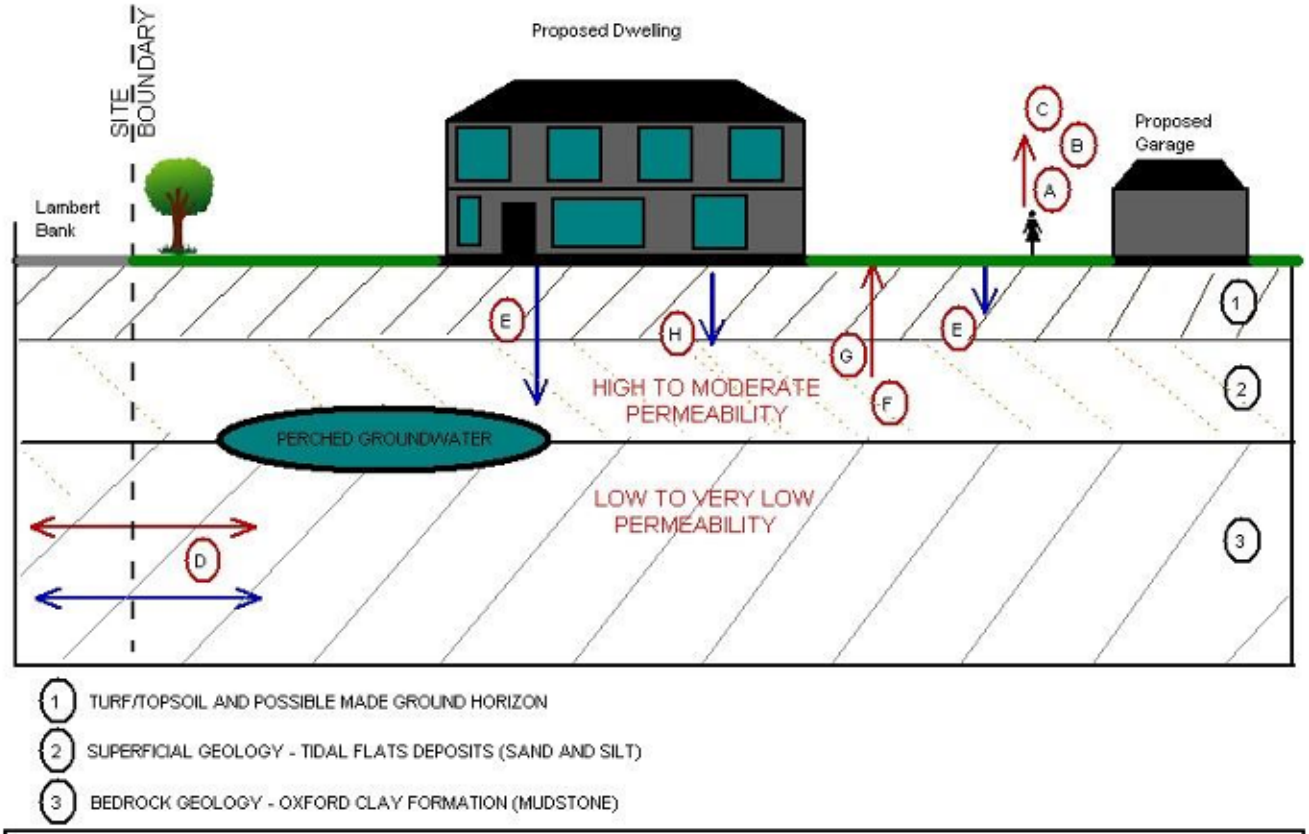
Of the six additional samples analysed as part of the current investigation no potential contaminants were found at elevated levels in any of the analysed samples and no asbestos was detected in any of the three samples inspected. One minor exceedance was noted in the leachate analysis for Fluoranthene though, as explained above, this is not at a high enough level to be of concern.

With all analysis results falling below the adopted assessment criteria it is therefore concluded that the investigation works have shown the site to be uncontaminated and fit for purpose in the context of the proposed residential end use and that no remedial works will be required.

5.3.1 CGHM

The conceptual ground hazard model (CGHM) presented on the following page shows the potential hazards and pollutant linkages which have been considered at the site.

Figure 1: CGHM – Conceptual cross section of site including a Source, Pathway and Receptor Model



IDENTIFIED HAZARDS Including Potential **CONTAMINATION SOURCES**

-Minor development and demolition activity on site
-Residential development including utilities and services
-Possible presence of made/in filled ground associated with residential development.
-Potential hazardous gas sourced from made/in-filled ground on and around site. (Thought unlikely)
-Ground instabilty via compresible deposits and running sand.

IDENTIFIED **RECEPTORS** and ASSOCIATED **PATHWAY**

A - End Users through Direct Contact / Inhalation / Ingestion. Buildings and hard-standing will encompass some of the site, removing any pathway to end users through direct contact in these areas.
B - Plants and Trees through uptake.
C - End Users through cultivation and consumption of vegetables / fruit. Possible given the intended end use of the site.
D - Neighbouring Sites through lateral migration (in soil and water, including surface water run-off).
Linkages A to D not present due to low level of contaminants returned
E - Ground water through leaching of sub-soil.
No mobile contaminants identified
F - Building and services through direct contact.
Ground not agressive with regard to concrete design
G -End users and buildings through ground gas migration.
Not within scope of investigation. Phase 1 study regarded gas migration risk as Very Low
H - Buidlings and structures due to ground instability via compressible deposits (moderate) and running sand (high)
Not within scope of investigation. Known as being dealt with by other parties

6. Hazardous Gas

6.1 Gas Regime

The findings of the earlier Phase 1 Desk Study Report suggested that there were only limited sources for ground gas to be generated at the site.

On assessment of the actual ground conditions at the site during the course of the intrusive investigation works confirmed the above thereby, the attending geo-environmental engineer deemed that the installation of ground gas monitoring wells and associated ongoing monitoring visits would be unnecessary. This decision was taken based on the almost completely natural, undisturbed condition of soils throughout much of the site (and there generally ≤0.40m, of made ground present at site surface), and the obviously low organic content of subsoils encountered in the trial pits sunk at the site.

Natural underlying soils, being sandy silt, are concluded to be of very low organic content and the tested soils have returned results indicating a low organic content. In addition, previous SI works at the site had not indicated any organic peat horizons within the 2.7m of natural silt beneath the site.

Guidance published in CL:AIRE research bulletin RB17 ("A Pragmatic Approach to Ground Gas Risk Assessment." CL:AIRE, November 2012) allows assessment of likely ground gas risk for the majority of proposed development sites without a necessity for monitoring.

Table A1 in Appendix A (page 9) of that document states that gas monitoring or protection measures would not be expected to be required at sites with "natural soils with low organic content and less than 1m of made ground that comprises general infill". The entirety of the study site certainly falls into this category.

As such no gas protection measures are anticipated to be required in proposed new structures at the site.

Given the above review of ground conditions, it is concluded that the costs and delays of a full gas monitoring exercise at the site would not easily be justified.

6.2 Radon Gas

The desk study findings confirmed that Radon protection is not necessary for new buildings at the site.

7 Conclusions

7.1 Contamination

Analysis of the ground conditions at the site and an assessment of the potential pathways have confirmed that soils at the site are generally uncontaminated and fit for purpose in the proposed residential end use.

No risk to local ground and/or surface waters has been identified.

Consequently, no remediation will be required at the site.

7.2 Concrete Design

The results of chemical analyses of the fill returned Water Soluble Sulphate levels of between 16mgl^{-1} and 64mgl^{-1} and pH levels of between 8.2 to 8.5. On this basis concrete in contact with the ground may be designed to ACEC Class DS-1 AC-1s of "BRE Special Digest 1 – Concrete in aggressive ground".

END OF REPORT

The findings and contents of this (intrusive) Site Investigation Report pertain solely to the study area(s) outlined herein and are based solely on the findings of the excavations undertaken as part of the current exercise unless otherwise stated. The findings and/or recommendations of this report do not take into account any ground conditions that may be present but have hitherto not been encountered and as such further investigation and/or a reconsideration of the findings of this report should be undertaken if such conditions are subsequently encountered or an alternative development plan or land use is subsequently proposed.

This report considers various environmental and/or geological risks posed to the site and/or proposed development and offers advice accordingly as guidance only. The findings of this report will remain valid provided no change of ground or groundwater conditions, either natural or anthropogenic, take place and no warrantee is offered or implied.

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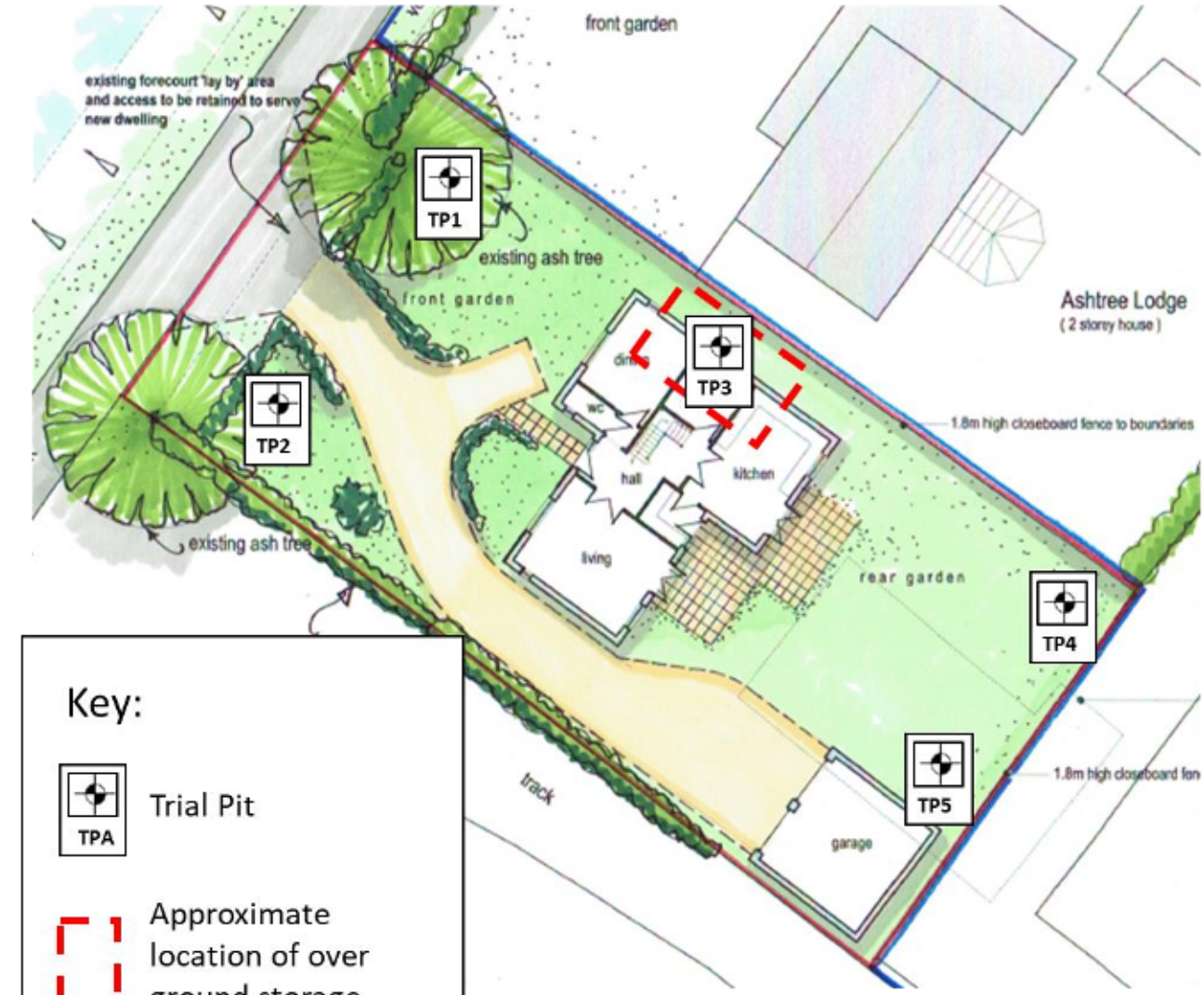
APPENDIX 1

Site Plan,

Trial Pit Logs

GEOINVESTIGATE Ltd.

OUR REF: G19175	YOUR REF:	SITE PLAN (NOT TO SCALE)
DATE: 21/05/19	LOCATION: Ashtree Lodge, Lambert Bank, Gedney Hill PE12 0PR	



GEOINVESTIGATE Ltd.

Your Ref. **Our Ref.** G19175 **TP No.1** **Sheet No. 1 of 1**
Location: Ashtree Lodge, Lambert Bank, Gedney Hill, Spalding PE12 0PR **DATE**: 21/05/19

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.30	MADE GROUND. 'Loose/Soft' brown and dark brown sandy gravelly clay. Gravel is fine to coarse of sandstone and brick	300			O	Cv kN/m^2			0.20
0.60	MADE GROUND. 'Soft' light brown sandy gravelly clay. Gravel is fine to coarse of brick and sandstone.	300							0.50
0.90	Loose' light brown and orange clayey silty SAND/sandy SILT	300			O				0.70 0.90
	Trial Pit terminated at 0.90m								

Remarks:
No casing
Machine excavated to 0.90m
Trial pit remained stable and dry on completion

Key:
Slotted Pipe
Plain Pipe
Bentonite
Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

TP1

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref.** G19175 **BH No.2** **Sheet No. 1 of 1**
Location: Ashtree Lodge, Lambert Bank, Gedney Hill, Spalding PE12 0PR **DATE**: 21/05/19

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.10	MADE GROUND. 'Dense' sandy fine to	100				Cv kN/m^2			
0.20	coarse gravel of sandstone	100			O				0.20
0.40	MADE GROUND. 'Dense' yellow builders sand.	200							
	MADE GROUND. 'Medium dense' red and purple clayey gravelly sand. Gravel is fine to coarse and cobbles of brick and sandstone	500							0.50
0.90	Loose' light brown and orange clayey silty SAND/sandy SILT				O				0.70 0.90
	Trial Pit terminated at 0.90m								

Remarks:
No casing
Machine excavated to 0.90m
Trial pit remained stable and dry on completion

Key:
Slotted Pipe
Plain Pipe
Bentonite
Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

TP2

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref.** G19175 **TP No.3** **Sheet No. 1 of 1**
Location: Ashtree Lodge, Lambert Bank, Gedney Hill, Spalding PE12 0PR **DATE**: 21/05/19

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.30	MADE GROUND. 'Loose/Soft' brown and dark brown sandy gravelly clay. Gravel is fine to coarse of sandstone and brick	300			O	Cv kN/m^2			0.20
0.90	Loose' light brown and orange clayey silty SAND/sandy SILT	600			O				0.50 0.70 0.90
	Trial Pit terminated at 0.90m								

Remarks:
No casing
Machine excavated to 1.00m
Trial pit remained stable and dry on completion

Key:
Slotted Pipe
Plain Pipe
Bentonite
Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

TP3

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref.** G19175 **TP No.4** **Sheet No. 1 of 1**
Location: Ashtree Lodge, Lambert Bank, Gedney Hill, Spalding PE12 0PR **DATE**: 21/05/19

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.35	MADE GROUND. 'Loose/Soft' brown and dark brown sandy gravelly clay. Gravel is fine to coarse of sandstone and brick	350			O	Cv kN/m^2			0.20
1.00	Loose' light brown and orange clayey silty SAND/sandy SILT	650			O				0.50 0.75 1.00
	Trial pit terminated at 1.00m								

Remarks:
No casing
Machine excavated to 1.00m
Trial pit remained stable and dry on completion

Key:
Slotted Pipe
Plain Pipe
Bentonite
Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

TP4

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref.** G19175 **BH No.5** **Sheet No. 1 of 1**
Location: Ashtree Lodge, Lambert Bank, Gedney Hill, Spalding PE12 0PR **DATE**: 21/05/19

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
	MADE GROUND. 'Loose/Soft' brown and dark brown sandy gravelly clay. Gravel is	300			O	Cv kN/m^2			0.20
0.30	fine to coarse of sandstone and brick								
	Loose' light brown and orange clayey silty SAND/sandy SILT	600			O				0.50
0.90									0.70
	Trial Pit terminated at 0.90m								0.90

Remarks:
No casing
Machine excavated to 0.90m
Trial pit remained stable and dry on completion

Key:
Slotted Pipe
Plain Pipe
Bentonite
Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

TP5

APPENDIX 2

Chemtech Analytical Test Report

ANALYTICAL TEST REPORT

Contract no:	79104
Contract name:	Land adj Ashtree Lodge, Lambert Bank, Gedney Hill PE12 0PR
Client reference:	G19175
Clients name:	Geo Investigate
Clients address:	Units 3a & 4 Terry Dicken Industrial Estate Ellerbeck Way, Stokesley North Yorkshire TS9 7AE
Samples received:	31 May 2019
Analysis started:	31 May 2019
Analysis completed:	07 June 2019
Report issued:	07 June 2019

Notes:

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

Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.

Methods, procedures and performance data are available on request.

Results reported herein relate only to the material supplied to the laboratory.

This report shall not be reproduced except in full, without prior written approval.

Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

BTEX compounds are identified by retention time only and may include interference from co-eluting compounds.

Key:

U UKAS accredited test

M MCERTS & UKAS accredited test

$ Test carried out by an approved subcontractor

I/S Insufficient sample to carry out test

N/S Sample not suitable for testing

NAD No Asbestos Detected

Approved by:

J. Campbell

John Campbell
Director

Chemtech Environmental Limited

SAMPLE INFORMATION

MCERTS (Soils):

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

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

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
79104-1	TP1	0.20	Clay with Gravel & Roots	-	-	21.6
79104-2	TP2	0.20	Clay with Gravel & Roots	-	-	17.8
79104-3	TP3	0.20	Clay with Gravel & Roots	-	-	15.2
79104-4	TP4	0.20	Clay with Gravel & Roots	-	-	16.0
79104-5	TP5	0.20	Clay with Gravel & Roots	-	-	16.6

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SOILS

Lab number			79104-1	79104-2	79104-3	79104-4	79104-5
Sample id			TP1	TP2	TP3	TP4	TP5
Depth (m)			0.20	0.20	0.20	0.20	0.20
Date sampled			21/05/2019	21/05/2019	21/05/2019	21/05/2019	21/05/2019
Test	**Method**	**Units**					
Arsenic (total)	CE127 M	mg/kg As	13	14	13	14	14
Boron (water soluble)	CE129	mg/kg B	2.2	3.4	2.1	2.2	2.0
Cadmium (total)	CE127 M	mg/kg Cd	0.2	0.2	<0.2	<0.2	<0.2
Chromium (total)	CE127 M	mg/kg Cr	37	38	38	50	36
Chromium (III)	-	mg/kg CrIII	37	38	38	50	36
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1	<1
Copper (total)	CE127 M	mg/kg Cu	14	23	12	16	10
Lead (total)	CE127 M	mg/kg Pb	49	95	68	22	18
Mercury (total)	CE127 M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel (total)	CE127 M	mg/kg Ni	17	30	17	21	18
Selenium (total)	CE127 M	mg/kg Se	0.8	0.7	0.7	0.8	0.8
Zinc (total)	CE127 M	mg/kg Zn	119	89	65	120	58
pH	CE004 M	units	8.0	8.0	7.9	7.9	8.1
Sulphate (2:1 water soluble)	CE049 U	mg/l SO_4	23	58	25	64	16
Sulphide	CE079	mg/kg S^{2-}	<10	<10	<10	<10	<10
Cyanide (free)	CE077	mg/kg CN	<1	<1	<1	<1	<1
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1	<1
Thiocyanate	CE145 M	mg/kg SCN	1.8	<1	<1	<1	<1
Phenols (total)	CE078	mg/kg PhOH	<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon (TOC)	CE072 M	% w/w C	2.3	2.5	1.2	1.6	1.0
Estimate of OMC (calculated from TOC)	CE072 M	% w/w	4.0	4.3	2.1	2.7	1.7
PAH							
Acenaphthene	CE087 M	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	CE087 M	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	CE087 U	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(a)anthracene	CE087 U	mg/kg	<0.02	0.37	<0.02	0.20	<0.02
Benzo(a)pyrene	CE087 U	mg/kg	<0.02	0.44	<0.02	0.20	<0.02
Benzo(b)fluoranthene	CE087 M	mg/kg	<0.02	0.64	<0.02	0.34	<0.02
Benzo(ghi)perylene	CE087 M	mg/kg	<0.02	0.31	<0.02	0.13	<0.02
Benzo(k)fluoranthene	CE087 M	mg/kg	<0.03	0.21	<0.03	0.06	<0.03
Chrysene	CE087 M	mg/kg	<0.03	0.43	<0.03	0.21	<0.03
Dibenz(ah)anthracene	CE087 M	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	CE087 M	mg/kg	0.08	0.84	0.07	0.47	<0.02
Fluorene	CE087 U	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Indeno(123cd)pyrene	CE087 M	mg/kg	<0.02	0.31	<0.02	0.12	<0.02
Naphthalene	CE087 M	mg/kg	<0.02	0.03	<0.02	<0.02	<0.02
Phenanthrene	CE087 M	mg/kg	<0.02	0.22	<0.02	0.10	<0.02
Pyrene	CE087 M	mg/kg	0.08	0.80	0.05	0.41	<0.02
PAH (total of USEPA 16)	CE087	mg/kg	<0.34	4.60	<0.34	2.23	<0.34
BTEX & TPH							
Benzene	CE057 U	mg/kg	<0.01	-	<0.01	-	-

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SOILS

Lab number			79104-1	79104-2	79104-3	79104-4	79104-5
Sample id			TP1	TP2	TP3	TP4	TP5
Depth (m)			0.20	0.20	0.20	0.20	0.20
Date sampled			21/05/2019	21/05/2019	21/05/2019	21/05/2019	21/05/2019
Test	**Method**	**Units**					
Toluene	CE057 U	mg/kg	<0.01	-	<0.01	-	-
Ethylbenzene	CE057 U	mg/kg	<0.01	-	<0.01	-	-
m & p-Xylene	CE057 U	mg/kg	<0.02	-	<0.02	-	-
o-Xylene	CE057 U	mg/kg	<0.01	-	<0.01	-	-
VPH Aromatic (>EC5-EC7)	CE067	mg/kg	<0.01	-	<0.01	-	-
VPH Aromatic (>EC7-EC8)	CE067	mg/kg	<0.01	-	<0.01	-	-
VPH Aromatic (>EC8-EC10)	CE067	mg/kg	<0.01	-	<0.01	-	-
EPH Aromatic (>EC10-EC12)	CE068	mg/kg	<1	-	<1	-	-
EPH Aromatic (>EC12-EC16)	CE068	mg/kg	<1	-	<1	-	-
EPH Aromatic (>EC16-EC21)	CE068	mg/kg	<1	-	<1	-	-
EPH Aromatic (>EC21-EC35)	CE068	mg/kg	1	-	<1	-	-
EPH Aromatic (>EC35-EC44)	CE068	mg/kg	<1	-	<1	-	-
VPH Aliphatic (>C5-C6)	CE067	mg/kg	<0.1	-	<0.1	-	-
VPH Aliphatic (>C6-C8)	CE067	mg/kg	<0.1	-	<0.1	-	-
VPH Aliphatic (>C8-C10)	CE067	mg/kg	<0.1	-	<0.1	-	-
EPH Aliphatic (>C10-C12)	CE068	mg/kg	<4	-	<4	-	-
EPH Aliphatic (>C12-C16)	CE068	mg/kg	15	-	<4	-	-
EPH Aliphatic (>C16-C35)	CE068	mg/kg	98	-	10	-	-
EPH Aliphatic (>C35-C44)	CE068	mg/kg	46	-	<10	-	-
Subcontracted analysis							
Asbestos (qualitative)	$	-	NAD	-	-	NAD	NAD

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PREPARED LEACHATES

Lab number			79104-3L	79104-5L
Sample id			TP3	TP5
Depth (m)			0.20	0.20
Test	**Method**	**Units**		
Arsenic (dissolved)	CE128 U	µg/l As	6.20	10.92
Boron (dissolved)	CE128 U	µg/l B	24	23
Cadmium (dissolved)	CE128 U	µg/l Cd	<0.07	<0.07
Chromium (dissolved)	CE128 U	µg/l Cr	<0.2	<0.2
Copper (dissolved)	CE128 U	µg/l Cu	3.7	1.6
Lead (dissolved)	CE128 U	µg/l Pb	0.5	<0.2
Mercury (dissolved)	CE128 U	µg/l Hg	<0.008	<0.008
Nickel (dissolved)	CE128 U	µg/l Ni	2.4	0.7
Selenium (dissolved)	CE128 U	µg/l Se	0.28	0.17
Zinc (dissolved)	CE128 U	µg/l Zn	<1	<1
pH	CE004 U	units	8.2	8.5
Sulphate	CE049 U	mg/l SO_4	<10	<10
Sulphur (dissolved)	CE128 U	mg/l S	2.0	0.9
Sulphide	CE079	µg/l S^{2-}	<100	<100
Cyanide (free)	CE147	µg/l CN	<20	<20
Cyanide (total)	CE147	µg/l CN	<20	<20
Thiocyanate	CE014	µg/l SCN	<200	<200
Phenols (total)	CE148	µg/l PhOH	12	<10
PAH				
Acenaphthene	CE051	µg/l	<0.1	1.0
Acenaphthylene	CE051	µg/l	<0.1	<0.1
Anthracene	CE051	µg/l	<0.1	<0.1
Benzo(a)anthracene	CE051	µg/l	<0.1	<0.1
Benzo(a)pyrene	CE051	µg/l	<0.1	<0.1
Benzo(b)fluoranthene	CE051	µg/l	<0.1	<0.1
Benzo(ghi)perylene	CE051	µg/l	<0.1	<0.1
Benzo(k)fluoranthene	CE051	µg/l	<0.1	<0.1
Chrysene	CE051	µg/l	<0.1	<0.1
Dibenz(ah)anthracene	CE051	µg/l	<0.1	<0.1
Fluoranthene	CE051	µg/l	<0.1	1.2
Fluorene	CE051	µg/l	<0.1	1.2
Indeno(123cd)pyrene	CE051	µg/l	<0.1	<0.1
Naphthalene	CE051	µg/l	<0.1	<0.1
Phenanthrene	CE051	µg/l	0.8	2.9
Pyrene	CE051	µg/l	<0.1	<0.1
PAH (total of USEPA 16)	CE051	µg/l	<1.6	6.3

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE127	Arsenic (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg As
CE129	Boron (water soluble)	Hot water extract, ICP-MS	Dry		0.5	mg/kg B
CE127	Cadmium (total)	Aqua regia digest, ICP-MS	Dry	M	0.2	mg/kg Cd
CE127	Chromium (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cr
-	Chromium (III)	Calculation: Cr (total) - Cr (VI)	Dry		1	mg/kg CrIII
CE146	Chromium (VI)	Acid extraction, Colorimetry	Dry		1	mg/kg CrVI
CE127	Copper (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cu
CE127	Lead (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Pb
CE127	Mercury (total)	Aqua regia digest, ICP-MS	Dry	M	0.5	mg/kg Hg
CE127	Nickel (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Ni
CE127	Selenium (total)	Aqua regia digest, ICP-MS	Dry	M	0.3	mg/kg Se
CE127	Zinc (total)	Aqua regia digest, ICP-MS	Dry	M	5	mg/kg Zn
CE004	pH	Based on BS 1377, pH Meter	As received	M	-	units
CE049	Sulphate (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	10	mg/l SO_4
CE079	Sulphide	Extraction, Continuous Flow Colorimetry	As received		10	mg/kg S^{2-}
CE077	Cyanide (free)	Extraction, Continuous Flow Colorimetry	As received		1	mg/kg CN
CE077	Cyanide (total)	Extraction, Continuous Flow Colorimetry	As received		1	mg/kg CN
CE145	Thiocyanate	Weak acid extraction, Colorimetry	Dry	M	1	mg/kg SCN
CE078	Phenols (total)	Extraction, Continuous Flow Colorimetry	As received		0.5	mg/kg PhOH
CE072	Total Organic Carbon (TOC)	Removal of IC by acidification, Carbon Analyser	Dry	M	0.1	% w/w C
CE072	Estimate of OMC (calculated from TOC)	Calculation from Total Organic Carbon	Dry	M	0.1	% w/w
CE087	Acenaphthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Acenaphthylene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Anthracene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Benzo(a)anthracene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Benzo(a)pyrene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Benzo(b)fluoranthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(ghi)perylene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(k)fluoranthene	Solvent extraction, GC-MS	As received	M	0.03	mg/kg
CE087	Chrysene	Solvent extraction, GC-MS	As received	M	0.03	mg/kg
CE087	Dibenz(ah)anthracene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Fluoranthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Fluorene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Indeno(123cd)pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Naphthalene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Phenanthrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	PAH (total of USEPA 16)	Solvent extraction, GC-MS	As received		0.34	mg/kg
CE057	Benzene	Headspace GC-FID	As received	U	0.01	mg/kg
CE057	Toluene	Headspace GC-FID	As received	U	0.01	mg/kg
CE057	Ethylbenzene	Headspace GC-FID	As received	U	0.01	mg/kg
CE057	m & p-Xylene	Headspace GC-FID	As received	U	0.02	mg/kg
CE057	o-Xylene	Headspace GC-FID	As received	U	0.01	mg/kg
CE067	VPH Aromatic (>EC5-EC7)	Headspace GC-FID	As received		0.01	mg/kg

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE067	VPH Aromatic (>EC7-EC8)	Headspace GC-FID	As received		0.01	mg/kg
CE067	VPH Aromatic (>EC8-EC10)	Headspace GC-FID	As received		0.01	mg/kg
CE068	EPH Aromatic (>EC10-EC12)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC12-EC16)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC16-EC21)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC21-EC35)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC35-EC44)	Solvent extraction, GC-FID	As received		1	mg/kg
CE067	VPH Aliphatic (>C5-C6)	Headspace GC-FID	As received		0.1	mg/kg
CE067	VPH Aliphatic (>C6-C8)	Headspace GC-FID	As received		0.1	mg/kg
CE067	VPH Aliphatic (>C8-C10)	Headspace GC-FID	As received		0.1	mg/kg
CE068	EPH Aliphatic (>C10-C12)	Solvent extraction, GC-FID	As received		4	mg/kg
CE068	EPH Aliphatic (>C12-C16)	Solvent extraction, GC-FID	As received		4	mg/kg
CE068	EPH Aliphatic (>C16-C35)	Solvent extraction, GC-FID	As received		4	mg/kg
CE068	EPH Aliphatic (>C35-C44)	Solvent extraction, GC-FID	As received		10	mg/kg
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

Chemtech Environmental Limited

METHOD DETAILS

METHOD	PREPARED LEACHATES	METHOD SUMMARY	STATUS	LOD	UNITS
CE002	Leachate preparation (EA)	L:S 10:1		-	-
CE128	Arsenic (dissolved)	ICP-MS	U	0.06	µg/l As
CE128	Boron (dissolved)	ICP-MS	U	6	µg/l B
CE128	Cadmium (dissolved)	ICP-MS	U	0.07	µg/l Cd
CE128	Chromium (dissolved)	ICP-MS	U	0.2	µg/l Cr
CE128	Copper (dissolved)	ICP-MS	U	0.4	µg/l Cu
CE128	Lead (dissolved)	ICP-MS	U	0.2	µg/l Pb
CE128	Mercury (dissolved)	ICP-MS	U	0.008	µg/l Hg
CE128	Nickel (dissolved)	ICP-MS	U	0.5	µg/l Ni
CE128	Selenium (dissolved)	ICP-MS	U	0.07	µg/l Se
CE128	Zinc (dissolved)	ICP-MS	U	1	µg/l Zn
CE004	pH	Based on BS 1377, pH Meter	U	-	units
CE049	Sulphate	Ion Chromatography	U	10	mg/l SO_4
CE128	Sulphur (dissolved)	ICP-MS	U	0.2	mg/l S
CE079	Sulphide	Continuous Flow Colorimetry		100	µg/l S2-
CE147	Cyanide (free)	Continuous Flow Colorimetry		20	µg/l CN
CE147	Cyanide (total)	Continuous Flow Colorimetry		20	µg/l CN
CE014	Thiocyanate	Colorimetry		200	µg/l SCN
CE148	Phenols (total)	Continuous Flow Colorimetry		10	µg/l PhOH
CE051	Acenaphthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Acenaphthylene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Anthracene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(a)anthracene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(a)pyrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(b)fluoranthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(ghi)perylene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(k)fluoranthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Chrysene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Dibenz(ah)anthracene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Fluoranthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Fluorene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Indeno(123cd)pyrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Naphthalene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Phenanthrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Pyrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	PAH (total of USEPA 16)	Solvent extraction, GC-MS		1.6	µg/l

Chemtech Environmental Limited

DEVIATING SAMPLE INFORMATION

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

Key

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

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
79104-1	TP1	0.20	N	
79104-2	TP2	0.20	N	
79104-3	TP3	0.20	N	
79104-4	TP4	0.20	N	
79104-5	TP5	0.20	N	