

Site: St James Park, Former MMU Campus, Didsbury
Plots: 19, 25, 37-39, 801 and The Lodge
Date: 15th July 2019
NHBC Ref: Phase 2 - 713376



1 INTRODUCTION

LK Consult (LKC) has been appointed by PJ Livesey Holdings Ltd to validate the depth of the garden capping layer laid down at the development at St James Park, Former MMU Campus, Didsbury.

This validation report concerns Plots 19, 25, 37-39, 801 and The Lodge. These plots consist of a rear garden with Plots 25, 37 and 39 having a small area of soft landscaping to the front of the property. Plots 19, 38, 801 and The Lodge have a paved driveway to the front.

The requirement for remedial works across the site arose as a result of previous site investigations and risk assessments carried out by LK Consult Limited (ref. LKC 16 1066-02 Post Demolition Site Investigation, Risk Assessment and Updated Remediation Strategy, dated 15th December 2016) which outlined the remediation and validation requirements. These comprised the following recommendations:

- i) Option 1: Environmental capping layer comprising 450mm clean suitable soil in rear gardens and 300mm in front gardens and areas of landscaping over either 100mm MOT stone (included in total soil depth) or geotextile marker.
- ii) Option 2: Further sampling and risk assessment on a block by block basis (nominally a total of 4 soil samples per plot with 1 in the front garden) or selected soil samples in any landscaped areas. If soil results are below generic assessment criteria then no specific clean validated environmental cover depth will be required, but a nominal 150mm covering of topsoil as a growing medium (if required).
- iii) Validation testing of any site won or imported material to be re-used onsite in gardens and soft landscaping to ensure it is 'suitable for use'. All site won or imported material should be tested at a rate of 1 sample per 50m³ for topsoil and 1 sample per 150m³ for subsoil.
- iv) Details of unexpected contamination.
- v) Provision of waste transfer notes for any disposal of contaminated soil offsite.

A validation checklist was provided to the ground workers and presented in Appendix A.

2 IMPORTED MATERIAL

Topsoil for use in the garden and soft landscaping areas has been imported to site. The material used comprised approximately 600m³ of topsoil supplied by Huperade from a greenfield site at New Manor Farm, Stretford.

Composite topsoil samples were taken from garden areas (ref: TS401-TS403 and TS501-TS503) and subjected to the following analytical suite as a conservative measure:

- Arsenic, cadmium, total chromium, hexavalent chromium, copper, lead, zinc, selenium, nickel, vanadium, mercury, speciated PAH, boron, cyanide (free and total), total phenol, TPH CWG, BTEX, pH, soluble sulphate, asbestos and SOM.

Soil samples were collected in plastic tubs, amber glass jars and amber vials and despatched to Chemtest of Newmarket in cool boxes with ice packs.

Soil results for the topsoil are presented in Appendix B. No elevated levels of contaminants were identified in the soil samples collected when compared to Generic Assessment Criteria presented in the agreed Remediation Strategy and presented again in Appendix C.

3 CAPPING LAYER IN GARDEN AREAS

For these plots, Option 1 was undertaken by PJ Livesey. The recommendation for the garden capping layer in Plots 19, 25, 37-39, 801 and The Lodge was that it should comprise a minimum 300mm thickness to the front and 450mm to the rear with a demarcation layer.

LKC attended site on 17th April and 14th May 2019 to inspect the capping layer construction and depth in the rear and front garden areas. Photographs are provided in Appendix D and the observations are summarised below.

Location	Topsoil Depth (mm)	Subsoil Depth (mm)	Membrane or 100mm MOT	Total Depth (mm)	Required Depth (mm)	Pass (✓) or Fail (x)
Plot 19 Front	Fully Hardstood					
Plot 19 Rear	600	N/A	Membrane	600	450	✓
Plot 25 Front	500	N/A	Membrane	500	300	✓
Plot 25 Rear	570	N/A	Membrane	570	450	✓
Plot 37 Front	300	N/A	Membrane	300	300	✓
Plot 37 Rear	450	N/A	Membrane	450	450	✓
Plot 38 Front	Fully Hardstood					
Plot 38 Rear	450	N/A	Membrane	450	450	✓
Plot 39 Front	330	N/A	Membrane	330	300	✓
Plot 39 Rear	640	N/A	Membrane	640	450	✓
Plot 801 Front	Fully Hardstood					
Plot 801 Rear	500	N/A	Membrane	500	450	✓
The Lodge Front	Fully Hardstood					
The Lodge Rear	720	N/A	MOT	720	450	✓

LKC were able to verify that, in the places inspected within the front and rear gardens of Plots 19, 25, 37-39, 801 and The Lodge, and the front gardens of Plots 25, 37 and 39 the capping layer depths were in accordance with the requirements of the Remediation Strategy.

4 CONCLUSIONS

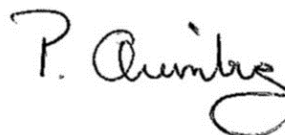
LKC has completed the validation of the garden capping layers within Plots 19, 25, 37-39, 801 and The Lodge and conclude that, in the places inspected, chemically suitable material has been laid to an appropriate depth.

Report Prepared By:



Kerrell Walley
Senior Geo-Environmental Scientist

Report Reviewed By:



Dr Paul Quimby
Director

Enc:

Appendix A: Remediation Strategy Validation Checklist

Appendix B: Certificates of Analysis – Imported Soil

Appendix C: Generic Assessment Criteria Values

Appendix D: Plot Photographs

Disclaimer

This report has been prepared by LKC who have exercised such professional skill, care and diligence as may reasonably be expected of a properly qualified and competent consultant experienced in preparing reports of a similar scope. However, to the extent that the report is based on or relies upon information contained in records, reports or other materials provided to LKC which have not been independently produced or verified, LKC gives no warranty, representation or assurance as to the accuracy or completeness of such information.

This report is issued on the condition that LKC will not be held liable for any loss arising from ground conditions between sampling points (i.e. boreholes/trial pits/hand augers/surface samples) which have not been shown by the sampling points or related testing carried out during the investigation, nor for any loss arising from conditions below the maximum depth of the investigation, or for any works done to the garden areas following the date of inspection. Opinions on such conditions, where given, are for general guidance only.

This report is prepared solely for the benefit of PJ Livesey Holdings Ltd. It may not be relied upon by, or submitted to a third party for their reliance for the purposes of valuation, mortgage, insurance and regulatory approval, until all invoices have been settled in full. Those using this information in subsequent assessments or evaluations do so at their own risk.

Appendix A – Remediation Strategy Validation Checklist

Site Works / Validation Check List – LKC 16 1066 – MMU Didsbury Housing Development



Plots	Validation Work	Additional Notes
Imported / Site Won Soil / stone	-Require information from soil provider on source and amount of soil provided (if sourced offsite). -LKC will need to collect and analyse a suitable number of samples per stockpile/source. -Topsoil tested at 1 sample 50m³. -Subsoil tested at 1 sample per 150m³. -Stone tested at 1 sample per 500m³. -If provenance proven that subsoil is natural quarried material then no testing required. -A minimum of 3 samples per source is required. -If site won material then should be stockpiled and tested at the same rate, but will need appropriate exemptions / permits to re-use onsite.	-Soil sampling should be undertaken from source or from a stockpile onsite. Can be sampled when in gardens; however, may have to be removed if unsuitable. -Soil samples will be undertaken on an accelerated 3 working day turnaround.
Option 2 Block Specific SI	-Useful if time constraints and where you do not wish for an environmental capping layer. -Nominal 3 soil sample from rear garden and 1 soil sample from front. -Selected soil sampling in landscaped (POS) areas. -All data in that block / POS will be risk assessed and a Block by Block / POS assessment and recommendations provided in a report. -This additional sampling will apply near TPO's, where the full environmental capping layer may not be able to be achieved. Due to root protection.	-If data fail then an environmental capping layer will still be required and a report will not be needed. - If soil passes and no formal environmental capping layer is required then a formal depth is not necessary. A nominal 150mm topsoil is recommended as a growing medium and to cover undesirable material.
Option 1 Garden Areas	Rear Gardens <i>Unless a Block by Block site investigation is undertaken and soil passes.</i> -450mm total depth soil capping layer (includes minimum 150m topsoil) required for these plots. -This includes a Hi-Viz geotextile at the base of the capping layer OR 100mm MOT type 1 (minimal fines) and 350mm depth soil capping layer (includes minimum 150mm topsoil).	-Site manager to photograph laying of separation geotextile OR 100mm MOT in each garden area. -LKC need to validate the depth of the cover layer by digging small hole in each garden area, measuring the depth and taking validatory photos.
Option 1 Landscaped Areas	All Front gardens and Landscaped Areas <i>Unless a Block by Block / POS site investigation is undertaken and soil passes.</i> -300mm total depth soil capping layer (includes minimum 150m topsoil) required for these landscaped areas. -This includes a Hi-Viz geotextile at the base of the capping layer OR 100mm MOT type 1 (minimal fines) and 200mm depth soil capping layer (includes minimum 150mm topsoil).	-Site manager to photograph laying of separation geotextile OR 100mm MOT in each garden area. -LKC need to validate the depth of the cover layer by digging small hole in each garden area, measuring the depth and taking validatory photos.
Site	Unexpected Contamination -During earthworks if contractor finds visual or olfactory evidence of contamination and/or asbestos then LKC should be informed and if necessary material will need to be sampled so that it can be disposed of at an appropriate licensed tip. -Material should be stockpiled on Visqueen and covered prior to disposal and/or testing. -All disposal tickets will be required for the Completion Report.	-If considerable earthworks or soil movement is occurring it would be advisable that LKC undertake a Watching Brief during earthworks.
Site	Local Authority Site Completion Report -Manchester Council require a Site Completion Report for whole site once all validation complete. -Individual plot reports may be required for NHBC for individual plot sales before site is fully completed.	-Can only be done once development is completed. -Manchester Council may provide a letter of comfort for each plot that has been completed satisfactory (if individual plot reports undertaken).

NOTE:

Minimum 24 hours notice to attend site.

Contacts

LK Consult

Unit 29, Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS Tel: 0161 763 7200

Paul Quimby – p.quimby@thelkgroup.com

Kerrell Walley – k.walley@thelkgroup.com

SUITABILITY OF ANY IMPORTED MATERIAL AS CLEAN COVER

Recommended validation sampling requirements for environmental capping layer soils presented in the following table.

Material Type	Source	Suite of Analysis	Sampling Rate
Topsoil	Greenfield	Suite A	1 sample per 50m ³ (minimum of 3 samples per source)
	Brownfield / Unknown / Site Won	Suite B	
Subsoil	Brownfield / Unknown / Site Won	Suite B	1 sample per 150m ³ (minimum of 3 samples per source)
	First Generation i.e. quarried sand (su (break layer)	No testing is required. Certification of material provenance is required.	
Physical Stone Break Layer	Recycled Stone (6F2 / min. fines)	Suite B	1 sample per 500m ³ (minimum of 3 samples per source)

Recommended validation sampling requirements for environmental capping layer soils.

Notes:

Suite A - Heavy metals, pH, water soluble sulphate, speciated PAH, soil organic matter and asbestos screen.

Suite B - Heavy metals, pH, water soluble sulphate, speciated PAH, phenol, total and free cyanide, soil organic matter, asbestos screen, banded petroleum hydrocarbons (TPH CWG), BTEX, MTBE.

ENVIRONMENTAL COVER LAYER

Private Gardens

Private garden areas should comprise a cover layer depth of at least 450mm. A typical construction detail is provided below. Subsoil may be replaced by topsoil if required.

GROUND LEVEL

450mm (minimum)		150mm (minimum) chemically validated TOPSOIL
		200mm chemically validated SUBSOIL
		100mm PHYSICAL BREAK LAYER (typically MOT Type 1)
		Existing MADE GROUND

Soft Landscaped Areas and Front Gardens

Soft landscaping areas and front gardens should comprise a cover layer depth of at least 300mm. A typical construction detail is provided below:

GROUND LEVEL

300mm (minimum)		200mm (minimum) chemically validated TOPSOIL
		100mm PHYSICAL BREAK LAYER (typically MOT Type 1)
		Existing MADE GROUND

If suitable break layer material is not available, then the **break layer may be substituted for a separation geotextile** and the subsoil / topsoil depth increased by 100mm to maintain the required capping layer material depth.

Appendix B – Certificates of Analysis – Imported Soil



Final Report

Report No.: 18-10339-1

Initial Date of Issue: 24-Apr-2018

Client LK Consult

Client Address: Unit 29 Eton Business Park
Eton Hill Road
Radcliffe
Manchester
Lancashire
M26 2ZS

Contact(s): Paul Quimby
Contaminated Land

Project LKC 16 1066 MMU Didsbury

Quotation No.: **Date Received:** 17-Apr-2018

Order No.: 736050 **Date Instructed:** 17-Apr-2018

No. of Samples: 3

Turnaround (Wkdays): 5 **Results Due:** 23-Apr-2018

Date Approved: 24-Apr-2018

Approved By:



Details: Glynn Harvey, Laboratory Manager

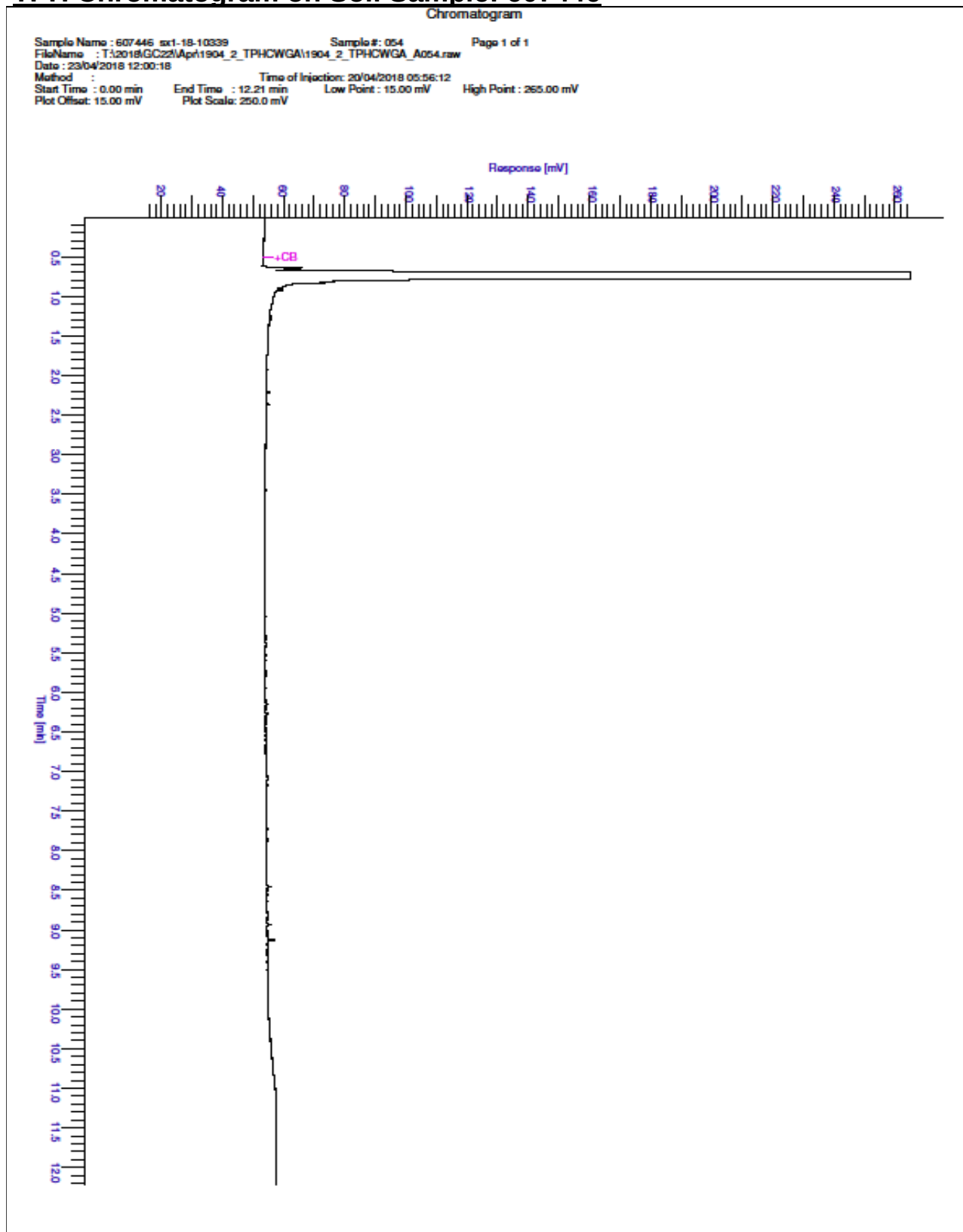
Project: LKC 16 1066 MMU Didsbury

Client: LK Consult	Chemtest Job No.:				18-10339	18-10339	18-10339
Quotation No.:	Chemtest Sample ID.:				607446	607447	607448
	Client Sample ID.:				TS401	TS402	TS403
	Sample Type:				SOIL	SOIL	SOIL
	Date Sampled:				16-Apr-2018	16-Apr-2018	16-Apr-2018
	Asbestos Lab:				COVENTRY	COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD			
ACM Type	U	2192		N/A	-	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	15	13	12
Soil Colour	N	2040		N/A	Brown	Brown	Brown
Other Material	N	2040		N/A	Stones, Roots	Stones, Roots	Stones, Roots
Soil Texture	N	2040		N/A	Sand	Sand	Sand
Chromatogram (TPH)	N			N/A	See Attached	See Attached	See Attached
pH	M	2010		N/A	7.8	7.9	7.8
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	< 0.40	0.40	< 0.40
Sulphate (2:1 Water Soluble) as SO ₄	M	2120	g/l	0.010	< 0.010	0.023	0.017
Cyanide (Free)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Arsenic	M	2450	mg/kg	1.0	17	18	16
Cadmium	M	2450	mg/kg	0.10	0.21	0.22	0.18
Chromium	M	2450	mg/kg	1.0	12	12	9.9
Copper	M	2450	mg/kg	0.50	300	390	320
Mercury	M	2450	mg/kg	0.10	0.26	0.27	0.24
Nickel	M	2450	mg/kg	0.50	16	16	14
Lead	M	2450	mg/kg	0.50	230	280	240
Selenium	M	2450	mg/kg	0.20	< 0.20	< 0.20	< 0.20
Vanadium	U	2450	mg/kg	5.0	18	19	17
Zinc	M	2450	mg/kg	0.50	310	360	310
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.40	4.3	5.5	4.7
Fuel Type	N	2670		N/A	PAH	PAH	PAH
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0

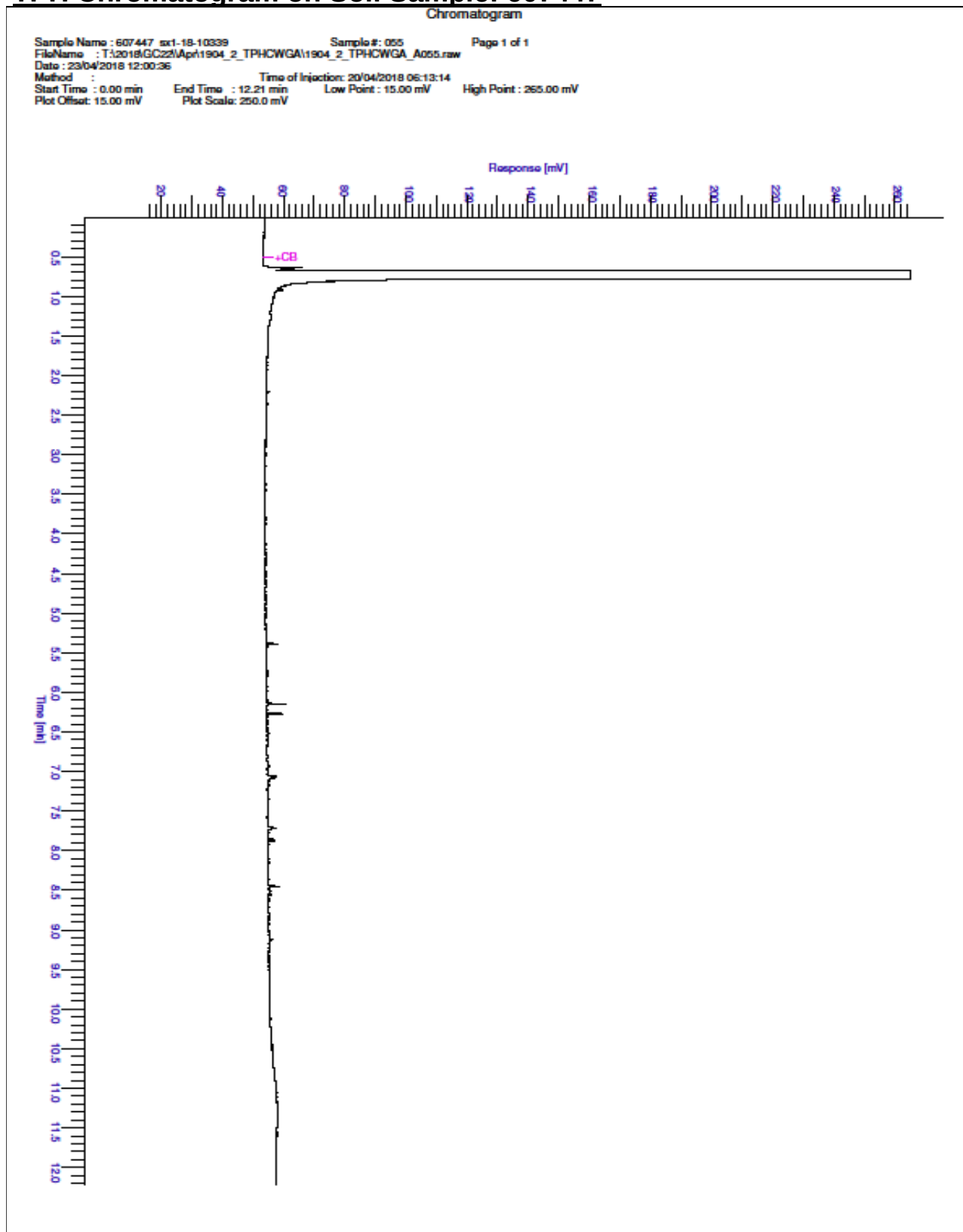
Project: LKC 16 1066 MMU Didsbury

Client: LK Consult	Chemtest Job No.:				18-10339	18-10339	18-10339
Quotation No.:	Chemtest Sample ID.:				607446	607447	607448
	Client Sample ID.:				TS401	TS402	TS403
	Sample Type:				SOIL	SOIL	SOIL
	Date Sampled:				16-Apr-2018	16-Apr-2018	16-Apr-2018
	Asbestos Lab:				COVENTRY	COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD			
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	5.7	9.2	10
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	21	30	20
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	26	39	31
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	26	39	31
Benzene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Toluene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
o-Xylene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Naphthalene	M	2800	mg/kg	0.10	0.24	0.67	0.23
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10	0.15	0.20
Fluorene	M	2800	mg/kg	0.10	< 0.10	0.14	0.14
Phenanthrene	M	2800	mg/kg	0.10	0.87	1.5	1.6
Anthracene	M	2800	mg/kg	0.10	0.18	0.31	0.35
Fluoranthene	M	2800	mg/kg	0.10	1.4	2.4	2.6
Pyrene	M	2800	mg/kg	0.10	1.3	2.2	2.7
Benzo[a]anthracene	M	2800	mg/kg	0.10	0.66	1.3	1.6
Chrysene	M	2800	mg/kg	0.10	0.69	1.3	1.6
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	0.90	1.6	2.0
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	0.29	0.56	0.78
Benzo[a]pyrene	M	2800	mg/kg	0.10	0.62	1.1	1.6
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	0.49	0.75	1.0
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	0.15	0.17
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	0.46	0.79	0.99
Total Of 16 PAH's	N	2800	mg/kg	2.0	8.1	15	18
Total Phenols	M	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30

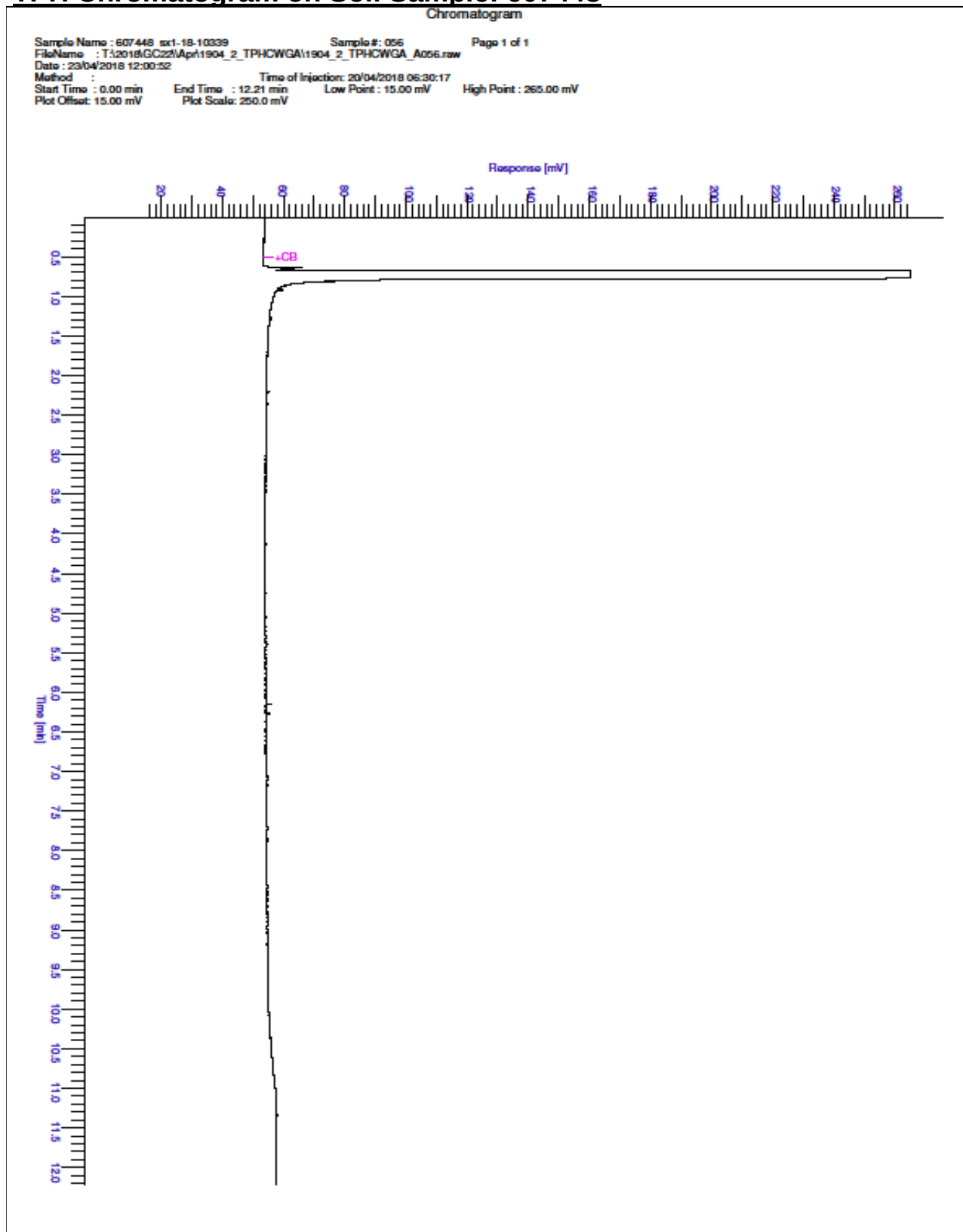
TPH Chromatogram on Soil Sample: 607446



TPH Chromatogram on Soil Sample: 607447



TPH Chromatogram on Soil Sample: 607448



SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenzo[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

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

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

All Asbestos testing is performed at the indicated laboratory

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

Sample Deviation Codes

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

Sample Retention and Disposal

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

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

Charges may apply to extended sample storage

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

customerservices@chemtest.co.uk



Final Report

Report No.: 18-34206-1

Initial Date of Issue: 12-Nov-2018

Client LK Consult

Client Address: Unit 29 Eton Business Park
Eton Hill Road
Radcliffe
Manchester
Lancashire
M26 2ZS

Contact(s): Contaminated Land
Paul Quimby

Project LKC 16 1066 Former MMU Campus,
Didsbury

Quotation No.:

Order No.: 736496

No. of Samples: 10

Turnaround (Wkdays): 5

Date Approved: 12-Nov-2018

Date Received: 02-Nov-2018

Date Instructed: 02-Nov-2018

Results Due: 08-Nov-2018

Approved By:

Details: Robert Monk, Technical Manager

Results - Soil

Client: LK Consult	Chemtest Job No.:				18-34206	18-34206	18-34206	18-34206	18-34206	18-34206	18-34206	18-34206
Quotation No.:	Chemtest Sample ID.:				718221	718222	718223	718224	718225	718226	718227	718228
	Client Sample ID.:				TSS01	TS502	TS503	Plot 22	Plot 22	Plot 22	Plot 22	Plot 23
	Sample Location:							S101	S102	S103	S104	S101
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Date Sampled:				31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018
	Asbestos Lab:				DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	Accred.	SOP	Units	LOD								
ACM Type	U	2192		N/A	-	-	-	-	-	-	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	16	12	14	13	14	11	11	13
Soil Colour	N	2040		N/A	Brown,	Brown,	Brown,	Brown,	Brown,	Brown,	Brown,	Brown,
Other Material	N	2040		N/A	Stones,	Stones,	Stones,	Stones,	Stones,	Stones,	Stones,	Stones, Roots,
Soil Texture	N	2040		N/A	Loam,	Loam,	Loam,	Loam,	Loam,	Loam,	Loam,	Loam,
Chromatogram (TPH)	N			N/A	See Attached	See Attached	See Attached					
pH	M	2010		N/A	8.1	8.3	8.3	8.2	8.2	8.4	8.7	8.3
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.54	0.64	0.52					
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.015	0.027	< 0.010	0.035	0.022	0.083	0.18	0.030
Cyanide (Free)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50					
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50					
Arsenic	M	2450	mg/kg	1.0	14	12	10	13	13	13	15	13
Cadmium	M	2450	mg/kg	0.10	0.28	0.22	0.20	0.24	0.21	0.36	0.32	0.23
Chromium	M	2450	mg/kg	1.0	12	11	11	12	11	14	11	11
Copper	M	2450	mg/kg	0.50	29	29	23	23	28	25	22	26
Mercury	M	2450	mg/kg	0.10	0.42	0.41	0.34	0.35	0.46	0.34	0.30	0.39
Nickel	M	2450	mg/kg	0.50	15	15	13	14	14	15	13	14
Lead	M	2450	mg/kg	0.50	110	110	88	97	100	96	92	92
Selenium	M	2450	mg/kg	0.20	0.28	0.22	0.25	< 0.20	0.30	< 0.20	< 0.20	0.22
Vanadium	U	2450	mg/kg	5.0	16	15	14	15	15	18	14	14
Zinc	M	2450	mg/kg	0.50	61	63	54	52	56	61	50	55
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.40	4.8	4.8	4.1	3.1	5.7	5.3	3.5	4.1
Fuel Type	N	2670		N/A	PAH	PAH	PAH					
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	46	33	26					
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	46	33	26					
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					

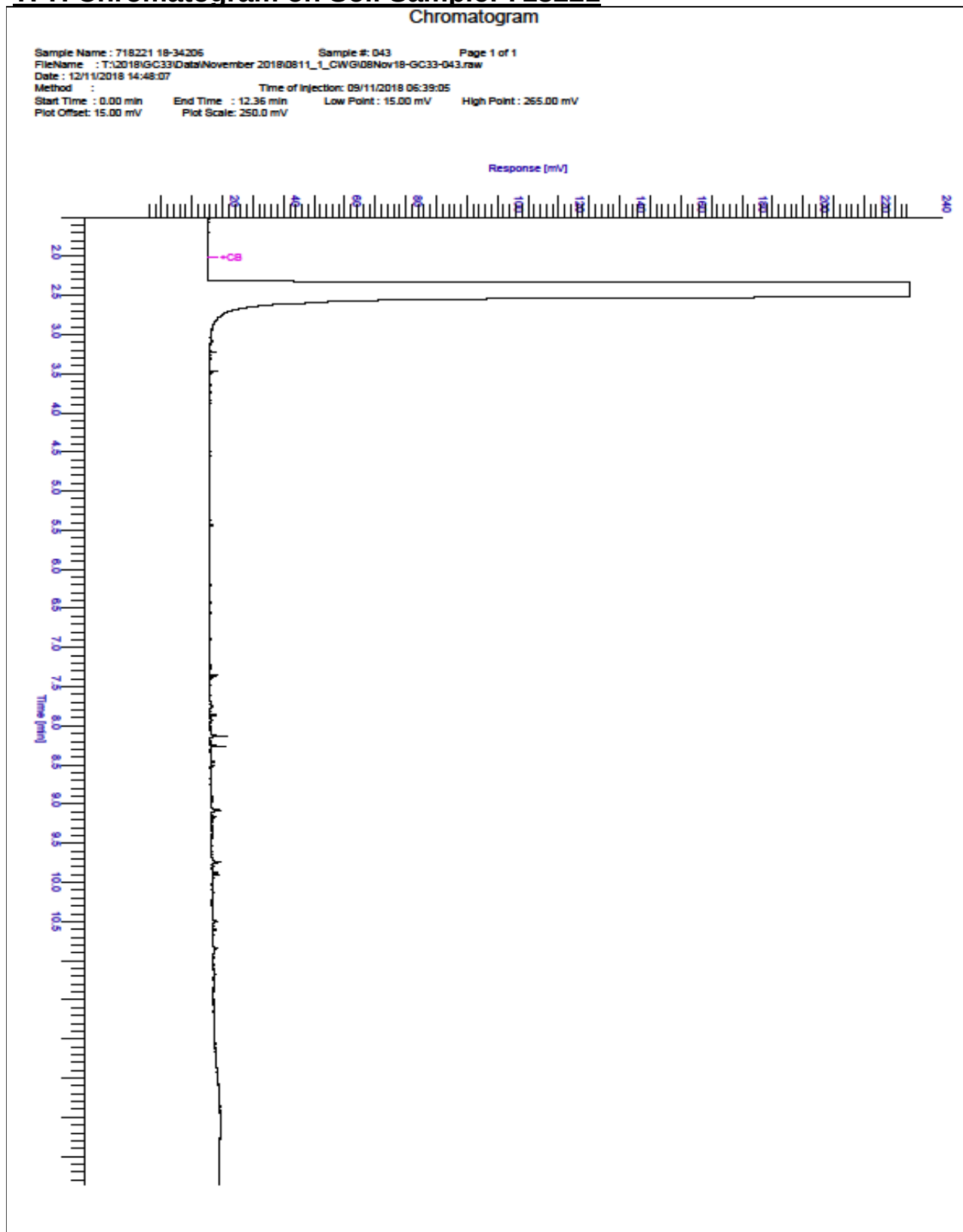
Results - Soil

Client: LK Consult	Chemtest Job No.:				18-34206	18-34206	18-34206	18-34206	18-34206	18-34206	18-34206	18-34206
Quotation No.:	Chemtest Sample ID.:				718221	718222	718223	718224	718225	718226	718227	718228
	Client Sample ID.:				TSS01	TS502	TS503	Plot 22	Plot 22	Plot 22	Plot 22	Plot 23
	Sample Location:							S101	S102	S103	S104	S101
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Date Sampled:				31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018	31-Oct-2018
	Asbestos Lab:				DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	Accred.	SOP	Units	LOD								
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	9.8	5.7	4.1					
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	200	92	42					
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0					
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	210	97	46					
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	250	130	73					
Benzene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0					
Toluene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0					
Ethylbenzene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0					
m & p-Xylene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0					
o-Xylene	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0					
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0					
Naphthalene	M	2800	mg/kg	0.10	0.13	0.20	0.24	0.46	0.13	0.67	0.11	0.33
Acenaphthylene	N	2800	mg/kg	0.10	0.11	0.16	0.10	0.24	0.15	0.24	< 0.10	0.26
Acenaphthene	M	2800	mg/kg	0.10	< 0.10	0.13	0.46	0.38	0.21	1.8	< 0.10	0.22
Fluorene	M	2800	mg/kg	0.10	< 0.10	0.17	0.27	0.32	0.23	1.6	0.12	0.24
Phenanthrene	M	2800	mg/kg	0.10	1.6	2.8	4.2	4.0	3.0	14	1.6	3.6
Anthracene	M	2800	mg/kg	0.10	0.33	0.65	0.86	1.1	0.72	3.7	0.36	1.1
Fluoranthene	M	2800	mg/kg	0.10	3.2	4.5	5.1	4.7	4.7	18	2.9	5.4
Pyrene	M	2800	mg/kg	0.10	3.3	4.7	4.9	4.6	4.2	15	3.1	5.2
Benzo[a]anthracene	M	2800	mg/kg	0.10	0.98	1.9	1.9	1.6	1.7	6.8	1.3	2.1
Chrysene	M	2800	mg/kg	0.10	1.3	2.3	2.1	2.0	2.0	7.6	1.5	2.5
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	1.3	2.4	2.3	1.9	2.0	8.1	1.7	2.6
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	0.38	0.84	0.66	0.62	0.54	3.4	0.56	0.78
Benzo[a]pyrene	M	2800	mg/kg	0.10	0.83	1.6	1.6	1.4	1.5	6.9	1.4	1.9
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	0.41	0.92	0.82	0.66	0.63	4.2	0.68	1.0
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.76	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	0.63	1.1	1.1	0.96	0.91	3.9	0.87	1.3
Total Of 16 PAH's	N	2800	mg/kg	2.0	15	24	27	25	23	97	16	29
Total Phenols	M	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30					

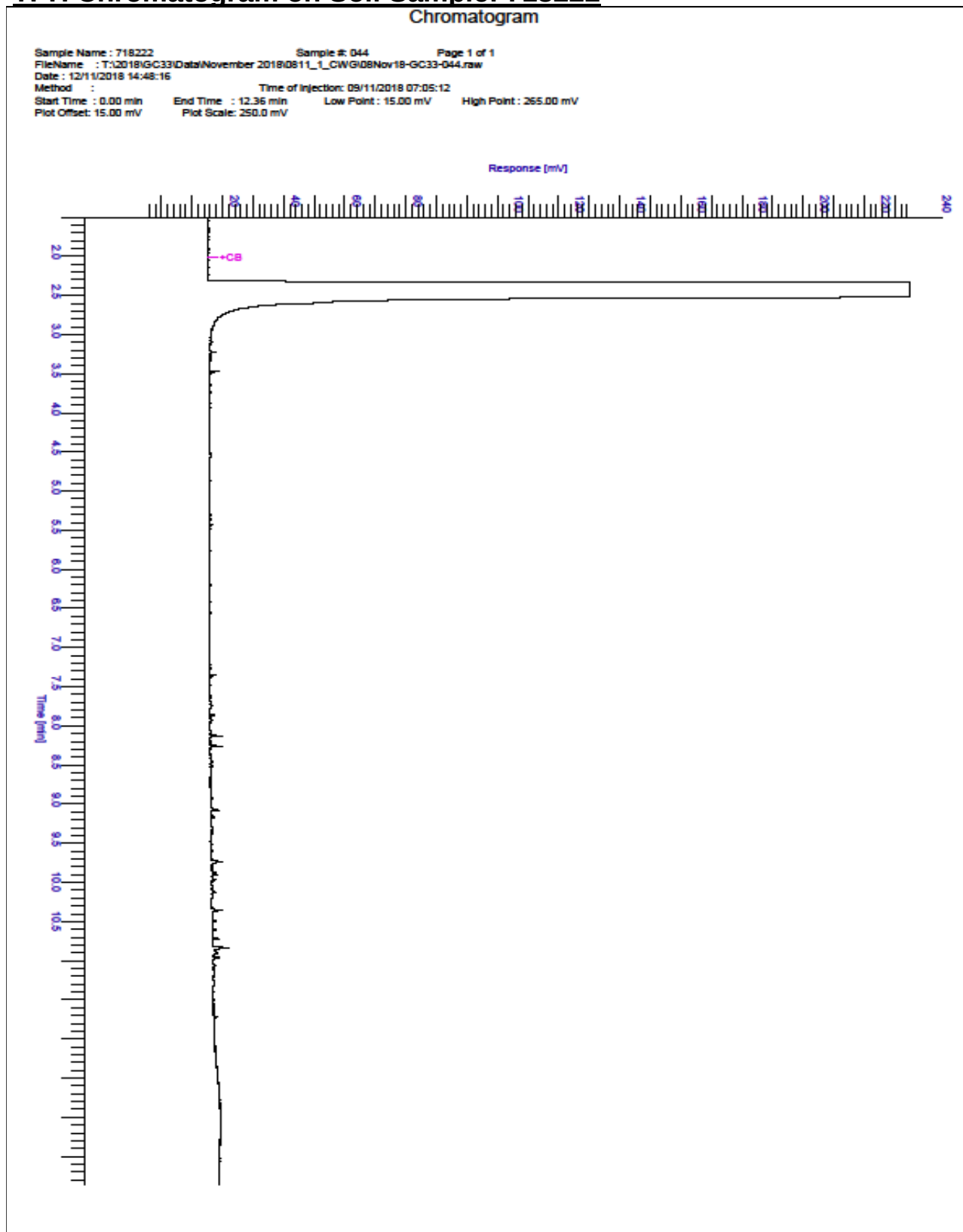
Client: LK Consult	Chemtest Job No.:				18-34206	18-34206
Quotation No.:	Chemtest Sample ID.:				718229	718230
	Client Sample ID.:				Plot 23	Plot 23
	Sample Location:				S102	S103
	Sample Type:				SOIL	SOIL
	Date Sampled:				31-Oct-2018	31-Oct-2018
	Asbestos Lab:				DURHAM	DURHAM
Determinand	Accred.	SOP	Units	LOD		
ACM Type	U	2192		N/A	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	15	16
Soil Colour	N	2040		N/A	Brown,	Brown,
Other Material	N	2040		N/A	Stones, Roots,	Stones,Roots,
Soil Texture	N	2040		N/A	Loam,	Loam,
Chromatogram (TPH)	N			N/A		
pH	M	2010		N/A	8.2	8.3
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40		
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.029	0.072
Cyanide (Free)	M	2300	mg/kg	0.50		
Cyanide (Total)	M	2300	mg/kg	0.50		
Arsenic	M	2450	mg/kg	1.0	13	15
Cadmium	M	2450	mg/kg	0.10	0.26	0.27
Chromium	M	2450	mg/kg	1.0	12	14
Copper	M	2450	mg/kg	0.50	27	32
Mercury	M	2450	mg/kg	0.10	0.41	0.57
Nickel	M	2450	mg/kg	0.50	15	17
Lead	M	2450	mg/kg	0.50	110	120
Selenium	M	2450	mg/kg	0.20	0.27	0.26
Vanadium	U	2450	mg/kg	5.0	15	18
Zinc	M	2450	mg/kg	0.50	59	70
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.40	4.8	4.8
Fuel Type	N	2670		N/A		
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0		
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0		
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0		
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0		
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0		
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0		
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0		
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0		
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0		
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0		
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0		
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0		

Client: LK Consult	Chemtest Job No.:				18-34206	18-34206
Quotation No.:	Chemtest Sample ID.:				718229	718230
	Client Sample ID.:				Plot 23	Plot 23
	Sample Location:				S102	S103
	Sample Type:				SOIL	SOIL
	Date Sampled:				31-Oct-2018	31-Oct-2018
	Asbestos Lab:				DURHAM	DURHAM
Determinand	Accred.	SOP	Units	LOD		
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0		
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0		
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0		
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0		
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0		
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0		
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0		
Benzene	M	2760	µg/kg	1.0		
Toluene	M	2760	µg/kg	1.0		
Ethylbenzene	M	2760	µg/kg	1.0		
m & p-Xylene	M	2760	µg/kg	1.0		
o-Xylene	M	2760	µg/kg	1.0		
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0		
Naphthalene	M	2800	mg/kg	0.10	0.13	0.65
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	0.14
Acenaphthene	M	2800	mg/kg	0.10	0.19	0.85
Fluorene	M	2800	mg/kg	0.10	0.15	0.62
Phenanthrene	M	2800	mg/kg	0.10	2.1	6.2
Anthracene	M	2800	mg/kg	0.10	0.47	1.4
Fluoranthene	M	2800	mg/kg	0.10	3.6	7.3
Pyrene	M	2800	mg/kg	0.10	3.2	6.5
Benzo[a]anthracene	M	2800	mg/kg	0.10	1.4	2.4
Chrysene	M	2800	mg/kg	0.10	1.6	3.1
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	1.6	3.0
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	0.52	0.94
Benzo[a]pyrene	M	2800	mg/kg	0.10	1.3	2.3
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	0.70	1.3
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	0.92	1.7
Total Of 16 PAH's	N	2800	mg/kg	2.0	18	38
Total Phenols	M	2920	mg/kg	0.30		

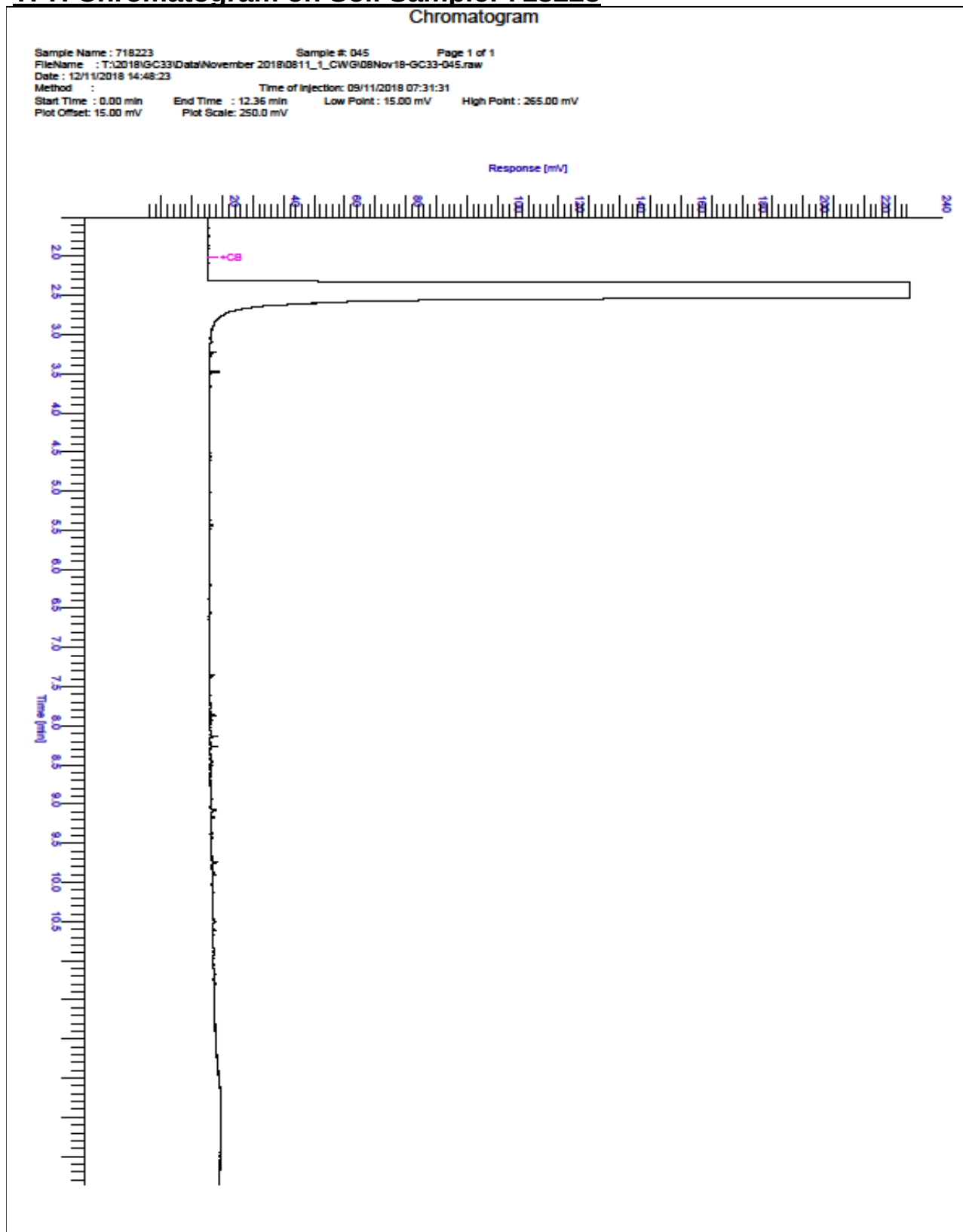
TPH Chromatogram on Soil Sample: 718221



TPH Chromatogram on Soil Sample: 718222



TPH Chromatogram on Soil Sample: 718223



SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

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

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

All Asbestos testing is performed at the indicated laboratory

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

Sample Deviation Codes

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

Sample Retention and Disposal

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

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

Charges may apply to extended sample storage

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

customerservices@chemtest.com

Appendix C – Plot Photographs

Plot 19



Photograph 1:
View of front garden of Plot 19.



Photograph 2:
View of the rear garden of Plot 19.



Photograph 3:
View of soil in capping layer excavation in rear garden of Plot 19 with geotextile membrane visible.



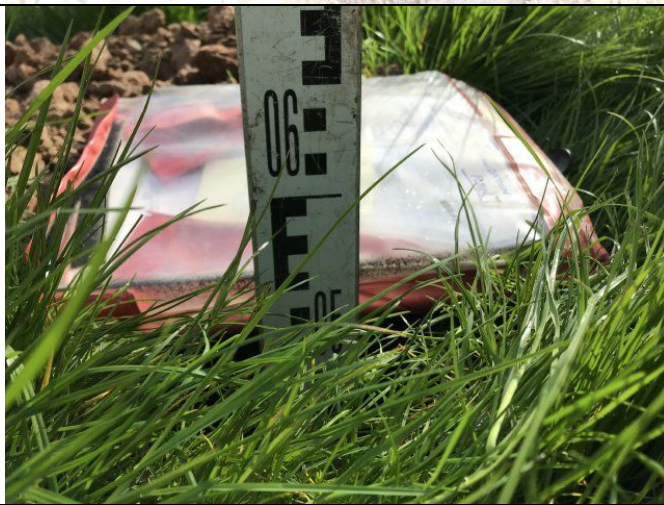
Photograph 4:
Depth measurement in rear garden of Plot 19.

Plot 25



Photograph 5:

View of soil in capping layer excavation in front garden of Plot 25 with geotextile membrane visible.



Photograph 6:

Depth measurement in front garden of Plot 25.



Photograph 7:

View of the rear garden of Plot 25.



Photograph 8:
View of soil in capping layer excavation in rear garden of Plot 25 with geotextile membrane visible.



Photograph 9:
Depth measurement in rear garden of Plot 25.

Plot 37



Photograph 10:
View of front garden of Plot 37.



Photograph 11:
View of soil in capping layer excavation in front garden of Plot 37 with geotextile membrane visible.



Photograph 12:
Depth measurement in front garden of Plot 37.



Photograph 13:
View of the rear garden of Plot 37.

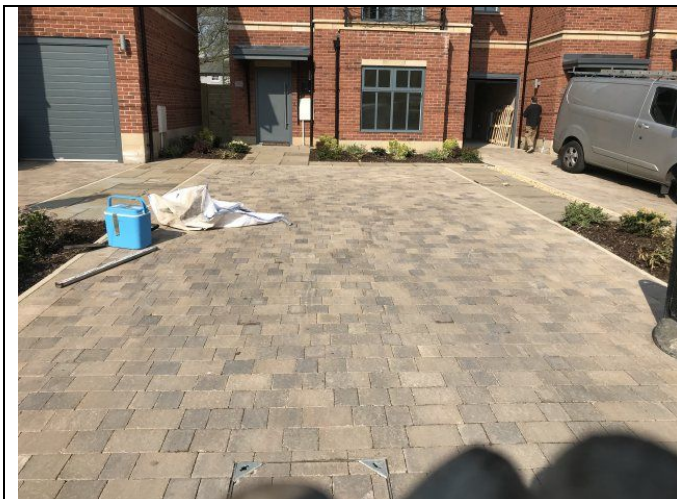


Photograph 14:
View of soil in capping layer excavation in rear garden of Plot 37 with geotextile membrane visible.



Photograph 15:
Depth measurement in rear garden of Plot 37.

Plot 38



Photograph 16:
View of front garden of Plot 38.



Photograph 17:
View of the rear garden of Plot 38.



Photograph 18:
View of soil in capping layer excavation in rear garden of Plot 38 with geotextile membrane visible.



Photograph 19:
Depth measurement in rear garden of Plot 38.

Plot 39



Photograph 20:
View of front garden of Plot 39.



Photograph 21:
View of soil in capping layer excavation in front garden of Plot 39 with geotextile membrane visible.



Photograph 22:
Depth measurement in front garden of Plot 39.



Photograph 23:
View of the rear garden of Plot 39.



Photograph 24:
View of soil in capping layer excavation in rear garden of Plot 39 with geotextile membrane visible.



Photograph 25:
Depth measurement in rear garden of Plot 39.

Plot 801



Photograph 26:
View of front garden of Plot 801.



Photograph 27:
View of soil in capping layer excavation in rear garden of Plot 801 with geotextile membrane visible.



Photograph 28:
Depth measurement in rear garden of Plot 801.

The Lodge



Photograph 29:
View of rear garden of The Lodge.



Photograph 30:
View of soil in capping layer excavation in rear garden of The Lodge with MOT visible.



Photograph 31:
Depth measurement in rear garden of The Lodge.

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- » Invasive Species
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- » Land Drilling