LK CONSULT LIMITED

PART OF THE LK GROUP

LAND AT

PETRE WOOD

LANGHO

GEO-ENVIRONMENTAL INVESTIGATION AND RISK ASSESSMENT

Prepared for:

Lancaster Maloney Ltd.

Mottram House

43 Greek Street

Stockport

SK3 8AX

By:

LK Consult Ltd

Bury Business Centre

Kay Street

Bury

Lancashire

BL9 6BU

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Reviewed By	Colin Crompton	**Signature**	

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1 INTRODUCTION

1.1 Background

LK Consult Ltd (LKC) has been commissioned by Lancaster Maloney Ltd. to carry out a geo-environmental investigation and risk assessment for land at Petre Wood, Langho. The investigation was undertaken in support of a future planning application to develop the site for a residential end use. Information is therefore required on the properties of any potential contaminants that may be present in, on or under the site.

The aims of this report are to establish the feasibility of developing this site, to demonstrate to the Local Planning Authority that in accordance with the National Planning Policy Framework (NPPF)[1] the site may be developed for a residential end use and that appropriate site investigation and risk assessment works are in place to allow conditional approval of any future planning application.

A Preliminary Risk Assessment (PRA) report has previously been undertaken by LKC (Ref: CL-602-LKC 12 1001-01, dated October 2012) and summarised in Section 2. This risk assessment should be read in conjunction with the previous PRA report.

Additionally a Site Investigation Report has previously been undertaken by GCM Consulting Engineers (GCM) (Ref: 3577, dated December 2005) on the area of land to the south of the stream onsite and to the south offsite. Relevant information from the GCM report has been incorporated into this assessment.

1.2 Site Details

A summary of site settings is presented in Table 1-1. Figures 1 and 2 indicate the site location and boundary. Figure 3 indicates the proposed development.

Location	South and east of the A59 in Langho, north of Petre Wood Close. National Grid Reference 370930E 434960N.
Area	6700m^2.
Topography	Between 71 and 78 meters above ordnance datum (AOD). Site slopes to the south west.
Land Use	<u>Site</u> Rough grassland with some trees over the whole site, stream running through the site flowing south east to north west. <u>Surrounding Area</u> South: Residential Properties (Petre Wood Close and Petre Wood Crescent). North and west: A59 (Road). East: Farm land.
Proposed Development	25 residential properties including soft landscaping and car parking.

Table 1-1: Summary of site details for Land at Petre Wood, Langho.

[1] DCL (2012). "National Planning Policy Framework." Department of Communities and Local Government. March 2012.

2 PREVIOUS WORK

2.1 Summary of Existing Information

A PRA report (Ref: CL-602-LKC 12 1001-01, dated October 2012) has previously been undertaken by LKC.

The report comprised a review of factual information sources such as site history via historical mapping, geology, hydrogeology and an Envirocheck search. A preliminary contamination conceptual model was provided which identified several potential pollutant linkages.

A summary of the available information is provided below along with the preliminary conceptual model.

2.2 Site History

The site history is summarised in Table 2-1.

Site Features	Location	Map Dates Present	Comments
Site Mainly Undeveloped	Whole site	1847-1969	-Site possibly associated with Petre House Farm.
Un-named stream	SW corner	1893-1969	-Potentially culverted after 1969.
Path	Running NW to S	1893-1977	-Path redirected due to the new road, the footpath is marked from N to S from 1973 mapping.
Undifferentiated Building	SE of site	1912-1913	-No longer present after this date.
Cuttings	SW of site	1932-1969	-No longer identified on 1970 mapping.
Undifferentiated Building	Central S	2012	-Identified as an animal shelter from the site reconnaissance.
Surrounding Area Features	**Distance/ Location**	**Map Dates Present**	**Comments**
Pond	170m E	1848-1913	-Annotated as marsh on 1932 mapping only. -Potentially infilled after this date.
Undifferentiated buildings	Adjacent to S	1969-2006	-Possible Garden Centre. -Replaced by housing development.
Garage	80m S	1969-Present	-No longer annotated as garage from 2006 mapping. -Building still present on 2012 mapping. -Identified as a Garage from site reconnaissance.
Road Development	Adjacent W and N	1970-Present	-A59 road development is first marked in 1970, which is completed by 1973 mapping. -With associated cuttings/embankments.
Petre House Farm	Adjacent E	1969-2012	-Buildings adjacent to eastern site boundary in 1969, although annotated on site on subsequent mapping. -Buildings associated with the farm marked onsite to the NE in 1973.

Table 2-1: Summary of significant historical features; surrounding area features include significant potentially contaminative features within 100m of the site or 250m of the site if a potential landfill (i.e. a possible source of landfill gas) is identified.

Surrounding Area Features	Distance/ Location	Map Dates Present	Comments
Household Waste Disposal Centre	15m S	1992-2011	-Annotated as a Recycling Centre in 2011. -Recycling Centre closed in April 2011.
Residential dwellings	Adjacent S	2009-Present	-Petre Wood Close and Petre Wood Crescent.
Undifferentiated Building	50m S	2012	-Identified as a Gulf petrol station from site reconnaissance.

Table 2-1(cont'd): Summary of significant historical features; Land at Petre Wood, Langho.

2.3 Environmental Setting

The site setting is summarised in Table 2-2.

Summary of Environmental Settings			
Geology	Superficial		-Till, Devensian.
	Bedrock		-Mudstone, Bowland Shale Formation.
	Faulting		-None within 1km.
	BGS logs		-SD73SE5, 46m NE (Envirocheck Map ID 30): -Thin clay, gravel and sand layers to 55.17m. -Shale to 171.60m with a coal layer from 121.01m to 121.92m. -Sandstone and shale to 193.55m.
Hydrogeology	Aquifer Designation	Superficial	-Unproductive.
		Bedrock	-Secondary Undifferentiated.
	Groundwater abstractions		-None within 1km.
Hydrology	Nearest surface water		-Drain on site. -Un-named stream 62m NW.
	Flooding		-No risk.
	Surface water abstractions		-None within 1km.
	Discharge consent		-3 within 1km. -Nearest 85m S, United Utilities Water Plc, storm overflow/storm tank, into freshwater stream-tributary of Bushburn Brook.
	Pollution Incidents		-None within 250m.
Mining	Coal Mining Referral Area		-Outside of coal field area.
	Mineral Abstraction		-Nearest 968m S. Higher Woodcocks, opencast sandstone, operator unknown, operation ceased.
Landfill sites (within 250m)	Known/Registered		-Historic Landfill Site 72m S at Petre Garage. Licence holder unknown, type of waste unknown.
	Potential		-Potentially culverted stream to the far west of the site, no longer marked after 1969 mapping. -Pond 190m E, on mapping from 1848- 1913.
Radon			-Probability of <1% of homes above Action Level. -No further action required.
Designated Sites			-None within 250m.
Contemporary Trade Directory			-6 within 250m. Nearest 78m SE. Car Centre, used car dealers, inactive.
Fuel Station Entries			-Petre Filling Station 50m SE. Currently open.

Table 2-2: Summary of the environmental settings for land at Petre Wood, Langho.

2.4 Previous Investigations

A Site Investigation Report has previously been undertaken by GCM Consulting Engineers (Ref: 3577 dated December 2005) and relevant information will be incorporated into this report.

Twelve boreholes were drilled across the site, four of which were positioned on site.

2.5 Site Reconnaissance

A site reconnaissance of the study site area was carried out by LKC on the 4th October 2012.

The site was accessed from a public footpath via a small drive way off Longsight Road. The area of proposed development is currently an open field. The site is bounded to the north and west by the A59, to the east by open fields, and to the south west by residential properties.

The ground across the study site was observed to be primarily grass with some wetland type plants (reeds and rushes). A number of small trees were observed along the western boundary and several large trees were also present onsite. A small area of concrete was noted on the north eastern boundary where a metal gate leads offsite.

The site sloped down towards the south west and was waterlogged. A small stream was identified running from the southern boundary to the north west which had steep embankments. The stream was observed to be fenced off, approximately 1 metre lower than ground level and was overgrown.

A derelict farm building was identified with a possible corrugated asbestos roof in the south of the site which appeared to house animals. Several large metal containers were also present in the south west corner of the site.

Small areas of rubble and possible fly-tipped materials, such as pallets, were observed on the southern boundary of the site. In addition a small trailer containing possible corrugated asbestos cement was observed alongside the derelict farm building. A small area of Horsetail was observed along the southern boundary.

The soil across the site appeared to be mainly orangish grey clay in the south and west of the site. The soil in the north west of the site appeared to be dark brown and very organic. Some made ground was encountered in the footprint of a former building.

2.6 Preliminary Contamination Conceptual Model

The preliminary contamination conceptual model using contaminant-pathway-receptor linkages based on guidance in CLR11[2] has been summarised in Table 2-3. This is based on the premise that if there is no pollutant linkage then there will be no risk to the receptor. The site will follow a residential land use scenario.

A summary of contamination sources are as follows:

- Demolition of structures and land raising using ash and clinker – metals, PAHs, asbestos (ACM).

A summary of possible pathways are as follows:

[2] EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

- Human Health - ingestion (of soil, dust, vegetables), inhalation (of dust, fibres, vapours), dermal contact (of soils and dust).
- Controlled Waters: Un-named stream onsite, Un-named stream 62m NW and Secondary Undifferentiated Aquifer.

A summary of possible receptors are as follows:

- Human Health: Future site residents.
- Controlled Waters: Un-named stream onsite, un-named stream 62m north west, and underlying Secondary Undifferentiated Aquifer.
- Buildings and Services: Landfill/ground gas and contaminants that could affect integrity of building materials and service pipes.
- Flora: within future gardens.

It should be noted that there may be risk from short term exposure from contaminated soil to site workers. The Preliminary Contamination Conceptual Model deals with long term exposure to key receptors. Acute risks can be easily mitigated by good environmental management of the site during site works. Standard health and safety precautions (as per HSE guidance[3]) should be adopted by all workers involved with site enabling and construction works. Therefore, this receptor is not considered in the contamination conceptual model.

Pollutant Linkage No.	Contaminant					Pathway	Receptor
	ACM	Gases		Contaminants			
		Hazardous	Ground	Organic	Inorganic		
PL1	?	x	x	?	?	-Dermal contact. -Ingestion of soils and vegetables. -Inhalation of contaminated soil, fibres and dust.	-Future site residents (inc. veg uptake).
PL2	x	x	x	?	x	-Inhalation of vapours. -Vapour migration through permeable strata.	-Future site residents. -Offsite receptors.
PL3	x	?	x	x	x	-Inhalation of hazardous gas. -Migration through permeable strata. -Build up and explosion of gas.	-Future site residents. -Offsite receptors (if gas is generated on site). -Site buildings.
PL4	x	x	x	?	?	-Groundwater migration through permeable strata. -Perched waters migration on site.	-Un-named stream on site. -Secondary Undifferentiated Aquifer. -Un-named stream 62m NW.
PL5	x	x	x	x	?	-Contact with potential hazards.	-Site buildings.
PL6	x	x	x	?	?	-Ingestion of tainted water supply. -Corrosion of metal pipework.	-Future site residents. -Pipework.
PL7	x	x	x	x	?	-Root uptake of phytotoxic contaminants.	-Flora in future gardens.

Table 2-3 Contamination Conceptual Model for land at Petre Wood, Langho.
Key: ? – pollutant linkage possible; x – pollutant linkage unlikely

Seven generic pollutant linkages have been identified due to the likely presence of made ground onsite and risk from hazardous gas.

It was considered that detailed intrusive investigations were required to assess these linkages further. These investigations are outlined in Section 3.

[3] HSE (1991). "Protection of workers and the general public during development of contaminated land" London HMSO.

3 GROUND INVESTIGATION

3.1 Site Investigation Design and Methodology

In order to assess the ground conditions at the site and to investigate the potential pollutant linkages identified in the preliminary contamination conceptual model an intrusive investigation was undertaken.

The investigation was carried out on the 14th and 15th December 2012 and comprised the following:

- Drilling of 10no. window sample boreholes from 3.92mbgl to 5.45mbgl (referenced WS101 to WS110).
- Standard Penetration Tests (SPTs) approximately every 1m in natural strata.
- Head space samples were collected for onsite testing using a Photoionisation Detector (PID) and further soil samples were collected for laboratory chemical analysis.
- Installation of wells in five boreholes for gas monitoring, groundwater sampling.

All borehole and locations are shown in Figure 4 and include relevant locations from the previous investigation by GCM.

The number of sampling points corresponds to one location per 25m square centres (approximate herringbone pattern). This is considered to be a conservative sampling density and is in line with BS10175[4].

All profile logs are provided in Appendix A and are in line with BS14688-1[5].

3.2 Sampling Protocol

3.2.1 Soil Sample Collection

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation[6].

Soil was collected for onsite testing. A plastic zip bag was half filled with soil allowing a suitably sized headspace. The bag was sealed and stored for at least 20 minutes before being tested for total volatile organic compounds using a TVA-1000 photoionisation detector (PID). Results of the PID readings are presented on the profile logs (Appendix A). The on-site monitoring was carried out in line CIRIA C665[7].

Soil samples of approximately 500g were recovered in amber jars, amber vials for volatile analysis and plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the Chemtest laboratory in Newmarket. If collection was not possible the same day then samples were stored in the sample storage fridge at the LK Group offices below 4˚C. Samples were tracked using appropriate Chain of Custody forms provided by Chemtest.

A total of sixteen representative soil samples were taken during the site investigation, all of which were selected for chemical contamination analysis.

[4] British Standard (2011). “Investigation of Potentially Contaminated Sites – Code of Practice.” BS10175:2011
[5] British Standards (2002) Geotechnical investigation and testing – Identification and Classification of Soil. Part 1: Identification and description. BS EN ISO 14688-1:2002
[6] EA (2000). “Technical Aspects Of Site Investigation. Volumes 1 & 2 Text Supplements Research and Development Technical Report.” P5-065/Tr.
[7] CIRIA (2007). “Assessing Risks Posed by Hazardous Ground Gases to Buildings.” CIRIA C665

Soil samples were taken from the made ground and natural strata to represent site conditions.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III)[8].

Many of the tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix B. The soil risk assessment is presented in Section 6.2.

3.2.2 Water Sample Collection

To establish the condition of groundwater LKC undertook five groundwater samples (referenced WS101, WS103, WS105, WS108 and WS110).

The groundwater samples were collected a minimum of one week after drilling had finished. Sample collection was undertaken using a low flow sampling pump using thin walled tubing to encourage laminar flow and minimise the potential loss of volatiles during sampling. The sample was collected in glass and plastic bottles and a glass vial. The borehole was purged of all standing water and the sample collected from the recharged water.

Many of the tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix C. The controlled waters risk assessment is presented in Section 6.3.

3.2.3 Geotechnical Testing

In-situ geotechnical tests were performed in the boreholes to further characterise the sub-soil conditions. In total, forty seven Standard Penetration Tests were performed on the underlying sub-soils.

Shear Vane tests were performed in the natural clay identified in the boreholes to further characterise the sub-soil conditions. In total, thirty nine tests were undertaken.

Atterberg Limits were tested on selected clay samples to ascertain the risk of shrinkability from trees. The analysis was undertaken by Murray Rix of Stockport and the Certificates of Analysis are presented in Appendix D.

A summary of these results is provided in Section 5.

3.2.4 Summary of Analysis Suites

A summary of analysed soil and water samples are presented in Table 3.2.

[8] Palmer, CD and Roberts, WP (1994). "Natural Attenuation of Hexavalent Chromium in Groundwater and Soils." EPA Issue EPA/540/5-94/505.

Sampling Suites			No. Soil Samples	No. Water Samples
Heavy Metals / Metalloids	Arsenic	Lead	16	5
	Cadmium	Mercury		
	Chromium (total)	Nickel		
	Copper	Selenium		
	Zinc	Chromium (VI)		
	Vanadium			
Inorganic	Bulk Asbestos Analysis		16	--
	Water Soluble Boron		6	0
	Free Cyanide	Total Cyanide		
	PAH 16 (speciated)		16	5
	Combined pesticide suite		2	0
	Phenols (total)		6	
	TPHCWG			
	BTEX & MTBE			
General	pH		16	5
	SOM		16	
	Hardness		--	
Geotechnical	Water Soluble Sulphate		16	0
	Atterberg Limits		4	--

Table 3-2: Contamination Sampling Suites for land at Petre Wood, Langho.

3.2.5 Gas Monitoring

Five of the ten boreholes (WS101, WS103, WS105, WS108 and WS110) have been monitored on six occasions from 21st December 2012 to 13th March 2013, over a range of barometric pressures.

Installation details for this site are typical for gas monitoring wells as described in CIRIA C665[9] comprising 1m unslotted pipe and a length of slotted pipe work surrounded by pea gravel and sealed at the top with bentonite and concrete. A 0.5m unslotted pipe was used in WS103 to maximise the capacity of gas to enter the borehole.

The response zones for the window sample boreholes were installed along the entire length of the borehole as specific response zones could not be isolated.

Monitoring was undertaken using a Geotechnical Instruments GA2000 plus in accordance with the monitoring protocol outlined in CIRIA C665 (flow rate measured first). Monitoring visits also include periods of falling barometric pressure and heavy snowfall to approach possible worst-case temporal conditions.

The gas monitoring results are reproduced in full in Appendix E and are summarised in Section 6.4.

9 CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665

4 GROUND CONDITIONS

4.1 Soil

The ground conditions beneath the site comprised made ground underlain by natural sandy gravelly clay. A discrete band of fine sand was noted in WS108 and WS109. These natural strata are underlain by possible mudstone bedrock in WS101, WS103, WS105, WS106 and WS110. A summary of typical ground conditions are detailed below in Table 4-1.

Depth to Top of Strata (mbgl)	Depth to Base of Strata (mbgl)	Thickness of Strata (m)	Description
0.0 to 0.1	0.3 to 0.5	0.2 to 0.5	**MADE GROUND 1:** Ash and clinker. Only evident in locations WS101 and WS107.
0.0 to 0.5	0.1 to 0.6	0.1	**MADE GROUND 2:** Whole and part red brick. Only evident in locations WS101 and WS107.
0.0	0.05 to 1.0	0.05 to 1.0	**MADE GROUND 3:** Dark brown slightly sandy slightly gravelly clay. Evident in WS108, WS109 and WS110. Organic fibres, occasional red brick and occasional timber noted in WS110 only.
0.0	0.2	0.2	**TOPSOIL:** Dark brown slightly sandy slightly gravelly clay. Evident in WS103, WS104, WS105 and WS106.
0.0 to 1.0	3.9 to >5.45	3.1 to 5.45	**CLAY:** Light to dark brown very soft to very stiff slightly sandy gravelly clay. Evident in all WS locations. Rootlets noted in WS101, WS102 and WS103. Mottling only noted in WS101. Organic fibres noted in WS108 and WS109 only.
3.9 to 4.5	4.5 to 5.2	0.6 to 0.7	**SAND:** Medium dense brown fine sand. Evident in WS108 and WS109 only.
4.1	4.27	>0.17	**MUDSTONE:** Extremely weak dark grey mudstone. (Possibly bedrock or large cobble) Recovered in WS110 only. Mudstone bedrock possibly encountered in WS101, WS103, WS105 and WS106.

Table 4-1: Summary of ground conditions for land at Petre Wood, Langho.

4.2 Groundwater

Groundwater monitoring has been undertaken on six occasions during the gas monitoring surveys.

An oil-water interface probe (approximately 1cm detection limit) was used to detect the presence of free phase hydrocarbons within each borehole. Results are summarised in Table 4-2.

BH Ref	Depth to Top of Groundwater (mbgl)				No. Visits	Groundwater Sampled Y or N?	Free Product Detected	Hydrocarbon Odours in Groundwater (No. Visits)
	Max	Min	Base	Response				
WS101	0.64	0.2	2.89	1.0-3.0 (C)	6	Yes	No	0
WS102	Not Installed				Drilling	N/A	No	0
WS103	0.5	0.0	4.1	0.5-4.5 (C)	6	Yes	No	0
WS104	Not Installed				Drilling	N/A	No	0
WS105	0.89	0.4	2.3	1.0-4.5 (C)	6	Yes	No	0
WS106	Not Installed				Drilling	N/A	No	0
WS107	Not Installed				Drilling	N/A	No	0
WS108	1.14	0.0	3.78	1.0-4.0 (C/S)	6	Yes	No	0
WS109	Not Installed				Drilling	N/A	No	0
WS110	1.7	0.2	3.96	1.0-4.0 (C)	6	Yes	No	0

Table 4-2: Summary of water strike depths within sampling locations for land at Petre Wood, Langho.
Response Zones:
S=Sand; C=Clay

Groundwater fluctuated over the monitoring period, especially during times of heavy rainfall where some areas of the site were waterlogged.

Due to periods of water logging LKC advise this is taken into consideration for the development.

5 GEOTECHNICAL APPRAISAL

5.1 Standard Penetration Tests

Forty seven in-situ standard penetration tests (SPTs) were undertaken, all of which were in the natural ground. The results are summarised in Table 5-1 below and provided within the profile logs in Appendix A.

Depth (mbgl)	WS101	WS102	WS103	WS104	WS105	WS106	WS107	WS108	WS109	WS110
1.0-1.45	14 (C)	3 (C)	7 (C)	1 (C)	12 (C)	13 (C)	9 (C)	21 (C)	21 (C)	4 (C)
2.0-2.45	28 (C)	19 (C)	18 (C)	22 (C)	12 (C)	21 (C)	23 (C)	20 (C)	20 (C)	10 (C)
3.0-3.45	43 (C)	12 (C)	22 (C)	20 (C)	11 (C)	18 (C)	21 (C)	20 (C)	13 (C)	16 (C)
3.5-3.95	50/ 267mm (M)	-	-	-	-	-	-	-	-	-
4.0-4.45	-	13 (C)	22 (C)	17 (C)	11 (C)	18 (C)	14 (C)	17 (S)	17 (C)	50/ 118mm (M)
4.5-4.95	-	-	50/ 0mm (M)	-	-	-	-	21 (C)	-	-
5.0-5.45	-	27 (C)	-	23 (C)	-	50/ 0mm (M)	17 (C)	-	23 (S/C)	-

Table 5-1: Summary of SPT (N) values recorded for land at Petre Wood, Langho.
M = Mudstone; S = Sand; C = Clay

5.2 Shear Vane Readings

Thirty nine shear vane readings were undertaken, all of which were in the natural clay strata. The results are summarised in Table 5-2 below as Undrained Shear Strengths (USS) and provided within the profile logs in Appendix A.

Depth (mbgl)	USS (kPa)-									
	WS101	WS102	WS103	WS104	WS105	WS106	WS107	WS108	WS109	WS110
0.0-1.0	40	90	60	50	59	65	70	-	-	-
1.0-2.0	160	70	95	40	-	40	120	117	52	32
2.0-3.0	160-200	110	110	140	-	100	170	87	128	77
3.0-4.0	-	65	80	-	30	70	70	48	108	44
4.0-5.0	-	50	70	80	-	-	60	-	59	-

Table 5-2: Summary of shear vane values (USS) recorded for land at Petre Wood, Langho.

5.3 Foundation Considerations

No foundation loads for the proposed new buildings on the site have been provided. The proposed site layout is shown in Figure 3. The proposed buildings occupy the entire site; as such the data from all of the boreholes is considered relevant.

The geological sequence encountered within the boreholes is generally consistent and comprises a made ground or topsoil layer underlain soft to very stiff clay. Medium dense sand was evident in WS108 and WS109 only.

5.3.1 Made Ground/Topsoil

Due to the low density and compressible nature of the made ground/ topsoil these strata are not considered suitable for supporting structural loads. In addition, it is considered unlikely that this material will provide sufficient support for a ground bearing slab.

5.3.2 Natural Clay

Clay strata encountered from 1.0mbgl to 1.45mbgl returned ‘N’ values of between 1 and 21 characterising these strata as soft to stiff. The average value was 10.5

Shear vane readings undertaken in the upper metre returned USS values of between 32kPa and 160kPa. The average value is 62kPa. The SPT ‘N’ values and hand shear vane readings appear to correlate well.

Considering the average SPT ‘N’ values and the average USS values LKC estimate an allowable bearing pressure of at least 75kN/m^2 with 1m of penetration into the natural clay, however soft spots will prevail and will need to be addressed.

Higher estimated allowable bearing pressures will likely result with increasing depth. Ground was found to be waterlogged over the majority of the site.

5.3.3 Natural Sand

Sand strata encountered from 3.9mbgl to 5.2mbgl have ‘N’ values from between 17 and 23 characterising the strata as medium dense.

5.3.4 Atterberg Limits and Moisture Content

Four representative samples of natural clay (WS102 1.5-2.0m, WS103 1.5-2.0m, WS104 2.0-2.5m and WS108 1.5-1.7m) were subjected to Atterberg Limits and Moisture Content testing and the results are summarised in Table 5-3.

Chapter 4.2 of the NHBC standards gives guidance on building near trees and indicates a modified plasticity index should be calculated prior to consideration of the type of adjacent trees, height and water demand. The above factors can then be used to select an appropriate foundation depth.

The modified plasticity index (I’p) as stipulated in NHBC Chapter 4.2-D5 is given by the formula:

I’p = plasticity index (Ip) x % less than 425µm sieve / 100%

Sample Ref. and depth	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Class	Passing 425 micron (%)	Modified Plasticity Index (%)
WS102 1.5-2.0m	14	24	11	13	CL	98	12.74
WS103 1.5-2.0m	16	32	14	18	CL	98	17.64
WS104 2.0-2.5m	17	34	16	18	CL	94	16.92
WS108 1.5-1.7m	17	35	16	19	CL	99	18.81

Table 5-3: Summary of moisture content and plasticity index testing for land at Petre Wood, Langho

The modified plasticity index is between 12.74% and 18.81%. This characterises the clay as having a low volume change potential.

Dense areas of saplings were noted towards the eastern and southern regions of the site. A review of the supplied Tree Survey and Implications Assessment Report (SEP Ltd, dated September 2012) indicates these saplings are common alder and common ash trees. Several mature trees including a large oak tree, willow tree and coniferous trees were also noted offsite adjacent to the site boundary and are expected to remain.

In accordance with guidance given in NHBC Standards Appendix 4.2H the minimum foundation depth with respect to shrinkability may be calculated in Table 5-4.

Volume Change Potential	The Plasticity Indices of the clay is 12.74% to 18.81% giving a **LOW** shrinkage potential.
Establish Species	Saplings of common alder and common ash trees. Water demand will be moderate among species. Trees are to be removed.
Establish Appropriate Tree Height (H)	Mature height for species previously mentioned can reach up to 18m for common alder and 23 for common ash.
Establish Tree Zone of Influence	The zone of influence is calculated as 0.75 x mature height for a moderate water demand height, giving 13.5m for common alder and 17.25m for common ash.
Establish Distance (D)	The minimum perpendicular distance of trees to the footings is approximately under the footings (based on proposed building locations).
Calculate Distance (D) / Height (H)	D/H = (0 / 18) = 0.0 for common alder. D/H = (0 / 23) = 0.0 for common ash.
Determine Foundation Depth	Using Chart 3 in Appendix 4.2B gives a foundation depth of 1.6m.
Adjust the depth according to climatic zone	Figure 13 indicates a reduction of 150mm foundation depth would be appropriate. **<u>Minimum Final Foundation Depth = 1.45m</u>**

Table 5-4: Foundation Depth Calculation for land at Petre Wood, Langho.

Using NHBC methodology for calculating possible shrinkability associated with adjacent trees, a minimum final foundation depth of 1.45m within the tree zone of influence has been calculated. This assumes the presence of ash and alder trees which are to be removed, are of moderate water demand and have a mature height of 23m.

5.4 Concrete Specification

Based upon the results of the soil sample analysis and groundwater results, sulphate resistant concrete is not required at the site. The concentrations of soluble sulphate in the made ground when contrasted to BRE Digest 2005[10] categorise the concrete requirement as DS-1 AC-1s.

5.5 Soakaway Testing

Owing to the high groundwater levels across the site soakaway testing was not undertaken.

[10] BRE (2005)."Concrete in Aggressive Ground." Special Digest 1.

6 GENERIC RISK ASSESSMENT

6.1 Introduction

Current good practice requires that the findings from a site investigation should be evaluated on a site specific basis, using a risk based approach. Risk assessment involves identification and evaluation of the hazards presented by the concentrations of contaminants measured followed by an evaluation of the risks which are associated with these hazards (CLR11[11]). Information gathered from the risk assessment has been collated in the revised contamination conceptual model in Section 6.6.

6.2 Soil Risk Assessment

The results of the soil samples were compared to the new Soil Guideline Values (SGVs). Unfortunately, there are only a select number of new SGVs currently available and therefore, where there are no SGVs, ATRISK Soil Screening Values (SSVs) have been used as screening values. These have been generated using the CLEA V1.06 model[12] based on 1% and 6% SOM and are considered scientifically robust and conservative. All these criteria now follow current UK methodology[13,14,15,16]. A summary of the ATRISK SSVs (Revision 3 for 1% SOM) for a sandy soil and a residential land use scenario are provided in Appendix F.

A selection of other contaminants not presented by ATKINS has been presented by the CL:AIRE[17]. They have generated GACs for a number of contaminants using the UK methodology and will be used as appropriate. A summary of the CL:AIRE GACs are presented in Appendix F.

LKC should note that ATRISK previously used a less conservative oral index dose (ID) for B(a)P (Revision 1 for 1% SOM for residential land use). This was based on a peer reviewed paper by O'Brian[18]and is still referenced in the updated ATRISK SSVs, even though the TOX 2[19] oral index dose is used to generate the SSV. The FAQ stated that the ID was changed due to customer feedback for more conservatism, but still considered the O'Brian ID suitable. Full justification is provided in Appendix G (residential as an example). Based on the justification provided, LKC will still use Revision 1 for residential end use, which generates an SSV of 2.1mg/kg for 1% SOM. It should be noted that Revision 1 will also be suitable for other carcinogenic PAHs.

For ATRISK SSVs where contaminants (such as PAHs) are above the lowest aqueous or vapour saturation limits by <10% the combined values have been used, as per the EA CLEA user manual where no free product has been observed.

ATRISK derived values for volatile petroleum hydrocarbons take into account the conservative nature of the J&E model, as described in the /SR3 report (10 to 100 times overestimation for petroleum hydrocarbons[20]) by applying a 10x sub-surface soil to indoor

[11] EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.
[12] EA (2008). "CLEA Software (Version 1.05) Handbook." Science Report – SC050021/SR4.
[13] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.
[14] EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
[15] EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.
[16] EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.
[17] CL:AIRE (2009). "The Soil Generic Assessment Criteria for Human Health Risk Assessment."
[18] O'Brian, J; Constable, A; Renwick, AG *et.al* (2006). "Approaches to the Risk Assessment of Genotoxic Carcinogens in Food: A Critical Appraisal." *Food and Chemical Toxicology* 44(2006) 1613-1635.
[19] EA (2002). "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzo(a)pyrene." R&D Publication TOX 2.
[20] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.

air correction factor. A similar approach was undertaken when generating the BTEX SGVs.

The lead SSV has been derived using a threshold substance, which differs from the original SGV blood level model. In the interim before the official SGV for lead has been published LKC will continue to use the old lead SGV.

With regards to chromium the generic value uses toxicity data from TOX 4[21] and assumed to be all Cr(VI), i.e. the most harmful chromium oxidation state. The TOX 4 report recognises that assuming total chromium as Cr(VI) is "highly conservative" and that Cr(III) is of much less toxicity. Therefore, the risk assessment for chromium will be based upon the Cr(VI) results.

LKC consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P), dibenzo(a,h)anthracene (D(a,h)A) and naphthalene. This is due to B(a)P and D(a,h)A possibly being carcinogens and most toxic of the PAHs[22,23] and naphthalene the most volatile and soluble[24]. These determinands will be used to establish the risk from PAHs, although high concentrations of other PAHs will be compared to appropriate generic values, where appropriate.

Elevated results are presented in Table 6-1 below and all analysis sheets are presented in Appendix B.

	Contaminant	Units	No. of samples	Result Ranges	No. Exceeded	Criteria	Source of Criteria
PAHs	B(a)P	mg/kg	16	<0.1 to 3.7	WS110 (0.1-0.3m) = 2.6mg/kg WS110 (0.7-1.0m) = 3.7mg/kg	2.1	ATRISK SSV (R1)
General	pH	pH	16	Range 6.3 to 8.4			
General	SOM	%	16	Range <0.4 to 4.8			

Table 6-1: Summary of elevated analytical results for land at Petre Wood, Langho.

Notes:

Only results that exceeded SGVs and SSVs have been shown and results from **all depths** are noted. Assumed pH7 and SOM 1% where this parameter is required.

Elevated results have been identified for B(a)P (WS110 0.1-0.3m and 0.7-1.0m).

6.2.1 Hazard Quotient

To examine the potential additivity of toxicological effects between the petroleum hydrocarbon fractions a Hazard Index (HI) as described by the Environment Agency[25] technical report should be undertaken when there are no elevated petroleum hydrocarbons.

However, in each of the six samples submitted for TPHCWG analysis, all the banded fractions were below the limits of detection. Therefore a Hazard Index has not been undertaken.

[21] EA (2002). "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Chromium." R&D Publication TOX 4.
[22] EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.
[23] USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."
[24] EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5-079/TR1.
[25] EA (2005). "The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils." Science report P5-080/TR3.

6.2.2 Direct Contact Risk – Pollutant Linkage 1

Elevated B(a)P (two samples) was encountered in the made ground in WS110. This contaminant is a likely carcinogen and may pose a risk to future site residents.

Direct contact (ingestion, dermal and inhalation of dust) are the primary pathways to the receptor for these contaminants. Given limited number of elevated samples encountered for B(a)P and the localised areas of made ground this is not considered to be a site wide problem. The likely sources for B(a)P is from a combination of ash and clinker mortar in the made ground which was identified in WS101, WS107 and WS110 in the LKC investigation and BH02 in the previous GCM investigation.

No elevated contaminant concentrations were encountered across the remainder of the site.

Based upon the above, LKC consider Pollutant Linkage 1 to be complete for B(a)P in the made ground.

6.2.3 Inhalation Risk – Pollutant Linkage 2

No visual or olfactory evidence of volatile contaminants were identified on the site also onsite PID results do not show any elevated levels of volatile contaminants. Furthermore, no elevated levels of volatile contaminants were identified within the soil samples tested.

Based upon the above LKC consider Pollutant Linkage 2 to be incomplete.

6.3 Controlled Water Assessment

LKC considers the stream onsite and the un-named stream 62m NW as the primary receptors.

Since no potable groundwater abstractions have been identified within 1km of the site LKC considers groundwater results should be compared to River Basin District Standards and Threshold Values[26] and Environment Agency Values for freshwater Environmental Quality Standards[27] (EQS) for coarse fish. The EQS will be modified by values provided by the Surface Water Abstraction Directive (SWAD)[28] based on A2 treatment or UK Drinking Water Standards (UKDWS)[29,30] if these were not available.

The SWAD criteria is considered appropriate because when there are no EQS values water abstraction for drinking (after treatment) would be more realistic criteria than UKDWS. For example the UKDWS for hydrocarbons (dissolved/emulsified) is 10μg/l, whereas it would be 200μg/l using SWAD for normal physical/chemical treatment (A2 treatment). This standard has been repealed in 2007[31], but values have not been replaced currently in the Water Framework Directive. The contaminants only required in SWAD are TPH and PAHs, since the other contaminants are covered either by UKDWS or EQS, depending upon the receptor. A recent document by the EA on risk from petroleum hydrocarbons in groundwater[32] has not derived EQS values for emulsified hydrocarbons but state that it must not form distinctive films or produce harmful effect to

[26] Defra (2010) "The River Basin Districts Typology, Standards and Groundwater Threshold Values". Water Framework Directive (England and Wales) Directions 2010.
[27] EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990.".
[28] Surface Water Directive (EC 75/440/EEC); Water Supply (Water Quality) Regulations 1989, as modified.
[29] EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990.".
[30] HMSO (2009) "Water England: The private Water Supplies Regulations". Statutory Instruments No.3101.
[31] DWI (2008). "The 2009 Periodic Review of Prices – Guidance on Drinking Water Quality Requirements."
[32] EA (2009). "Petroleum Hydrocarbons in Groundwater: Supplementary Guidance for hydrological Risk Assessment."

fish. It is understood that the EA are working on providing guideline values for individual carbon bands. Until this has occurred LKC considers the use of SWAD to be still acceptable for TPH for surface waters.

Furthermore, the risk from List 2 compound (EC Dangerous Substance Directive 76/464/EEC) in a freshwater ecosystem is governed by the hardness of the water. Where applicable the hardness was taken into account for these contaminants.

No elevated levels of contaminants were identified within the water samples tested.

Based on the above LKC considers Pollutant Linkage 4 to be incomplete and no remediation is required to protect controlled waters.

6.4 Gas Risk Assessment

Six gas monitoring visits have been undertaken on the study site. A summary of the findings are provided within Table 6-2 below and all gas monitoring results are presented in Appendix E.

Following guidance set out in CIRIA C665[33] and BS8485:2007[34] peak methane and steady carbon dioxide concentrations have been used in the gas risk assessment. In addition, and as per guidance, flow rates were measured first (this was standard LKC protocol even before the guidance).

Boreholes	Range of Monitoring Results					Max GSV (l/hr)	CS
	Peak CH_4 (%v/v)	Steady CO_2 (%v/v)	Peak Flow (l/h)	Groundwater (mbgl)	Pressure (mb)		
WS101	<0.1	0.4 to 1.3	0.1 to 3.5*	Flooded to 0.64	6 Visits monitored >1000mb	0.035	CS1
WS103	<0.1	1.0 to 1.8	<0.1 to 0.1	Flooded to 0.5		1.8E-03	CS1
WS105	<0.1	1.8 to 3.7	0.1 to 2.6*	Flooded to 0.89		0.081	CS2
WS108	<0.1	0.4 to 1.4	0.1	Flooded to 1.14		1.4E-03	CS1
WS110	<0.1	1.9 to 3.3	0.1 to 0.5	0.2 to 1.7		0.012	CS1

Table 6-2: Summary of ground gas monitoring for land at Petre Wood, Langho.

Notes:

If concentrations / flow are zero then equipment detection limits are assumed.

CS – Characteristic Situation; TL= Traffic Light

* Elevated flow readings recorded on first visit only with high water levels.

BH01 was monitored on 6 no. occasions between 16th January 2006 and 4th March 2006. A methane concentration of 1.2% v/v was encountered on the first visit and a concentration of 1.5% v/v on the last visit. All other visits were at or less than 0.1% v/v. Carbon dioxide concentrations ranged from less than the limit of detection to a maximum of 3.3% v/v.

No flow values above the limit of detection were reporting in BH01.

[33] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665

[34] BSI (2007). "Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments." BS8485:2007.

In accordance with current guidance CIRIA C665, a Gas Screening Value (GSV) may be calculated. Assuming worst case scenario maximum concentrations and flow for methane and carbon dioxide generated a maximum GSV of 0.081 l/hr for carbon dioxide in WS105 which would place the gas risk within a Characteristic Situation (CS) 2. Due to the high water levels encountered during the first monitoring visit it is considered that this high flow rate (2.6l/hr) is erroneous and caused by rising groundwater entering the borehole installation. Therefore LKC consider that CS1 is appropriate due to the absence of significant depths of made ground and the maximum GSV is only slightly elevated above CS1 threshold.

The guidance also indicates that consideration to increasing the CS should be given where methane concentrations exceed 1% v/v methane or 5% v/v carbon dioxide. The previous monitoring survey in BH01 encountered a maximum methane concentration of 1.5% v/v; however there does not appear to be a source of this methane within the borehole log. On this basis LKC consider the data may be erroneous.

Based on the above Pollutant Linkage 3 is incomplete and no gas protection measures are required.

6.5 Additional Risk Assessment

6.5.1 Concrete

The concentrations of soluble sulphate in the soil when contrasted to BRE Digest[35] categorise the concrete requirement as DS-1 AC-1s and therefore no special requirements are required.

Based on the above LKC considers that Pollutant Linkage 5 is incomplete and no sulphate resistant concrete is required for the proposed buildings.

6.5.2 Potable Water Supply

United Utilities (UU) guidelines have been recently replaced with new guidance[36], where sampling is required for contaminants that include speciated petroleum hydrocarbons, chlorinated compounds, BTEX compounds, phenols, cresols, ethers, nitrobenzene, ketones, aldehydes and amines. However, the guidelines do state a robust risk assessment can be undertaken on why specific pipework is not required. No elevated levels of contaminants have been identified, however; this is subject to completing a UU risk assessment form and consultation with UU.

Therefore, at this stage LKC considers Pollutant Linkage 6 is possible pending the completion of a UU risk assessment document.

6.5.3 Phytotoxicity

No analysed soil concentrations are considered phytotoxic as outlined in BS3882[37]. Therefore, no remedial measures will be required for any areas of soft landscaping and gardens to protect flora, although consideration to the soil matrix should assessed to establish if made ground is a suitable growing medium for flora.

Therefore, pollutant linkage 7 is considered incomplete.

[35] BRE (2005).”Concrete in Aggressive Ground.” Special Digest 1.
[36] UU(2011). “United Utilities Water Supplementary Guidance for the Selection of Water Pipes in Land Potentially Affected by Contamination.”
[37] BS (2007). “Specifications for Topsoil and Requirements for use.” BS3882:2007

6.6 Revised Conceptual Model

A revised conceptual model may be undertaken for the site using all available data and this is presented in Table 6-3. Based on the results of the site investigation, only pollutant linkages that possibly still exist are shown. A description of the likelihood for the pollutant linkage to exist is summarised below.

Pollutant Linkage No.	Contaminant					Pathway	Receptor
	ACM	Gases		Contaminants			
		Hazardous	Ground	Organic	Inorganic		
PL1	x	x	x	✓	x	-Dermal contact. -Ingestion of soils and vegetables. -Inhalation of contaminated soil, fibres and dust.	-Future site residents (inc. veg uptake).
PL6	x	x	x	?	x	-Ingestion of tainted water supply. -Corrosion of metal pipework.	-Future site residents. -Pipework.

Table 6-3: Revised Contamination Conceptual Model for land at Petre Wood, Langho.
Key: ✓ – pollutant linkage identified; ? – pollutant linkage possible, x – pollutant linkage unlikely

6.6.1 Pollutant Linkage 1

Pollutant Linkage 1 (direct contact) is considered complete for future site residents who may come in contact with the made ground which was identified in BH02, WS101, WS107 and WS110.

Remedial measures will therefore be required in all garden and soft landscaping areas in these locations and elsewhere on the site where similar made ground is identified.

6.6.2 Pollutant Linkage 6

Potential pollutant linkage 6 refers to the possible contaminants permeating potable water pipes and direct contact of the potential contaminants by future pipe installers and maintenance workers.

The risk to potable water pipes is considered unlikely; however, this is subject to consultation with UU so this linkage remains possible as a precaution.

Further details of the outline remedial proposals and a remedial option appraisal are given in Section 7.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

LKC carried out a ground investigation at a site at Petre Wood, Langho in order to identify the ground conditions beneath the site and confirm the presence / absence of the potential pollutant linkages identified in the Preliminary Risk Assessment.

A total of ten window sample boreholes were undertaken by LKC across the site, soil samples were collected and monitoring wells were installed in five of the boreholes. In addition, four boreholes were undertaken on the site by GCM in 2005 associated with the housing development which is adjacent to the south of the site.

The ground conditions across the site comprised of made ground to a maximum depth of 1.0 mbgl over natural soft to very stiff clays. A thin (0.6m -0.7m) band of sand was noted in WS108 and WS109 only. Mudstone was noted in WS110 only. The made ground was noted to be ashy in places and was encountered in GCM BH02, WS101, WS107 and WS110.

A typical estimated bearing pressures at 1m penetration in the natural clay based upon average SPT ‘N’ values and USS values is 75kN/m^2. However soft spots do exist which may require the localised deepening, widening and/or re-inforcing of foundations.

Soakaway testing was not undertaken due to high groundwater levels.

Sand strata encountered from 3.9mbgl to 5.2mbgl have ‘N’ values from between 17 and 23 characterising the strata as medium dense.

Based on the assumption that the common ash and common alder trees are to be removed from the site which has moderate water demand, NHBC guidance estimates that a minimum foundation depth of 1.45m is required within the zone of influence of these trees (up to 17.5m radius).

Samples were analysed for contaminants of concern based on the findings of the PRA and the ground conditions encountered.

When compared to human health generic values for a residential land use scenario two B(a)P results from WS110 (2.6 and 3.7mg/kg) exceeded the generic criteria. Both samples were from the ashy made ground.

No elevated water test results have been identified from any of the samples based on conservative UKDWS. Therefore LKC considers the site does not pose a significant risk to controlled waters.

Gas monitoring results have identified maximum concentrations of methane of <0.1% v/v methane and 3.7% v/v carbon dioxide, with a maximum flow of 3.5 l/hr. A worst case GSV of 0.081 l/hr has been identified in WS105 which classifies the site as CS2. Previous monitoring in BH01 provided a maximum methane concentration of 1.5% v/v. Based upon a review of the borehole log LKC consider this reading may be erroneous. Due to the absence of made ground in WS105 and the GSV only being slightly elevated above the threshold value LKC consider CS1 is appropriate across the site and no gas protection measures are required.

Inorganic and organic contaminants are not considered to pose a possible risk to potable water pipes, subject to the completion of the United Utilities risk assessment document and confirmation of the installation depths of any potable pipework.

The site is not considered to pose a risk to concrete in building foundation or structures from sulphate or to flora from phytotoxic contaminants.

LKC conclude that there is one remaining pollutant linkage that still exists (relating to direct contact and one which is considered possible (installation of suitable potable pipe work), depending on further consultation with United Utilities.

7.2 Recommendations

The recommendations provided below are considered appropriate for the site based on the site investigation.

7.2.1 Soil Contamination – Direct Contact (Pollutant Linkage 1)

Pollutant linkage 1 has been identified for B(a)P in WS110. In addition similar ashy made ground was encountered in BH02, WS101 and WS107.

LKC advise that the made ground these areas of the site is unsuitable for retention in the upper 600mm in all garden and soft landscaped areas. It should be noted that similar made ground may exist elsewhere on the site and the contractors should be briefed on the steps to be taken upon the identification of such material

Remedial measures should include the removal of made ground from the proposed garden and soft landscaping areas with the material either disposed of appropriately off-site or retained under areas of roads or buildings onsite.

Otherwise where this material remains in below garden and soft landscaping areas a capping layer will be required and this should comprise:

- In landscaped areas LKC would recommend that a 300mm thick clean capping layer is employed comprising 100mm capillary break layer (MOT type 1 material, 20-30mm, minimal fines) and at least 200mm comprising clean inert fill and sufficient topsoil for a growing medium.
- In garden areas LKC would recommend that a 600mm thick clean capping layer is employed comprising 100mm capillary break layer (MOT type 1 material, 20-30mm, minimal fines) and at least 500mm comprising clean inert fill and sufficient topsoil for a growing medium.

LKC would also recommend that any incoming soil material for use on the site is chemically validated prior to importation.

7.2.2 Potable Water Supply (Pollutant Linkage 6)

A potential risk to potable water supplies has not been identified for the site if the pipes are laid within the natural strata.

A United Utilities Risk Assessment form will need to be completed once the proposed pipe routes and depths are determined.

7.2.3 Geotechnical

The information contained in this report should be utilised by the Structural Engineer to assist in the foundation design for the site.

Factors for consideration include possible localised soft spots in the shallow clay which may require localised deepening, widening and / or reinforcing of foundations, a minimum foundation depth of at least 1.45m within the zone of influence of the ash and alder trees to be removed and the localised standing water or flooding.

No soakaway testing was undertaken due to high groundwater levels.

7.3 Additional Considerations

7.3.1 Importation of Soil

If any soil is to be imported for use within soft landscaping of garden areas, the soil will need to be validated to ensure it is suitable for its proposed use.

7.3.2 Unexpected Contamination

The relevant contractors should be briefed that during development works at the site should any unusual ground conditions and / or visual or olfactory evidence of contamination be encountered at the site, LKC and the Local Authority should be informed and further assessment of the material may be required.

This briefing should include the identification of ashy made ground previously identified in BH01, WS101, WS107 and WS110 and the remedial steps required to be undertaken should the material be present beneath proposed garden and soft landscaping areas.

7.3.3 Health and Safety Considerations

In working with, removing or treating any contaminating material it is important that any potential risks associated with the actual site works are mitigated by good environmental management of the site during the remedial phases. Standard health and safety precautions (as per HSE guidance[38]) should be adopted by all workers involved with site enabling and construction works.

7.4 Remediation, Verification and Site Completion Report

It is also recommended that any remediation carried out on the site is validated by a third party and suitable documentary evidence provided in a Site Completion Report, such as photographs, consignment documents and analytical results. This should include as a minimum:

- Details on the remediation of the ashy made ground present in proposed garden areas.
- Verification of all imported soil for soft landscaping, site raising and garden areas. The sampling suite and regime should follow Local Authority guidance. A typical sampling regime would be 1 per 250m^3 for subsoil and 1 per 50m^3 for topsoil (or a minimum of 3 samples per source). Typical composite samples would be tested for a comprehensive suite comprising as a minimum heavy metals, speciated PAHs, petroleum hydrocarbons and asbestos screen.
- Information on the installation of protective pipes and / or sterile trenches, as required.

[38] HSE (1991). “Protection of workers and the general public during development of contaminated land” London HMSO.

The Site Completion Report will assist the Local Authority in the discharge of any future relevant planning condition and will also be of use to solicitors acting on behalf of any prospective conveyancer who may have concerns over the former use of the site.

FIGURES

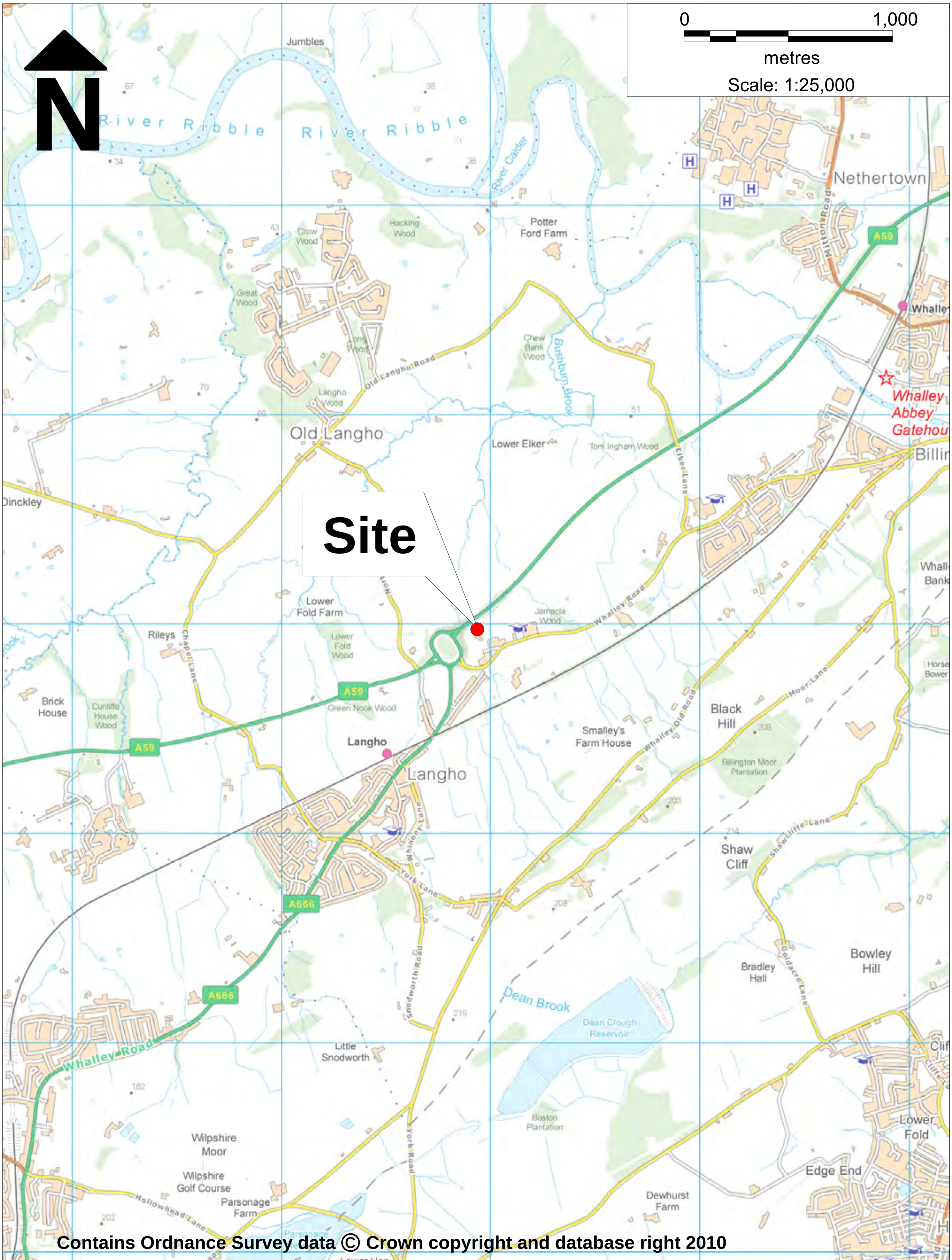

Figure 1: Location Plan, Land at Petre Wood, Langho, Blackburn

Drawn: October 2012 Scale: See Scale Bar (approx 1:25,000 @ A4)

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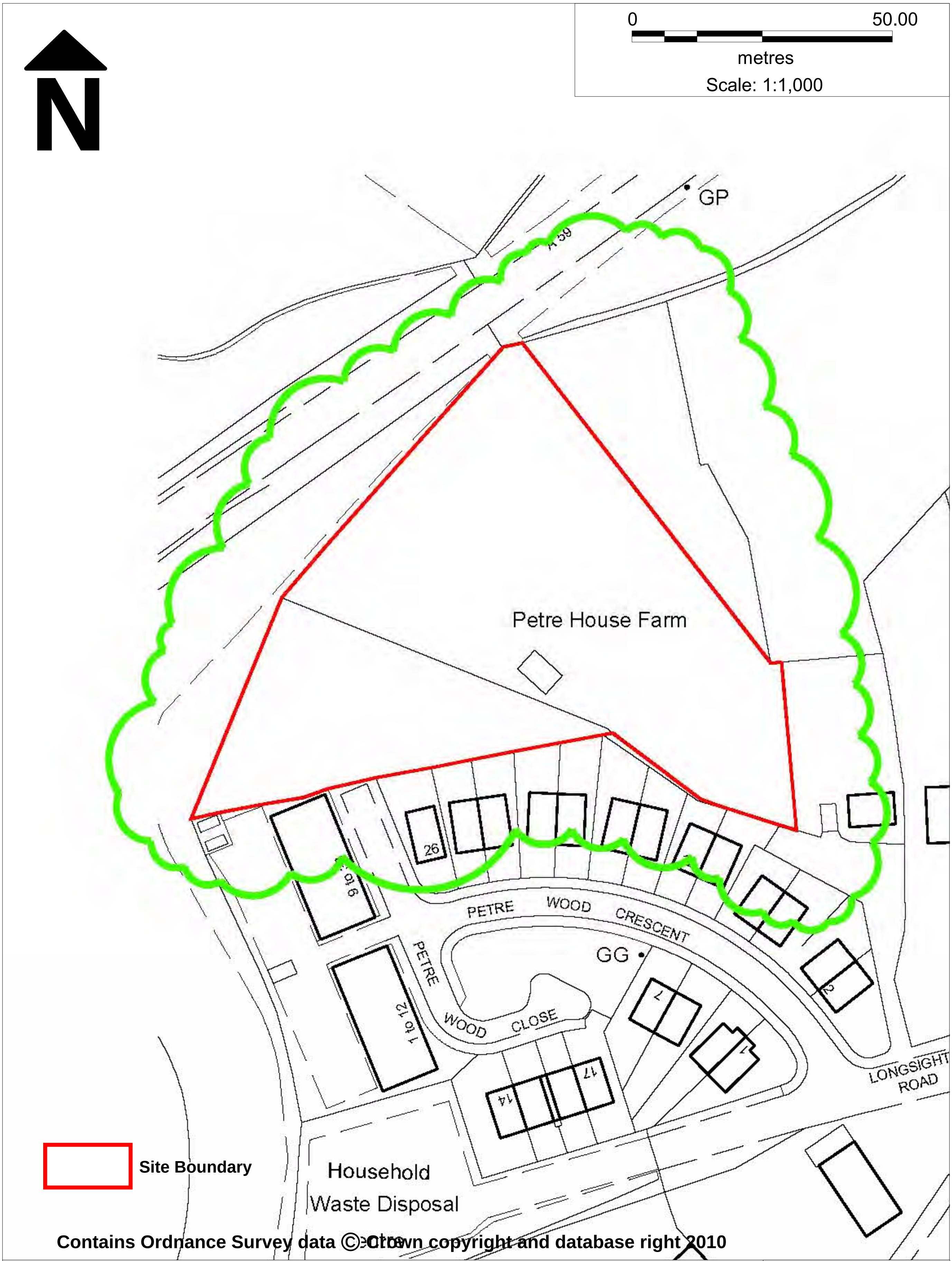

Figure 2: Site Boundary Plan, Land at Petre Wood, Langho, Blackburn

Drawn: December 2012 Scale: See Scale Bar (approx 1:1,000 @ A4)

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Figure 3: Proposed Site Plan, Land at Petre Wood, Langho, Blackburn

Drawn: December 2012 Scale: See Scale Bar (approx 1:1,000 @ A4)

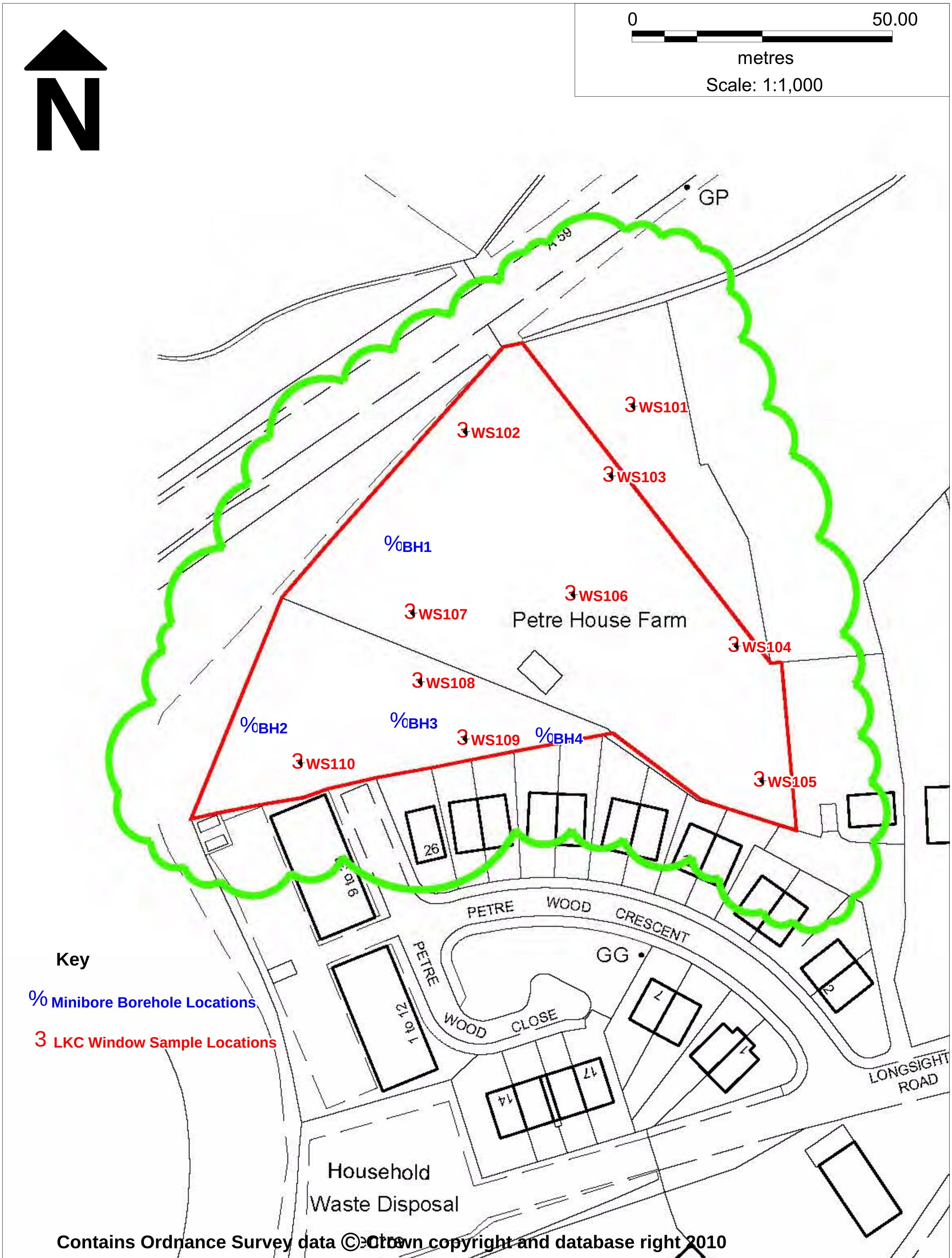

Figure 4: Sampling Location Plan, Land at Petre Wood, Langho, Blackburn

Drawn: December 2012 Scale: See Scale Bar (approx 1:1,000 @ A4)

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APPENDIX A

PROFILE LOGS

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com		**Site** Petre Wood, Langho	**Number** **WS101**
Excavation Method Drive-in Window Sampler	**Dimensions** / **Ground Level (mOD)**	**Client** Lancaster Maloney Ltd.	**Job Number** LKC 12 1001
	Location (Handheld GPS) 370952 E 435008 N / **Dates** 14/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					(0.50)	MADE GROUND: Ash and clinker.
					0.50 (0.10)	MADE GROUND: Whole red bricks (possible floor).
					0.60	Firm to very stiff brown slightly gravelly CLAY with rare rootlets and orange/grey mottling. Gravel is fine to coarse subangular to angular of mudstone.
0.70-1.00	C1					
0.70-1.00	PID 0.0ppm					
0.80	SV1 40kPa					
1.00-1.45	SPT N=14		3,3/3,3,3,5			
1.50	SV2 160kPa					
1.50-2.00	PID 0.0ppm					
2.00-2.45	SPT N=28		7,6/6,6,7,9			
					(3.32)	
2.40	SV3 200kPa					
2.80	SV4 160kPa					
3.00-3.45	SPT N=43		6,7/6,6,10,21			
3.50-3.92	SPT 50/267		6,7/9,10,17,14			
					3.92	
						Complete at 3.92m

Legend | Water | Instr

Remarks
Borehole dry.
WS refused at 3.92mbgl.

Scale (approx)	Logged By
1:40	RP

Figure No.
LKC 12 1001.WS101

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com		**Site** Petre Wood, Langho	**Number** **WS102**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd.	**Job Number** LKC 12 1001
	Location (Handheld GPS) 370927 E 435006 N	**Dates** 14/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.50 0.00-0.50	C1 PID 0.0ppm					Soft to stiff orangish brown sandy slightly gravelly CLAY with occasional roots. Sand is fine to coarse. Gravel is fine to coarse subangular to angular of mudstone.		
0.50	SV1 90kPa							
1.00-1.45	SPT N=3		0,0/0,1,1,1			Soft very sandy CLAY at 1.0 to 1.5mbgl.		
1.50 1.50-2.00 1.50-2.00	SV2 70kPa B1 PID							
2.00-2.45	SPT N=19		2,2/4,4,5,6					
2.50	SV3 110kPa				(5.45)			
3.00-3.45	SPT N=12		2,2/2,2,3,5					
3.50	SV4 65kPa							
4.00-4.45	SPT N=13		2,3/3,3,3,4					
4.50	SV5 50kPa							
5.00-5.45	SPT N=27		3,4/5,5,7,10					
					5.45	Complete at 5.45m		

Remarks	**Scale (approx)** 1:40	**Logged By** RP
	Figure No. LKC 12 1001.WS102	

LK CONSULT LTD
Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site	Number
Petre Wood, Langho	WS103

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Lancaster Maloney Ltd.	LKC 12 1001
	Location (Handheld GPS)	**Dates**	**Engineer**	**Sheet**
	370955 E 434997 N	14/12/2012	LKC	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.20)	TOPSOIL: Dark brown slightly sandy slightly gravelly clay.			
0.20-0.50	C1				0.20	Soft to stiff brown slightly sandy slightly gravelly CLAY with occasional roots. Sand is fine to coarse. Gravel is fine to coarse subangular to angular of mudstone.			
0.20-0.50	PID 0.0ppm								
0.50	SV1 60kPa								
1.00-1.45	SPT N=7		0,0/0,2,2,3						
1.50	SV2 95kPa					Gravel content increases with depth.			
1.50-2.00	B1								
1.50-2.00	PID 0.0ppm								
2.00-2.45	SPT N=18		3,3/3,3,5,7						
					(4.45)				
2.50	SV3 110kPa								
3.00-3.45	SPT N=22		2,3/4,5,6,7						
3.50	SV4 80kPa								
4.00-4.45	SPT N=22		2,2/3,4,5,10						
4.30	SV5 70kPa								
4.50-4.65	SPT 50/0		4,6/50						
					4.65				
						Complete at 4.65m			

Remarks
Borehole dry.
WS refused at 4.65mbgl (possible bedrock).

Scale (approx)	Logged By
1:40	RP

Figure No.
LKC 12 1001.WS103

LK CONSULT LTD

Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site	Petre Wood, Langho		**Number**	WS104
Excavation Method	Drive-in Window Sampler			
Dimensions				
Ground Level (mOD)				
Client	Lancaster Maloney Ltd.		**Job Number**	LKC 12 1001
Location (Handheld GPS)	370981 E 434964 N			
Dates	14/12/2012			
Engineer	LKC		**Sheet**	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	TOPSOIL: Dark brown slightly sandy slightly gravelly clay.		
0.20-0.90 0.20-0.90 0.50	C1 PID 0.0ppm SV1 50kPa				(0.70) 0.90	Firm light brown/orange sandy CLAY. Sand is fine to coarse.		
0.90-1.50 0.90-1.50 1.00-1.45 1.20	C2 PID 0.0ppm SPT N=1 SV2 40kPa		1,0/1,0,0,0		(0.60) 1.50	Very soft to soft grey brown very sandy CLAY. Sand is fine to coarse.		
2.00-2.45 2.00-2.50 2.00-2.50 2.50 3.00-3.45 4.00-4.45 4.50 5.00-5.45	SPT N=22 B1 PID 0.0ppm SV3 140kPa SPT N=20 SPT N=17 SV4 80kPa SPT N=23		3,3/4,5,6,7 2,3/3,4,6,7 2,2/4,4,4,5 5,4/4,6,6,7		(3.95) 5.45	Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse subangular to angular of mudstone. Gravel content increases with depth.		
						Complete at 5.45m		

Remarks
Borehole dry.

Scale (approx)	Logged By
1:40	RP

Figure No. LKC 12 1001.WS104

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com		**Site** Petre Wood, Langho	**Number** **WS105**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd.	**Job Number** LKC 12 1001
	Location (Handheld GPS) 370988 E 434943 N	**Dates** 14/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.20 0.00-0.20	C1 PID 0.0ppm				(0.20) 0.20	TOPSOIL: Dark brown sandy gravelly CLAY.			
0.50-1.00 0.50-1.00 0.70	C2 PID 0.0ppm SV1 59kPa				(0.80) 1.00	Firm light brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse subangular to angular of mudstone.			
1.00-1.45	SPT N=12		2,2/3,3,3,3			Soft to firm light grey brown very sandy CLAY. Sand is fine to coarse.			
1.30-1.50 1.30-1.50	B1 PID 0.0ppm								
2.00-2.45	SPT N=12		2,2/2,2,4,4						
3.00-3.45	SPT N=11		2,2/3,3,3,2		(3.70)				
3.40	SV2 30kPa								
4.00-4.45	SPT N=11		1,1/1,2,3,5		4.70				
						Complete at 4.70m			

Remarks Borehole dry. WS refused at 4.7mbgl (possible bedrock).	**Scale (approx)** 1:40	**Logged By** RP
	Figure No. LKC 12 1001.WS105	

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com			**Site** Petre Wood, Langho	**Number** **WS106**
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd.	**Job Number** LKC 12 1001
	Location (Handheld GPS) 370948 E 434974 N	**Dates** 14/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.20 0.00-0.20	C1 PID 0.0ppm				(0.20) 0.20	TOPSOIL: Dark brown slightly sandy slightly gravelly clay.		
0.50-1.00 0.50-1.00 0.70	C2 PID 0.0ppm SV1 65kPa					Firm to stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse subangular to angular of mudstone.		
1.00-1.45	SPT N=13		2,2/3,3,3,4					
1.50	SV2 40kPa							
2.00-2.45	SPT N=21		3,4/5,5,5,6					
2.50	SV3 100kPa				(4.95)			
3.00-3.45	SPT N=18		3,3/4,4,5,5					
3.50	SV4 70kPa							
4.00-4.45	SPT N=18		3,2/3,5,5,5					
5.00-5.15	SPT 50/0		5,6/50		5.15			
						Complete at 5.15m		

Remarks Borehole dry. WS refused at 5.15mbgl (possible bedrock).	**Scale (approx)** 1:40	**Logged By** RP
	Figure No. LKC 12 1001.WS106	

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	Site Petre Wood, Langho	Number **WS107**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Lancaster Maloney Ltd.	LKC 12 1001
	Location	**Dates** 14/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.10) 0.10	MADE GROUND: Whole red bricks.		
					(0.20) 0.30	MADE GROUND: Ash.		
0.30-1.00 0.30-1.00 0.50	C1 PID 0.0ppm SV1 70kPa					Firm to stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse subangular to angular of mudstone.		
1.00-1.45	SPT N=9		1,0/1,2,3,3			Gravel content increases with depth.		
1.50	SV2 120kPa							
2.00-2.45	SPT N=23		3,4/4,6,6,7					
2.50	SV3 170kPa							
					(5.15)			
3.00-3.45	SPT N=21		2,3/4,4,5,8					
3.50	SV4 70kPa							
4.00-4.45	SPT N=14		2,3/3,3,3,5					
4.50	SV5 60kPa							
5.00-5.45	SPT N=17		2,2/3,4,5,5					
					5.45			
						Complete at 5.45m		

Remarks	Scale (approx)	Logged By
Borehole dry.	1:40	RP
	Figure No. LKC 12 1001.WS107	

LK CONSULT LTD
Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site	Number
Petre Wood, Langho	WS108

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Lancaster Maloney Ltd.	LKC 12 1001
	Location	**Dates** 15/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
0.10-0.30	C1				(0.30) 0.30	MADE GROUND: Brown sandy clay. Sand is fine to coarse.
					(0.40) 0.70	Brown CLAY with grey/orange mottling.
0.80-1.00	C2					Stiff dark brown/grey slightly gravelly CLAY with organic fibres. Gravel is fine to coarse subangular to angular of sandstone.
1.00-1.45	SPT N=21		3,3/4,5,6,6			
1.00-2.00	SV1 117kPa				(1.30) 2.00	
2.00-2.45	SPT N=20		8,5/5,4,5,6			Firm to stiff dark brown slightly gravelly CLAY with cobbles. Grave is fine to coarse subangular to angular Cobble content decreases with depth.
2.00-3.00	SV2 87kPa					
2.50-2.70	B1					
3.00-3.45	SPT N=20		3,3/4,4,6,6		(1.90)	
3.60-3.80	B2					
3.70	SV3 48kPa				3.90	
4.00-4.45	SPT N=17		2,3/4,4,4,5		(0.60)	Medium dense brown fine SAND.
4.30-4.70	B3				4.50	
4.50-4.95	SPT N=21		4,5/5,5,5,6		(0.45) 4.95	Firm to stiff dark brown laminated CLAY.
						Complete at 4.95m

Remarks

Scale (approx)	Logged By
1:40	DE

Figure No.
LKC 12 1001.WS108

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com		**Site** Petre Wood, Langho	**Number** **WS109**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Drive-in Window Sampler			Lancaster Maloney Ltd.	LKC 12 1001
	Location	**Dates** 15/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.05) 0.05	MADE GROUND: Brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is fine to coarse subangular to angular.		
0.10-0.30	C1				(1.05) 1.10	Firm brown sandy CLAY with orange/grey mottling. Sand is fine to coarse.		
1.00-1.45 1.00-1.30 1.00-2.00	SPT N=21 C2 SV1 52kPa		2,2/3,4,8,6			Firm to stiff dark brown/grey slightly gravelly CLAY with organic fibres. Gravel is fine to coarse subangular to angular. Organic fibres only noted to 1.4m.		
2.00-2.45 2.00-3.00	SPT N=20 SV2 128kPa		3,4/5,4,5,6					
2.50-2.70	B1				(3.40)			
3.00-3.45 3.00-4.00	SPT N=13 SV3 108kPa		5,4/3,3,3,4			Occasional cobbles noted from 1.4m to 2.9m.		
3.50-3.70	B2							
4.00-4.45 4.00-4.50	SPT N=17 SV4 59kPa		2,3/3,4,5,5		4.50			
4.50-4.70	B3				(0.70)	Medium dense brown fine SAND.		
5.00-5.45	SPT N=23		3,3/5,5,6,7		5.20			
					(0.25) 5.45	Stiff grey CLAY.		
						Complete at 5.45m		

Remarks	**Scale (approx)**	**Logged By**
	1:40	RP
	Figure No. LKC 12 1001.WS109	

LK CONSULT LTD

Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com

Site Petre Wood, Langho				**Number** WS110
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd.	**Job Number** LKC 12 1001
	Location	**Dates** 15/12/2012	**Engineer** LKC	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
0.10-0.30	C1					MADE GROUND: Dark brown slightly sandy slightly gravelly clay with organic fibres, occasional red brick fragments and occasional timber.
					(1.00)	
0.70-1.00	C2					
					1.00	
1.00-1.45 1.00-2.00	SPT N=4 SV1 32kPa		0,1/1,1,1,1			Very soft to firm grey CLAY.
1.50-1.70	B1				(1.20)	
2.00-2.45	SPT N=10		2,2/2,2,3,3			
					2.20	Firm to stiff dark brown/grey slightly gravelly CLAY. Gravel is fine to coarse subangular to angular
2.50-2.80	B2					
2.70	SV2 77kPa					
3.00-3.45 3.00-4.00	SPT N=16 SV3 44kPa		2,3/3,4,4,5		(1.90)	
						Occasional cobbles noted from 3.3mbgl.
4.00-4.27 4.00-4.50	SPT 50/118 B3		4,15/24,26		4.10 (0.17) 4.27	Extremely weak dark grey MUDSTONE.
						Complete at 4.27m

Remarks
WS refused at 4.27mbgl.

Scale (approx)	Logged By
1:40	DE

Figure No. LKC 12 1001.WS110

Drilling Apparatus :	Auto-Trip Standard Penetration Test Drop Hammer
Scheme :	Land at Petre Farms, Longsight Road, Langho.
Date :	18/11/05

MINI BORE
Site Investigation
24 Pendle Fields, Fence, Burnley, BB12 9HN
Telephone/Fax : 01282 697491

Borehole Log No. 1

Depth (m)	Description	Vane Readings (kNm^{-2})	Symbol
0.0	TOPSOIL		
	Firm mid brown & grey mottled sandy CLAY with gravel inclusions		
0.5			
1.0	Stiff dark brown & grey mottled sandy CLAY with gravel inclusions & fragments of dark grey mudstone	119	
1.5			
	Stiff dark brown sandy CLAY with gravel inclusions & fragments of dark grey mudstone		
2.0		130+	
2.5			
	Standard Penetration Tests		
3.0	From 3.0m to 3.45m 3 / 3 - 3, 4, 3, 4 N = 14	130+	
3.5			
4.0			
	Refusal - probable stone boulder		
	NOTE: gas monitoring well installed to base of borehole.		
4.5	**Samples Recovered**		
	Glass Jars 0.5m, 1.0m, 1.5m, 2.0m		
	Bagged Sample 3.0m		
5.0			

Drilling Apparatus : Auto-Trip Standard Penetration Test Drop Hammer

Scheme : Land at Petre Farms, Longsight Road, Langho.

Date : 18/11/05

MINI BORE
Site Investigation
24 Pendle Fields, Fence, Burnley, BB12 9HN
Telephone/Fax : 01282 697491

Borehole Log No. 2

Depth (m)	Description	Vane Readings (kNm^{-2})	Symbol
0.0	MADE GROUND- topsoil over gravel, clay & ash		
0.5			
	MADE GROUND- brown sandy very soily clay with gravel inclusions		
1.0	Probable MADE GROUND- soft brown sandy clay with gravel inclusions **Standard Penetration Tests** From 1.0m to 1.45m 1 / 0 - 1, 0, 1, 0 N = 2		
1.5		58	
2.0			
2.5	From 2.5m to 2.95m 1 / 0 - 1, 0, 1, 1 N = 3		
3.0			
3.5			
4.0			
	Possible MADE GROUND- firm grey sandy clay with fragments of very dark grey mudstone		
4.5	**Samples Recovered** **Glass Jars** 0.5m, 1.0m, 1.5m, 2.0m, 3.8m **Bagged Sample** 2.5m		
5.0	End of Bore		

Drilling Apparatus : Auto-Trip Standard Penetration Test Drop Hammer

Scheme : Land at Petre Farms, Longsight Road, Langho.

Date : 18/11/05

MINI BORE
Site Investigation
24 Pendle Fields, Fence, Burnley, BB12 9HN
Telephone/Fax : 01282 697491

Borehole Log No. 3

Depth (m)	Description	Vane Readings (kNm^{-2})	Symbol
0.0	TOPSOIL		
	Firm to stiff becoming stiff brown & grey mottled sandy CLAY with gravel inclusions		
0.5			
1.0		130+	
1.5			
	Stiff dark brown & grey mottled sandy CLAY with gravel inclusions & fragments of dark grey mudstone		
2.0		130+	
2.5			
	Firm to stiff dark brown sandy CLAY		
3.0	Firm brown sandy CLAY with occasional gravel inclusions		
		77	
3.5			
	Standard Penetration Tests		
4.0	**From 4.0m to 4.45m 1 / 1 - 1, 1, 2, 1 N = 5**		
4.5			
	Samples Recovered		
	Glass Jars **0.4m, 1.0m, 1.5m, 2.4m, 3.5m**		
	Dark grey MUDSTONE		
5.0	End of Bore		

Drilling Apparatus :	Auto-Trip Standard Penetration Test Drop Hammer
Scheme :	Land at Petre Farms, Longsight Road, Langho.
Date :	16/11/05

MINI BORE
Site Investigation
24 Pendle Fields, Fence, Burnley, BB12 9HN
Telephone/Fax : 01282 697491

Borehole Log No. 4

Depth (m)	Description	Vane Readings (kNm^{-2})	Symbol
0.0	TOPSOIL		
	Firm to stiff becoming stiff brown & grey mottled sandy CLAY with gravel inclusions		
0.5			
	Standard Penetration Tests		
1.0	**From 1.0m to 1.45m 2 / 2 - 3, 2, 3, 4 N = 12**		
	Stiff dark brown & grey mottled sandy CLAY with gravel inclusions		
1.5			
	From 1.8m 50 Refusal	130+	
	Refusal - probable stone boulder		
2.0	Borehole dry during drilling		
	Samples Recovered		
	Glass Jars 0.4m, 0.9m, 1.6m		
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			

APPENDIX B

CONTAMINATION CERTIFICATES OF ANALYSIS – SOIL

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Chemtest
The right chemistry to deliver results

Results of analysis of 16 samples
received 19 December 2012

Report Date
04 January 2013

LKC 12 1001 - Petre Wood, Langho

Login Batch No					**219405**					
Chemtest LIMS ID					AI09637	AI09638	AI09639	AI09640	AI09641	AI09642
Sample ID					WS101	WS102	WS103	WS104	WS104	WS105
Sample No										
Sampling Date					14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012
Depth					0.70m - 1.00m	0.00m - 0.50m	0.20m - 0.50m	0.20m - 0.90m	0.90m - 1.50m	0.00m - 0.20m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*						
2030	Moisture		%	n/a	13.4	14.8	16.2	20.2	17.1	16.8
	Stones content (>50mm)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2040	Soil colour			M	brown	brown	brown	brown	brown	brown
	Soil texture			M	clay	clay	clay	clay	clay	clay
	Other material			M	stones	stones	stones	stones	stones	stones
2010	pH			M	8.2	7.5	7.4	7.0	7.1	7.8
2300	Cyanide (free)	57125	mg kg^{-1}	M	<0.50			<0.50		<0.50
	Cyanide (total)	57125	mg kg^{-1}	M	<0.50			<0.50		<0.50
2625	Organic matter		%	M	1.0	0.79	0.83	1.2	1.7	< 0.40
2120	Boron (hot water soluble)	7440428	mg kg^{-1}	M	<0.4			<0.4		<0.4
	Sulfate (2:1 water soluble) as SO4	14808798	g l^{-1}	M	<0.01	<0.01	<0.01	0.01	0.01	0.02
2490	Chromium (hexavalent)	18540299	mg kg^{-1}	N	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg^{-1}	M	10	7.0	6.2	6.1	3.3	0.76
	Cadmium	7440439	mg kg^{-1}	M	0.68	<0.1	0.31	0.11	<0.1	<0.1
	Chromium	7440473	mg kg^{-1}	M	22	16	9.9	10	3.9	5.3
	Copper	7440508	mg kg^{-1}	M	37	20	15	12	8.8	7.3
	Mercury	7439976	mg kg^{-1}	M	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Nickel	7440020	mg kg^{-1}	M	36	12	14	6.1	2.4	7.6
	Lead	7439921	mg kg^{-1}	M	27	17	15	17	12	6.4
	Selenium	7782492	mg kg^{-1}	M	0.32	0.21	0.25	0.23	<0.2	<0.2
	Vanadium	7440622	mg kg^{-1}	M	29	24	19	23	13	9.5
	Zinc	7440666	mg kg^{-1}	M	66	31	29	32	24	15
2675	TPH aliphatic >C5-C6		mg kg^{-1}	N	< 0.1			< 0.1		< 0.1

All tests undertaken between 19/12/2012 and 04/05/2013

* Accreditation status

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Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Results of analysis of 16 samples
received 19 December 2012

LKC 12 1001 - Petre Wood, Langho

Chemtest
The right chemistry to deliver results

Report Date
04 January 2013

Login Batch No					**219405**					
Chemtest LIMS ID					AI09643	AI09644	AI09645	AI09646	AI09647	AI09648
Sample ID					WS105	WS106	WS106	WS107	WS108	WS108
Sample No										
Sampling Date					14/12/2012	14/12/2012	14/12/2012	14/12/2012	15/12/2012	15/12/2012
Depth					0.50m - 1.00m	0.00m - 0.20m	0.50m - 1.00m	0.30m - 1.00m	0.10m - 0.30m	0.80m - 1.00m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*						
2030	Moisture		%	n/a	25.2	17	15.5	23.4	15.1	16.5
	Stones content (>50mm)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2040	Soil colour			M	brown	brown	brown	brown	brown	brown
	Soil texture			M	clay	clay	clay	clay	clay	clay
	Other material			M	stones	stones	stones	stones	stones	stones
2010	pH			M	6.9	7.5	7.6	6.3	6.4	7.5
2300	Cyanide (free)	57125	mg kg-¹	M		<0.50				
	Cyanide (total)	57125	mg kg-¹	M		<0.50				
2625	Organic matter		%	M	4.8	1.1	0.57	4.1	0.88	1.4
2120	Boron (hot water soluble)	7440428	mg kg-¹	M		<0.4			<0.4	
	Sulfate (2:1 water soluble) as SO4	14808798	g l-¹	M	0.02	0.04	<0.01	0.02	<0.01	<0.01
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg-¹	M	11	13	6.5	10	5.8	8.7
	Cadmium	7440439	mg kg-¹	M	0.38	0.45	0.11	0.46	0.11	0.23
	Chromium	7440473	mg kg-¹	M	12	33	31	11	7.8	25
	Copper	7440508	mg kg-¹	M	30	36	16	28	6.3	30
	Mercury	7439976	mg kg-¹	M	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Nickel	7440020	mg kg-¹	M	11	48	14	11	4.9	31
	Lead	7439921	mg kg-¹	M	58	29	17	55	<5	13
	Selenium	7782492	mg kg-¹	M	0.60	0.40	0.43	0.50	0.26	0.18
	Vanadium	7440622	mg kg-¹	M	27	41	30	24	20	31
	Zinc	7440666	mg kg-¹	M	100	82	29	100	21	63
2675	TPH aliphatic >C5-C6		mg kg-¹	N		< 0.1			< 0.1	

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Login Batch No					**219405**			
Chemtest LIMS ID					AI09649	AI09650	AI09651	AI09652
Sample ID					WS109	WS109	WS110	WS110
Sample No								
Sampling Date					15/12/2012	15/12/2012	15/12/2012	15/12/2012
Depth					0.10m - 0.30m	1.00m - 1.30m	0.10m - 0.30m	0.70m - 1.00m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*				
2030	Moisture		%	n/a	13.5	13.1	13.6	17.7
	Stones content (>50mm)		%	n/a	<0.02	<0.02	<0.02	<0.02
2040	Soil colour			M	brown	brown	brown	brown
	Soil texture			M	clay	clay	clay	clay
	Other material			M	stones	stones	stones	stones
2010	pH			M	7.3	7.9	8.4	7.9
2300	Cyanide (free)	57125	mg kg-¹	M	<0.50			
	Cyanide (total)	57125	mg kg-¹	M	<0.50			
2625	Organic matter		%	M	0.57	1.4	3.4	3.8
2120	Boron (hot water soluble)	7440428	mg kg-¹	M	<0.4			
	Sulfate (2:1 water soluble) as SO4	14808798	g l-¹	M	0.02	0.04	0.07	0.02
2490	Chromium (hexavalent)	18540299	mg kg-¹	N	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg-¹	M	9.9	13	12	14
	Cadmium	7440439	mg kg-¹	M	<0.1	0.77	0.41	0.87
	Chromium	7440473	mg kg-¹	M	15	18	18	18
	Copper	7440508	mg kg-¹	M	17	32	39	40
	Mercury	7439976	mg kg-¹	M	<0.1	<0.1	0.13	0.1
	Nickel	7440020	mg kg-¹	M	15	36	18	30
	Lead	7439921	mg kg-¹	M	15	27	75	63
	Selenium	7782492	mg kg-¹	M	0.55	1.2	<0.2	0.60
	Vanadium	7440622	mg kg-¹	M	24	25	25	31
	Zinc	7440666	mg kg-¹	M	46	89	110	97
2675	TPH aliphatic >C5-C6		mg kg-¹	N	< 0.1			

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Chemtest
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04 January 2013

					219405					
					AI09637	AI09638	AI09639	AI09640	AI09641	AI09642
					WS101	WS102	WS103	WS104	WS104	WS105
					14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012
					0.70m - 1.00m	0.00m - 0.50m	0.20m - 0.50m	0.20m - 0.90m	0.90m - 1.50m	0.00m - 0.20m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2675	TPH aliphatic >C6-C8		mg kg^{-1}	N	< 0.1			< 0.1		< 0.1
	TPH aliphatic >C8-C10		mg kg^{-1}	N	< 0.1			< 0.1		< 0.1
	TPH aliphatic >C10-C12		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aliphatic >C12-C16		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aliphatic >C16-C21		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aliphatic >C21-C35		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aliphatic >C35-C44		mg kg^{-1}	N	< 1			< 1		< 1
	TPH aromatic >C5-C7		mg kg^{-1}	N	< 0.1			< 0.1		< 0.1
	TPH aromatic >C7-C8		mg kg^{-1}	N	< 0.1			< 0.1		< 0.1
	TPH aromatic >C8-C10		mg kg^{-1}	N	< 0.1			< 0.1		< 0.1
	TPH aromatic >C10-C12		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aromatic >C12-C16		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aromatic >C16-C21		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aromatic >C21-C35		mg kg^{-1}	M	< 1			< 1		< 1
	TPH aromatic >C35-C44		mg kg^{-1}	N	< 1			< 1		< 1
	Total Petroleum Hydrocarbons		mg kg^{-1}	N	< 10			< 10		< 10
2700	Naphthalene	91203	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthylene	208968	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthene	83329	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Fluorene	86737	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Phenanthrene	85018	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Anthracene	120127	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Fluoranthene	206440	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	0.22	< 0.1
	Pyrene	129000	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	0.19	< 0.1

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					219405					
					AI09643	AI09644	AI09645	AI09646	AI09647	AI09648
					WS105	WS106	WS106	WS107	WS108	WS108
					14/12/2012	14/12/2012	14/12/2012	14/12/2012	15/12/2012	15/12/2012
					0.50m - 1.00m	0.00m - 0.20m	0.50m - 1.00m	0.30m - 1.00m	0.10m - 0.30m	0.80m - 1.00m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2675	TPH aliphatic >C6-C8		mg kg-¹	N		< 0.1			< 0.1	
	TPH aliphatic >C8-C10		mg kg-¹	N		< 0.1			< 0.1	
	TPH aliphatic >C10-C12		mg kg-¹	M		< 1			< 1	
	TPH aliphatic >C12-C16		mg kg-¹	M		< 1			< 1	
	TPH aliphatic >C16-C21		mg kg-¹	M		< 1			< 1	
	TPH aliphatic >C21-C35		mg kg-¹	M		< 1			< 1	
	TPH aliphatic >C35-C44		mg kg-¹	N		< 1			< 1	
	TPH aromatic >C5-C7		mg kg-¹	N		< 0.1			< 0.1	
	TPH aromatic >C7-C8		mg kg-¹	N		< 0.1			< 0.1	
	TPH aromatic >C8-C10		mg kg-¹	N		< 0.1			< 0.1	
	TPH aromatic >C10-C12		mg kg-¹	M		< 1			< 1	
	TPH aromatic >C12-C16		mg kg-¹	M		< 1			< 1	
	TPH aromatic >C16-C21		mg kg-¹	M		< 1			< 1	
	TPH aromatic >C21-C35		mg kg-¹	M		< 1			< 1	
	TPH aromatic >C35-C44		mg kg-¹	N		< 1			< 1	
	Total Petroleum Hydrocarbons		mg kg-¹	N		< 10			< 10	
2700	Naphthalene	91203	mg kg-¹	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthylene	208968	mg kg-¹	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthene	83329	mg kg-¹	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Fluorene	86737	mg kg-¹	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Phenanthrene	85018	mg kg-¹	M	0.63	< 0.1	< 0.1	0.45	< 0.1	< 0.1
	Anthracene	120127	mg kg-¹	M	0.25	< 0.1	< 0.1	0.28	< 0.1	< 0.1
	Fluoranthene	206440	mg kg-¹	M	1.7	< 0.1	< 0.1	0.92	< 0.1	< 0.1
	Pyrene	129000	mg kg-¹	M	1.5	< 0.1	< 0.1	0.75	< 0.1	< 0.1

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					WS109	WS109	WS110	WS110
					15/12/2012	15/12/2012	15/12/2012	15/12/2012
					0.10m - 0.30m	1.00m - 1.30m	0.10m - 0.30m	0.70m - 1.00m
					SOIL	*SOIL*	*SOIL*	*SOIL*
2675	TPH aliphatic >C6-C8		mg kg-¹	N	< 0.1			
	TPH aliphatic >C8-C10		mg kg-¹	N	< 0.1			
	TPH aliphatic >C10-C12		mg kg-¹	M	< 1			
	TPH aliphatic >C12-C16		mg kg-¹	M	< 1			
	TPH aliphatic >C16-C21		mg kg-¹	M	< 1			
	TPH aliphatic >C21-C35		mg kg-¹	M	< 1			
	TPH aliphatic >C35-C44		mg kg-¹	N	< 1			
	TPH aromatic >C5-C7		mg kg-¹	N	< 0.1			
	TPH aromatic >C7-C8		mg kg-¹	N	< 0.1			
	TPH aromatic >C8-C10		mg kg-¹	N	< 0.1			
	TPH aromatic >C10-C12		mg kg-¹	M	< 1			
	TPH aromatic >C12-C16		mg kg-¹	M	< 1			
	TPH aromatic >C16-C21		mg kg-¹	M	< 1			
	TPH aromatic >C21-C35		mg kg-¹	M	< 1			
	TPH aromatic >C35-C44		mg kg-¹	N	< 1			
	Total Petroleum Hydrocarbons		mg kg-¹	N	< 10			
2700	Naphthalene	91203	mg kg-¹	M	< 0.1	< 0.1	0.23	< 0.1
	Acenaphthylene	208968	mg kg-¹	M	< 0.1	< 0.1	0.24	< 0.1
	Acenaphthene	83329	mg kg-¹	M	< 0.1	< 0.1	0.61	< 0.1
	Fluorene	86737	mg kg-¹	M	< 0.1	< 0.1	0.34	< 0.1
	Phenanthrene	85018	mg kg-¹	M	< 0.1	< 0.1	2.9	4.7
	Anthracene	120127	mg kg-¹	M	< 0.1	< 0.1	1.1	1.5
	Fluoranthene	206440	mg kg-¹	M	< 0.1	< 0.1	4.3	9
	Pyrene	129000	mg kg-¹	M	< 0.1	< 0.1	3.7	7.1

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					219405					
					AI09637	AI09638	AI09639	AI09640	AI09641	AI09642
					WS101	WS102	WS103	WS104	WS104	WS105
					14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012
					0.70m - 1.00m	0.00m - 0.50m	0.20m - 0.50m	0.20m - 0.90m	0.90m - 1.50m	0.00m - 0.20m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Benzo[a]anthracene	56553	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Chrysene	218019	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[b]fluoranthene	205992	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[k]fluoranthene	207089	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[a]pyrene	50328	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Dibenzo[a,h]anthracene	53703	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Indeno[1,2,3-cd]pyrene	193395	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[g,h,i]perylene	191242	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Total (of 16) PAHs		mg kg^{-1}	M	< 2	< 2	< 2	< 2	< 2	< 2
2750	Fuel Type (soils)			N	N/A			N/A		N/A
2760	Methyl tert-butyl ether	1634044	µg kg^{-1}	N	< 1			< 1		< 1
	Benzene	71432	µg kg^{-1}	M	< 1.0			< 1.0		< 1.0
	Toluene	108883	µg kg^{-1}	M	< 1.0			< 1.0		< 1.0
	Ethylbenzene	100414	µg kg^{-1}	M	< 1.0			< 1.0		< 1.0
	m- & p-Xylene	1330207	µg kg^{-1}	U	< 1.0			< 1.0		< 1.0
	o-Xylene	95476	µg kg^{-1}	U	< 1.0			< 1.0		< 1.0
2820	Azinphos methyl	86500	mg kg^{-1}	N						
	Coumaphos	56724	mg kg^{-1}	N						
	Demeton (O+S)	8065483	mg kg^{-1}	N						
	Disulfoton	298044	mg kg^{-1}	N						
	Fensulfothion	115902	mg kg^{-1}	N						
	Fenthion	55389	mg kg^{-1}	N						
	Phorate	298022	mg kg^{-1}	N						
	Prothiophos	34643464	mg kg^{-1}	N						

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					219405					
					AI09643	AI09644	AI09645	AI09646	AI09647	AI09648
					WS105	WS106	WS106	WS107	WS108	WS108
					14/12/2012	14/12/2012	14/12/2012	14/12/2012	15/12/2012	15/12/2012
					0.50m - 1.00m	0.00m - 0.20m	0.50m - 1.00m	0.30m - 1.00m	0.10m - 0.30m	0.80m - 1.00m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Benzo[a]anthracene	56553	mg kg-¹	M	0.94	< 0.1	< 0.1	0.66	< 0.1	< 0.1
	Chrysene	218019	mg kg-¹	M	0.91	< 0.1	< 0.1	0.66	< 0.1	< 0.1
	Benzo[b]fluoranthene	205992	mg kg-¹	M	0.83	< 0.1	< 0.1	0.56	< 0.1	< 0.1
	Benzo[k]fluoranthene	207089	mg kg-¹	M	0.73	< 0.1	< 0.1	0.36	< 0.1	< 0.1
	Benzo[a]pyrene	50328	mg kg-¹	M	0.77	< 0.1	< 0.1	0.66	< 0.1	< 0.1
	Dibenzo[a,h]anthracene	53703	mg kg-¹	M	2	< 0.1	< 0.1	0.17	< 0.1	< 0.1
	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	0.41	< 0.1	< 0.1	0.25	< 0.1	< 0.1
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	0.46	< 0.1	< 0.1	1.1	< 0.1	< 0.1
	Total (of 16) PAHs		mg kg-¹	M	11	< 2	< 2	6.8	< 2	< 2
2750	Fuel Type (soils)			N		N/A			N/A	
2760	Methyl tert-butyl ether	1634044	µg kg-¹	N		< 1			<1.0	
	Benzene	71432	µg kg-¹	M		< 1.0			< 1.0	
	Toluene	108883	µg kg-¹	M		< 1.0			< 1.0	
	Ethylbenzene	100414	µg kg-¹	M		< 1.0			< 1.0	
	m- & p-Xylene	1330207	µg kg-¹	U		< 1.0			< 1.0	
	o-Xylene	95476	µg kg-¹	U		< 1.0			< 1.0	
2820	Azinphos methyl	86500	mg kg-¹	N		< 0.2				
	Coumaphos	56724	mg kg-¹	N		< 0.2				
	Demeton (O+S)	8065483	mg kg-¹	N		< 0.2				
	Disulfoton	298044	mg kg-¹	N		< 0.2				
	Fensulfothion	115902	mg kg-¹	N		< 0.2				
	Fenthion	55389	mg kg-¹	N		< 0.2				
	Phorate	298022	mg kg-¹	N		< 0.2				
	Prothiophos	34643464	mg kg-¹	N		< 0.2				

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					219405			
					AI09649	AI09650	AI09651	AI09652
					WS109	WS109	WS110	WS110
					15/12/2012	15/12/2012	15/12/2012	15/12/2012
					0.10m - 0.30m	1.00m - 1.30m	0.10m - 0.30m	0.70m - 1.00m
					SOIL	*SOIL*	*SOIL*	*SOIL*
2700	Benzo[a]anthracene	56553	mg kg-¹	M	< 0.1	< 0.1	2.2	4
	Chrysene	218019	mg kg-¹	M	< 0.1	< 0.1	2.5	4.3
	Benzo[b]fluoranthene	205992	mg kg-¹	M	< 0.1	< 0.1	2.7	3.6
	Benzo[k]fluoranthene	207089	mg kg-¹	M	< 0.1	< 0.1	1.5	3
	Benzo[a]pyrene	50328	mg kg-¹	M	< 0.1	< 0.1	2.6	3.7
	Dibenzo[a,h]anthracene	53703	mg kg-¹	M	< 0.1	< 0.1	0.31	0.54
	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	< 0.1	< 0.1	1.4	2.4
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	< 0.1	< 0.1	2	2.8
	Total (of 16) PAHs		mg kg-¹	M	< 2	< 2	29	47
2750	Fuel Type (soils)			N	N/A			
2760	Methyl tert-butyl ether	1634044	µg kg-¹	N	< 1			
	Benzene	71432	µg kg-¹	M	< 1.0			
	Toluene	108883	µg kg-¹	M	< 1.0			
	Ethylbenzene	100414	µg kg-¹	M	< 1.0			
	m- & p-Xylene	1330207	µg kg-¹	U	< 1.0			
	o-Xylene	95476	µg kg-¹	U	< 1.0			
2820	Azinphos methyl	86500	mg kg-¹	N			< 0.2	
	Coumaphos	56724	mg kg-¹	N			< 0.2	
	Demeton (O+S)	8065483	mg kg-¹	N			< 0.2	
	Disulfoton	298044	mg kg-¹	N			< 0.2	
	Fensulfothion	115902	mg kg-¹	N			< 0.2	
	Fenthion	55389	mg kg-¹	N			< 0.2	
	Phorate	298022	mg kg-¹	N			< 0.2	
	Prothiophos	34643464	mg kg-¹	N			< 0.2	

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Results of analysis of 16 samples received 19 December 2012

LKC 12 1001 - Petre Wood, Langho

Chemtest
The right chemistry to deliver results

Report Date
04 January 2013

					219405					
					AI09637	AI09638	AI09639	AI09640	AI09641	AI09642
					WS101	WS102	WS103	WS104	WS104	WS105
					14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012	14/12/2012
					0.70m - 1.00m	0.00m - 0.50m	0.20m - 0.50m	0.20m - 0.90m	0.90m - 1.50m	0.00m - 0.20m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2820	Sulprofos	35400432	$mg\ kg^{-1}$	N						
	Trichloronate	327980	$mg\ kg^{-1}$	N						
2840	alpha-HCH	319846	$mg\ kg^{-1}$	N						
	gamma-HCH	58899	$mg\ kg^{-1}$	N						
	beta-HCH	319857	$mg\ kg^{-1}$	N						
	Heptachlor	76448	$mg\ kg^{-1}$	N						
	delta-HCH	319868	$mg\ kg^{-1}$	N						
	Aldrin	309002	$mg\ kg^{-1}$	N						
	Heptachlor epoxide	1024573	$mg\ kg^{-1}$	N						
	gamma-Chlordane	5103742	$mg\ kg^{-1}$	N						
	alpha-Chlordane	5103719	$mg\ kg^{-1}$	N						
	Endosulfan I	959988	$mg\ kg^{-1}$	N						
	4,4'-DDE	72559	$mg\ kg^{-1}$	N						
	Dieldrin	60571	$mg\ kg^{-1}$	N						
	Endrin	72208	$mg\ kg^{-1}$	N						
	4,4'-DDD	72548	$mg\ kg^{-1}$	N						
	Endosulfan II	33213659	$mg\ kg^{-1}$	N						
	4,4'-DDT	50293	$mg\ kg^{-1}$	N						
	Endrin aldehyde	7421934	$mg\ kg^{-1}$	N						
	Endosulfan sulfate	1031078	$mg\ kg^{-1}$	N						
	Methoxychlor	72435	$mg\ kg^{-1}$	N						
	Endrin ketone	53494705	$mg\ kg^{-1}$	N						
	Hexachlorobutadiene	87683	$mg\ kg^{-1}$	N						
2920	Phenols (total)		$mg\ kg^{-1}$	N	<0.3			<0.3		<0.3

All tests undertaken between 19/12/2012 and 04/05/2013

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Results of analysis of 16 samples
received 19 December 2012

LKC 12 1001 - Petre Wood, Langho

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The right chemistry to deliver results

Report Date
04 January 2013

					219405					
					AI09643	AI09644	AI09645	AI09646	AI09647	AI09648
					WS105	WS106	WS106	WS107	WS108	WS108
					14/12/2012	14/12/2012	14/12/2012	14/12/2012	15/12/2012	15/12/2012
					0.50m - 1.00m	0.00m - 0.20m	0.50m - 1.00m	0.30m - 1.00m	0.10m - 0.30m	0.80m - 1.00m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2820	Sulprofos	35400432	mg kg^{-1}	N		< 0.2				
	Trichloronate	327980	mg kg^{-1}	N		< 0.2				
2840	alpha-HCH	319846	mg kg^{-1}	N		< 0.2				
	gamma-HCH	58899	mg kg^{-1}	N		< 0.2				
	beta-HCH	319857	mg kg^{-1}	N		< 0.2				
	Heptachlor	76448	mg kg^{-1}	N		< 0.2				
	delta-HCH	319868	mg kg^{-1}	N		< 0.2				
	Aldrin	309002	mg kg^{-1}	N		< 0.2				
	Heptachlor epoxide	1024573	mg kg^{-1}	N		< 0.2				
	gamma-Chlordane	5103742	mg kg^{-1}	N		< 0.2				
	alpha-Chlordane	5103719	mg kg^{-1}	N		< 0.2				
	Endosulfan I	959988	mg kg^{-1}	N		< 0.2				
	4,4'-DDE	72559	mg kg^{-1}	N		< 0.2				
	Dieldrin	60571	mg kg^{-1}	N		< 0.2				
	Endrin	72208	mg kg^{-1}	N		< 0.2				
	4,4'-DDD	72548	mg kg^{-1}	N		< 0.2				
	Endosulfan II	33213659	mg kg^{-1}	N		< 0.2				
	4,4'-DDT	50293	mg kg^{-1}	N		< 0.2				
	Endrin aldehyde	7421934	mg kg^{-1}	N		< 0.2				
	Endosulfan sulfate	1031078	mg kg^{-1}	N		< 0.2				
	Methoxychlor	72435	mg kg^{-1}	N		< 0.2				
	Endrin ketone	53494705	mg kg^{-1}	N		< 0.2				
	Hexachlorobutadiene	87683	mg kg^{-1}	N		< 0.2				
2920	Phenols (total)		mg kg^{-1}	N		<0.3			<0.3	

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Results of analysis of 16 samples received 19 December 2012

LKC 12 1001 - Petre Wood, Langho

Chemtest
The right chemistry to deliver results

Report Date 04 January 2013

					219405			
					AI09649	AI09650	AI09651	AI09652
					WS109	WS109	WS110	WS110
					15/12/2012	15/12/2012	15/12/2012	15/12/2012
					0.10m - 0.30m	1.00m - 1.30m	0.10m - 0.30m	0.70m - 1.00m
					SOIL	*SOIL*	*SOIL*	*SOIL*
2820	Sulprofos	35400432	mg kg-¹	N			< 0.2	
	Trichloronate	327980	mg kg-¹	N			< 0.2	
2840	alpha-HCH	319846	mg kg-¹	N			< 0.2	
	gamma-HCH	58899	mg kg-¹	N			< 0.2	
	beta-HCH	319857	mg kg-¹	N			< 0.2	
	Heptachlor	76448	mg kg-¹	N			< 0.2	
	delta-HCH	319868	mg kg-¹	N			< 0.2	
	Aldrin	309002	mg kg-¹	N			< 0.2	
	Heptachlor epoxide	1024573	mg kg-¹	N			< 0.2	
	gamma-Chlordane	5103742	mg kg-¹	N			< 0.2	
	alpha-Chlordane	5103719	mg kg-¹	N			< 0.2	
	Endosulfan I	959988	mg kg-¹	N			< 0.2	
	4,4'-DDE	72559	mg kg-¹	N			< 0.2	
	Dieldrin	60571	mg kg-¹	N			< 0.2	
	Endrin	72208	mg kg-¹	N			< 0.2	
	4,4'-DDD	72548	mg kg-¹	N			< 0.2	
	Endosulfan II	33213659	mg kg-¹	N			< 0.2	
	4,4'-DDT	50293	mg kg-¹	N			< 0.2	
	Endrin aldehyde	7421934	mg kg-¹	N			< 0.2	
	Endosulfan sulfate	1031078	mg kg-¹	N			< 0.2	
	Methoxychlor	72435	mg kg-¹	N			< 0.2	
	Endrin ketone	53494705	mg kg-¹	N			< 0.2	
	Hexachlorobutadiene	87683	mg kg-¹	N			< 0.2	
2920	Phenols (total)		mg kg-¹	N	<0.3			

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT
Asbestos in Soils

Chemtest

Results of analysis of 16 samples
received 19 December 2012
LKC 12 1001 - Petre Wood, Langho

Report Date
04 January 2013

Login Batch No: 219405

Qualitative Results

				SOP 2190	
				ACM Type	Asbestos Identification
Chemtest ID	Sample ID	Sample Desc	Depth (m)		
AI09637		WS101	0.70	-	No Asbestos Detected
AI09638		WS102	0.00	-	No Asbestos Detected
AI09639		WS103	0.20	-	No Asbestos Detected
AI09640		WS104	0.20	-	No Asbestos Detected
AI09641		WS104	0.90	-	No Asbestos Detected
AI09642		WS105	0.00	-	No Asbestos Detected
AI09643		WS105	0.50	-	No Asbestos Detected
AI09644		WS106	0.00	-	No Asbestos Detected
AI09645		WS106	0.50	-	No Asbestos Detected
AI09646		WS107	0.30	-	No Asbestos Detected
AI09647		WS108	0.10	-	No Asbestos Detected
AI09648		WS108	0.80	-	No Asbestos Detected
AI09649		WS109	0.10	-	No Asbestos Detected
AI09650		WS109	1.00	-	No Asbestos Detected
AI09651		WS110	0.10	-	No Asbestos Detected
AI09652		WS110	0.70	-	No Asbestos Detected

The detection limit for this method is 0.001%

Signed

Signed

Hollis Rosamond
Asbestos Analyst

All tests undertaken between 04-Jan-2013 and 4-Jan-2013

LIMS sample ID range AI09637 to AI09652

APPENDIX C

CONTAMINATION CERTIFICATES OF ANALYSIS – GROUNDWATER

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Results of analysis of 5 samples
received 9 January 2013

Chemtest
The right chemistry to deliver results

Report Date
17 January 2013

LKC 12 1001 - Petre Wood, Langho

Login Batch No					**220071**				
Chemtest LIMS ID					AI13436	AI13437	AI13438	AI13439	AI13440
Sample ID					WS101	WS103	WS105	WS108	WS110
Sample No									
Sampling Date					7/1/2013	7/1/2013	7/1/2013	7/1/2013	7/1/2013
Depth									
Matrix					*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*					
1010	pH	PH		U	8.1	7.4	7.2	7.5	7.6
1610	Total Organic Carbon	TOC	mg l-¹	N	11	24	24	14	13
1270	Hardness	HARD_TOT	mg CaCO3 l-¹	U	160	200	270	130	250
1450	Arsenic	7440382	µg l-¹	U	2.2	1.7	<1.0	1.6	1.4
	Cadmium	7440439	µg l-¹	U	<0.080	<0.080	<0.080	<0.080	<0.080
	Chromium	7440473	µg l-¹	U	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper	7440508	µg l-¹	U	<1.0	<1.0	<1.0	1.1	<1.0
	Mercury	7439976	µg l-¹	U	<0.50	<0.50	<0.50	<0.50	<0.50
	Nickel	7440020	µg l-¹	U	53	13	9.5	3.3	<1.0
	Lead	7439921	µg l-¹	U	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium	7782492	µg l-¹	U	9.9	3.3	2.3	2.8	1.9
	Vanadium	7440622	µg l-¹	U	<1.0	<1.0	<1.0	1.0	<1.0
	Zinc	7440666	µg l-¹	U	6.4	12	5.3	4.4	2.5
1490	Chromium (hexavalent)	18540299	µg l-¹	U	<20	<20	<20	<20	<20
1700	Naphthalene	91203	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Acenaphthylene	208968	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Acenaphthene	83329	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Fluorene	86737	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Phenanthrene	85018	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Anthracene	120127	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Fluoranthene	206440	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Pyrene	129000	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[a]anthracene	56553	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01

All tests undertaken between 09/01/2013 and 17/01/2013

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

Leyden Kirby
Unit 25 Bury Business Centre
Kay Street
Bury, Lancashire
BL9 6BU

FAO C Crompton / R Peart

LABORATORY TEST REPORT

Results of analysis of 5 samples
received 9 January 2013

LKC 12 1001 - Petre Wood, Langho

Chemtest
The right chemistry to deliver results

Report Date
17 January 2013

					220071				
					AI13436	AI13437	AI13438	AI13439	AI13440
					WS101	WS103	WS105	WS108	WS110
					7/1/2013	7/1/2013	7/1/2013	7/1/2013	7/1/2013
					WATER	*WATER*	*WATER*	*WATER*	*WATER*
1700	Chrysene	218019	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[b]fluoranthene	205992	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[k]fluoranthene	207089	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[a]pyrene	50328	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Dibenzo[a,h]anthracene	53703	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Benzo[g,h,i]perylene	191242	µg l-¹	N	<0.01	<0.01	<0.01	<0.01	<0.01
	Total (of 16) PAHs		µg l-¹	N	<0.2	<0.2	<0.2	<0.2	<0.2

All tests undertaken between 09/01/2013 and 17/01/2013
* Accreditation status
This report should be interpreted in conjuction with the notes on the accompanying cover page.

APPENDIX D

GEOTECHNICAL CERTIFICATES OF ANALYSIS

MURRAY RIX
33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871

UKAS TESTING 1580

TEST CERTIFICATE

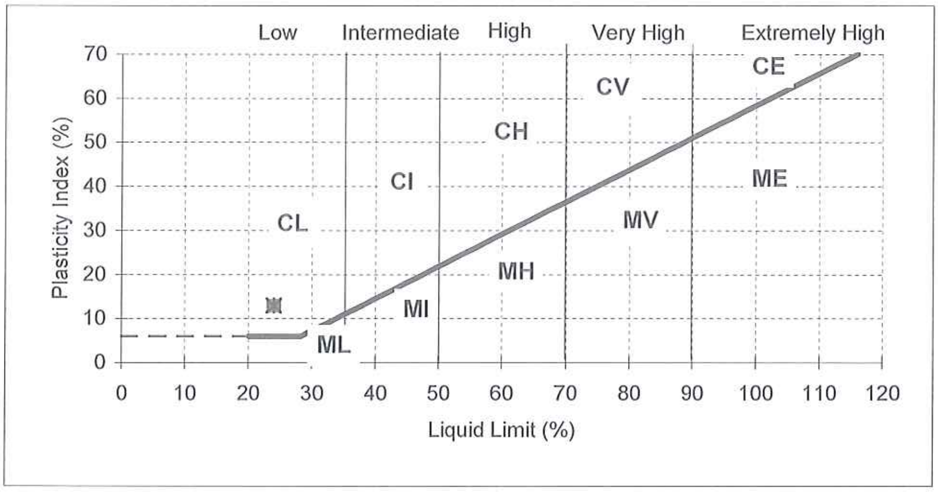
LIQUID AND PLASTIC LIMIT
BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Petre Wood, Langho
JOB NUMBER	MRN 2347/18

SAMPLE LABEL	WS102/1-5-2.0m	DATE SAMPLED	N/A
SAMPLE No.	54546	DATE RECEIVED	17-Dec-12
DATE TESTED	18-Dec-12	SAMPLED BY	Client

MATERIAL	Brown sandy silty Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
14	24	11	13	98



REMARKS
Sample was tested in natural condition

SIGNED

NAME A Richardson (Deputy Laboratory Manager) DATE 21-Dec-12

Page 2 of 5

MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871

UKAS TESTING 1580

TEST CERTIFICATE

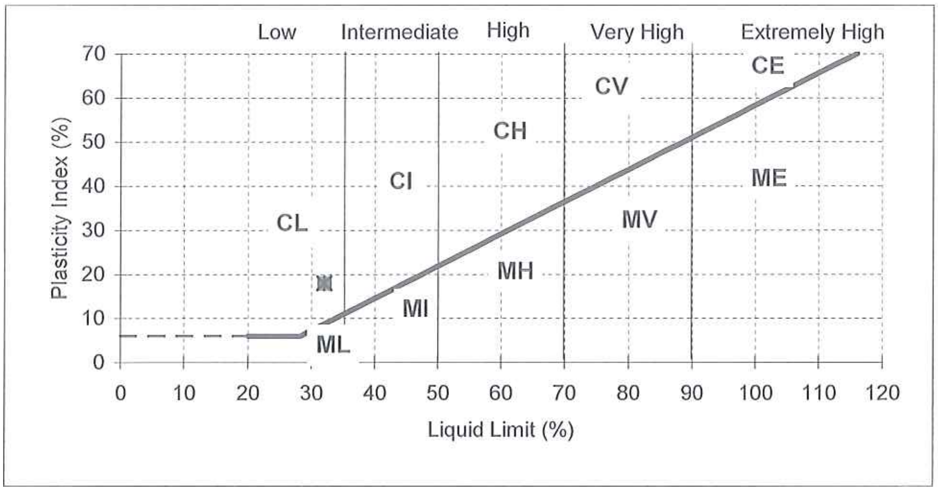
LIQUID AND PLASTIC LIMIT
BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Petre Wood, Langho
JOB NUMBER	MRN 2347/18

SAMPLE LABEL	WS103/1-5-2.0m	DATE SAMPLED	N/A
SAMPLE No.	54547	DATE RECEIVED	17-Dec-12
DATE TESTED	18-Dec-12	SAMPLED BY	Client

MATERIAL	Brown Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
16	32	14	18	98



REMARKS
Sample was tested in natural condition

SIGNED

NAME A Richardson DATE 21-Dec-12
Page 3 of 5 (Deputy Laboratory Manager)

MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871

UKAS TESTING 1580

TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3

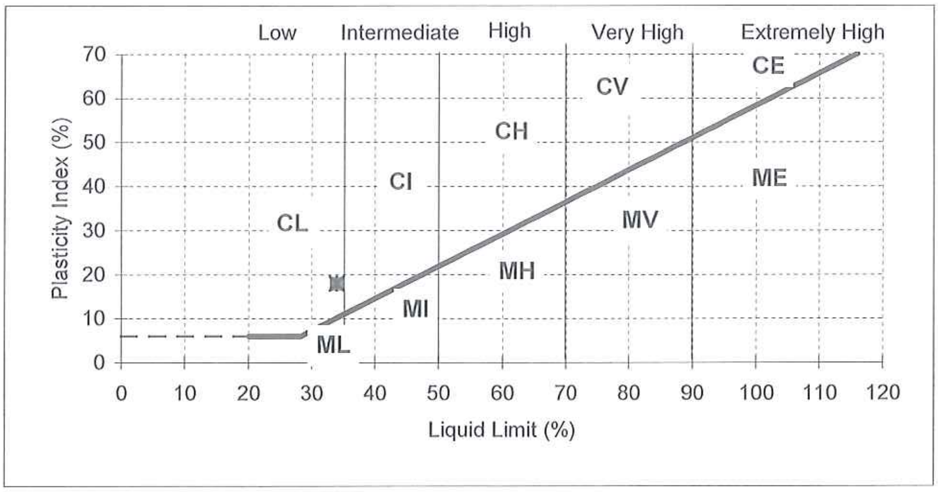
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Petre Wood, Langho
JOB NUMBER	MRN 2347/18

SAMPLE LABEL	WS104/2.0-2.5m	DATE SAMPLED	N/A
SAMPLE No.	54548	DATE RECEIVED	17-Dec-12
DATE TESTED	18-Dec-12	SAMPLED BY	Client

MATERIAL	Brown silty Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
17	34	16	18	94



REMARKS
Sample was tested in natural condition

SIGNED

NAME A Richardson DATE 21-Dec-12

(Deputy Laboratory Manager)

MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871

UKAS TESTING 1580

TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3

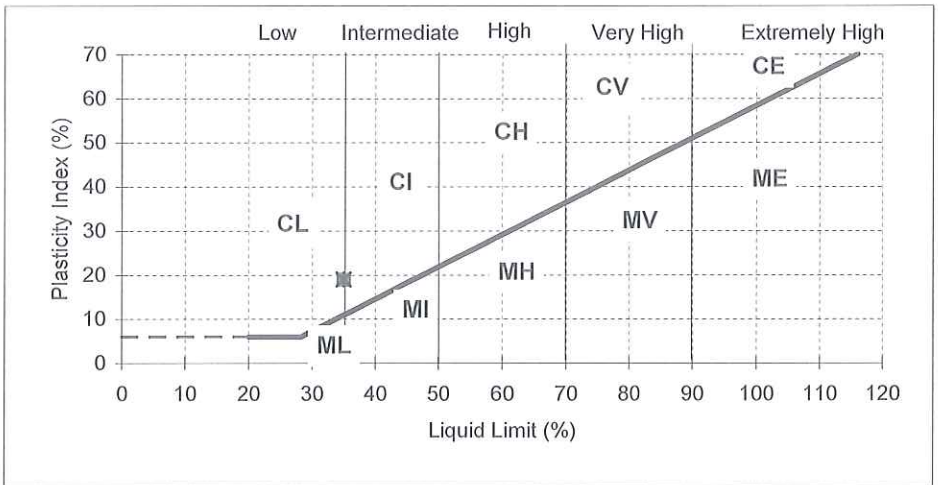
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Petre Wood, Langho
JOB NUMBER	MRN 2347/18

SAMPLE LABEL	WS108/1.5-1.7m	DATE SAMPLED	N/A
SAMPLE No.	54549	DATE RECEIVED	17-Dec-12
DATE TESTED	18-Dec-12	SAMPLED BY	Client

MATERIAL	Brown Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
17	35	16	19	99



REMARKS
Sample was tested in natural condition

SIGNED

NAME A Richardson DATE 21-Dec-12
(Deputy Laboratory Manager)

APPENDIX E

GAS MONITORING RESULTS

LK CONSULT LTD

GAS MONITORING RECORD

SITE	Petre Wood, Langho
REF	LKC 12 1001
DATE	21-Dec-2012
STAFF	RP
VISIT	1 of 6

EQUIPMENT*[1]		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000	GA07270	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally
Flow pod	533	Serviced & calibrated

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling
Weather Conditions	Lightly spitting, cold, slight breeze
Ground Conditions	Boggy

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	GSV*4 CH4 (l/hr)	GSV*4 CO2 (l/hr)	Comments
WS101	21/12/2012 08:49	0.0	1.0	17.2	0.0	0.0	0.0	0.0	81.8	1004.0	10.3	3.5	0.2	2.9	3.5E-03	3.5E-02	
WS103													0.0	4.1			Borehole Waterlogged
WS105	21/12/2012 09:04	0.0	3.1	19.0	0.0	0.0	5.0	0.0	77.9	1004.0	1.3	2.6	0.4	2.3	2.6E-03	8.1E-02	
WS108													0.0	3.8			Borehole Waterlogged
WS110	21/12/2012 09:14									1004.0	0.0	0.1	0.2	4.0			Borehole Waterlogged

ABBREVIATIONS

*[1]	Refer to Note 1
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume
ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

1. Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records. and service certificates.
2. CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
3. Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12 ltr/hr)
4. After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
5. Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to procedural documents

LK CONSULT LTD

GAS MONITORING RECORD

SITE	Petre Wood, Langho
REF	LKC 12 1001
DATE	7-Jan-2013
STAFF	RP
VISIT	2 of 6

EQUIPMENT*[1]		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000	GA07270	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally
Flow pod	533	Serviced & calibrated

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling
Weather Conditions	Dry, cold, slight breeze
Ground Conditions	Boggy

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	GSV*4 CH4 (l/hr)	GSV*4 CO2 (l/hr)	Comments
WS101	07/01/2013 08:45	0.0	0.8	15.1	0.0	0.0	0.0	0.0	84.1	1020.0	19.1	0.1	0.4	2.9	1.0E-04	8.0E-04	
WS103													0.2	3.3			Borehole Waterlogged
WS105	07/01/2013 09:09	0.0	3.7	17.1	0.0	0.0	0.0	0.0	79.2	1020.0	6.6	0.1	0.4	2.3	1.0E-04	3.7E-03	
WS108													0.2	3.8			Borehole Waterlogged
WS110	07/01/2013 09:53	0.0	2.0	17.5	0.0	0.0	0.0	0.0	80.5	1020.0	13.1	0.1	1.7	4.0	1.0E-04	2.0E-03	

ABBREVIATIONS

*[1]	Refer to Note 1
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume
ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

1. Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records. and service certificates.
2. CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
3. Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12 ltr/hr)
4. After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
5. Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to procedural documents

LK CONSULT LTD

GAS MONITORING RECORD

SITE	Petre Wood, Langho
REF	LKC 12 1001
DATE	22-Jan-2013
STAFF	RP
VISIT	3 of 6

EQUIPMENT*[1]		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000	GA07270	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally
Flow pod	533	Serviced & calibrated

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Rising
Weather Conditions	Dry, cold, breezey, overcast
Ground Conditions	Snowey and Boggy

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	GSV*4 CH4 (l/hr)	GSV*4 CO2 (l/hr)	Comments
WS101																	
WS103																	
WS105																	
WS108	22/01/2013 08:48	0.0	1.4	16.8	0.0	0.0	0.0	0.0	81.8	1002.0	17.0	0.1	0.9	3.8	1.0E-04	1.4E-03	
WS110	22/01/2013 08:40	0.0	2.4	17.5	0.0	0.0	0.0	0.0	80.1	1002.0	5.0	0.5	1.4	4.0	5.0E-04	1.2E-02	

ABBREVIATIONS

*[1]	Refer to Note 1	**ppm**	Parts per million
ND	Not detected	**mb**	Millibars
NR	Not recorded	**ltr/hr**	Litres per hour
UR	Unable to record	**mbgl**	Metres below ground level
OS	Off recordable scale	**LEL**	Lower explosive limit in air
N/A	Not applicable	**OEL**	Occupational exposure limit
% v/v	Percentage volume by total volume		

NOTES

1. Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records. and service certificates.
2. CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
3. Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12 ltr/hr)
4. After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
5. Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to procedural documents

LK CONSULT LTD

GAS MONITORING RECORD

SITE	Petre Wood, Langho
REF	LKC 12 1001
DATE	7-Feb-2013
STAFF	RP
VISIT	4 of 6

EQUIPMENT*[1]		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000	GA07270	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally
Flow pod	533	Serviced & calibrated

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Rising
Weather Conditions	Drizzle, cold, windy
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	GSV*4 CH4 (l/hr)	GSV*4 CO2 (l/hr)	Comments
WS101	07/02/2013 17:31	0.0	0.5	20.7	0.0	0.0	0.0	0.0	78.8	1014.0	6.5	0.1	0.5	2.9	1.0E-04	5.0E-04	
WS103	07/02/2013 17:22	0.0	1.8	18.6	0.0	0.0	0.0	0.0	79.6	1014.0	0.7	0.1	0.4	3.2	1.0E-04	1.8E-03	
WS105	07/02/2013 17:15	0.0	3.1	19.0	0.0	0.0	0.0	0.0	77.9	1014.0	1.0	0.1	0.6	2.2	1.0E-04	3.1E-03	
WS108	07/02/2013 17:02	0.0	0.6	19.3	0.0	0.0	0.0	0.0	80.1	1014.0	0.6	0.1	0.9	3.8	1.0E-04	6.0E-04	
WS110	07/02/2013 16:48	0.0	2.1	17.5	0.0	0.0	0.0	0.0	80.4	1014.0	0.1	0.1	1.4	4.0	1.0E-04	2.1E-03	

ABBREVIATIONS

*[1]	Refer to Note 1	**ppm**	Parts per million
ND	Not detected	**mb**	Millibars
NR	Not recorded	**ltr/hr**	Litres per hour
UR	Unable to record	**mbgl**	Metres below ground level
OS	Off recordable scale	**LEL**	Lower explosive limit in air
N/A	Not applicable	**OEL**	Occupational exposure limit
% v/v	Percentage volume by total volume		

NOTES

1. Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records. and service certificates.
2. CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
3. Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12 ltr/hr)
4. After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
5. Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to procedural documents

LK CONSULT LTD

GAS MONITORING RECORD

SITE	Petre Wood, Langho
REF	LKC 12 1001
DATE	25-Feb-2013
STAFF	RP
VISIT	5 of 6

EQUIPMENT*[1]		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000	GA07270	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally
Flow pod	533	Serviced & calibrated

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Rising
Weather Conditions	Dry, overcast, slight breeze
Ground Conditions	Damp

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	GSV*4 CH4 (l/hr)	GSV*4 CO2 (l/hr)	Comments
WS101	25/02/2013 16:17	0.0	0.4	20.8	0.0	0.0	1.0	0.0	78.8	1026.0	7.2	0.1	0.5	3.0	1.0E-04	4.0E-04	
WS103	25/02/2013 16:10	0.0	1.8	18.6	0.0	0.0	0.0	0.0	79.6	1026.0	0.3	0.1	0.4	3.2	1.0E-04	1.8E-03	
WS105	25/02/2013 16:04	0.0	2.1	20.3	0.0	0.0	2.0	0.0	77.6	1026.0	1.0	0.1	0.8	2.2	1.0E-04	2.1E-03	
WS108	25/02/2013 15:54	0.0	0.4	19.8	0.0	0.0	2.0	0.0	79.8	1026.0	9.6	0.1	1.0	3.8	1.0E-04	4.0E-04	
WS110	25/02/2013 15:48	0.0	1.9	17.2	0.0	0.0	3.0	0.0	80.9	1026.0	10.3	0.1	1.5	4.1	1.0E-04	1.9E-03	

ABBREVIATIONS

*[1]	Refer to Note 1	**ppm**	Parts per million
ND	Not detected	**mb**	Millibars
NR	Not recorded	**ltr/hr**	Litres per hour
UR	Unable to record	**mbgl**	Metres below ground level
OS	Off recordable scale	**LEL**	Lower explosive limit in air
N/A	Not applicable	**OEL**	Occupational exposure limit
% v/v	Percentage volume by total volume		

NOTES

1. Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records. and service certificates.
2. CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
3. Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12 ltr/hr)
4. After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
5. Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to procedural documents

7.2 Survey Results

Site	Petre Farm, Longsight Road, Langho, Blackburn

Date	16 January 2006

Atmospheric Conditions		
Air Pressure	Start	998 mb
	End	998 mb
	Trend (24 hr)	Falling
Wind	Calm	
Temperature	8.4 C	
Precipitation	Occasional light rain showers	
Ground	Wet	
Notes	Monitoring by GA 94(A) Analyser Serial no. G2390	

Monitoring Results

Point	Depth	Dia	CH_4	CO_2	O_2	Temp	Press	Flow	Dip	Notes
BH01	-	22	1.2	2.8	8.1	8.5	1.6	0.0	4.12	
BH05	-	22	7.2	3.1	6.9	8.7	2.9	0.0	1.28	
BH07	-	22	0.0	0.0	20.8	8.2	0.0	0.0	0.30	
BH12	-	22	0.5	1.8	12.2	8.1	2.7	0.0	1.11	

Date	21 January 2006

Atmospheric Conditions		
Air Pressure	Start	1023 mb
	End	1023 mb
	Trend (24 hr)	Rising
Wind	Calm	
Temperature	12.5 C	
Precipitation	None	
Ground	Damp	
Notes	Monitoring by GA 94(A) Analyser Serial no. G2390	

Monitoring Results

Point	Depth	Dia	CH_4	CO_2	O_2	Temp	Press	Flow	Dip	Notes
BH01	-	22	0.1	0.2	19.2	10.5	-0.9	0.0	4.12	
BH05	-	22	10.1	4.7	5.3	10.8	3.9	0.0	1.23	
BH07	-	22	0.0	0.0	20.8	10.3	0.0	0.0	0.27	
BH12	-	22	0.6	1.8	14.4	10.0	4.2	0.0	0.98	

Key
Depth : Borehole depth (m); Temp : Borehole temperature (C); Dia : Borehole diameter (mm); Press : Borehole pressure (mb); CH_4 : Flammable gas (% v/v); Flow : Gas flow rate (ms^{-1}); CO_2 : Carbon dioxide (% v/v); Dip : Dipmeter reading (m); O_2 : Oxygen (% v/v)

7.2 Survey Results (continued)

Site	Petre Farm, Longsight Road, Langho, Blackburn

Date	29 January 2006

Atmospheric Conditions		
Air Pressure	Start	1031 mb
	End	1031 mb
	Trend (24 hr)	Rising
Wind	Calm	
Temperature	5.6 C	
Precipitation	None	
Ground	Damp and frozen in places	
Notes	Monitoring by GA 94(A) Analyser Serial no. G2390	

Monitoring Results

Point	Depth	Dia	CH_4	CO_2	O_2	Temp	Press	Flow	Dip	Notes
BH01	-	22	0.0	0.0	20.2	5.2	-1.1	0.0	4.12	
BH05	-	22	10.8	4.7	5.5	5.3	0.0	0.0	1.32	
BH07	-	22	0.0	0.0	20.7	4.8	0.1	0.0	0.25	
BH12	-	22	0.3	1.0	19.8	4.7	-0.2	0.0	1.16	

Date	12 February 2006

Atmospheric Conditions		
Air Pressure	Start	1011 mb
	End	1011 mb
	Trend (24 hr)	Falling
Wind	Calm	
Temperature	11.2 C	
Precipitation	Persistent heavy rain	
Ground	Wet	
Notes	Monitoring by GA 94(A) Analyser Serial no. G2390	

Monitoring Results

Point	Depth	Dia	CH_4	CO_2	O_2	Temp	Press	Flow	Dip	Notes
BH01	-	22	0.1	3.3	16.1	9.1	1.2	0.0	4.12	
BH05	-	22	11.8	4.0	5.1	8.2	2.8	0.0	1.47	
BH07	-	22	0.0	0.0	20.6	8.5	0.2	0.0	0.14	
BH12	-	22	0.0	4.7	13.5	9.7	0.1	0.0	1.22	

Key
Depth : Borehole depth (m); Temp : Borehole temperature (C); Dia : Borehole diameter (mm); Press : Borehole pressure (mb); CH_4 : Flammable gas (% v/v); Flow : Gas flow rate (ms^{-1}); CO_2 : Carbon dioxide (% v/v); Dip : Dipmeter reading (m); O_2 : Oxygen (% v/v)

7.2 Survey Results (continued)

Site	Petre Farm, Longsight Road, Langho, Blackburn

Date	18 February 2006

Atmospheric Conditions		
Air Pressure	Start	984 mb
	End	984 mb
	Trend (24 hr)	Falling
Wind	Calm	
Temperature	8.5 C	
Precipitation	None	
Ground	Dry	
Notes	Monitoring by GA 94(A) Analyser Serial no. G2390	

Monitoring Results

Point	Depth	Dia	CH_4	CO_2	O_2	Temp	Press	Flow	Dip	Notes
BH01	-	22	0.0	2.1	14.6	8.8	-0.1	0.0	4.12	
BH05	-	22	8.0	2.9	8.0	7.8	4.7	0.0	1.38	
BH07	-	22	0.0	0.0	20.7	7.8	-0.1	0.0	0.25	
BH12	-	22	0.4	3.6	11.2	8.2	5.6	0.0	0.95	

Date	4 March 2006

Atmospheric Conditions		
Air Pressure	Start	994 mb
	End	994 mb
	Trend (24 hr)	Falling
Wind	Calm	
Temperature	5.3 C	
Precipitation	None	
Ground	Snow covered	
Notes	Monitoring by GA 94(A) Analyser Serial no. G2390	

Monitoring Results

Point	Depth	Dia	CH_4	CO_2	O_2	Temp	Press	Flow	Dip	Notes
BH01	-	22	1.5	4.0	12.4	2.9	0.5	0.0	4.12	
BH05	-	22	7.0	2.3	9.5	3.5	0.0	0.0	1.36	
BH07	-	22	0.0	0.0	20.7	3.0	0.2	0.0	0.25	
BH12	-	22	0.7	1.2	18.7	6.7	-0.1	0.0	1.15	

Key
Depth : Borehole depth (m); Temp : Borehole temperature (C); Dia : Borehole diameter (mm); Press : Borehole pressure (mb); CH_4 : Flammable gas (% v/v); Flow : Gas flow rate (ms^{-1}); CO_2 : Carbon dioxide (% v/v); Dip : Dipmeter reading (m); O_2 : Oxygen (% v/v)

APPENDIX F

GENERIC SOIL ASSESSMENT CRITERIA

Author	Atkins	
Revision	3	
Date	31/03/2011	
Title	**SSVs derived using CLEA for 1% SOM, sand soil type, Residential with the consumption of homegrown produce land use**	

Compound	SSV mg/kg	Notes
1,1,1-Trichloroethane	2.23	
1,1,1,2-Tetrachloroethane	0.353	
1,1,2,2-Tetrachloroethane	0.695	
1,1,2-Trichloroethane	0.258	
1,1-Dichloroethane	0.827	
1,1-Dichloroethene	0.0857	
1,2-Dichloroethane	0.00190	
1,2,4-Trimethylbenzene	0.906	
1,2-Dichloropropane	0.00784	
2,4-Dichloro-o-cresol	31.1	
2,4-Dimethylphenol	17.2	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered.
2,4-Dinitrotoluene	1.41	
2,6-bis(1,1-dimethyl)-4-(1-methylpropyl)-phenol	21.7	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 18.7 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2,6-Dinitrotoluene	0.751	
2-Chloronaphthalene	1.42	
2-Methylphenol	78.1	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. Users must consider total exposure from all methylphenol isomers and not consider them in isolation. In line with the approach published by EIC when assessing total cresols, the lowest SSV of each methylphenol isomer may be chosen to compare to the total methylphenol concentration.
3-Methylphenol	77.4	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. Users must consider total exposure from all methylphenol isomers and not consider them in isolation. In line with the approach published by EIC when assessing total cresols, the lowest SSV of each methylphenol isomer may be chosen to compare to the total methylphenol concentration.
4-Methylphenol	76.8	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. Users must consider total exposure from all methylphenol isomers and not consider them in isolation. In line with the approach published by EIC when assessing total cresols, the lowest SSV of each methylphenol isomer may be chosen to compare to the total methylphenol concentration.
Acenaphthene	588	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 157 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Anthracene	8270	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 3.48 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.

Author Atkins
Revision 3
Date 31/03/2011

Title **SSVs derived using CLEA for 1% SOM, sand soil type, Residential with the consumption of homegrown produce land use**

Compound	SSV mg/kg	Notes
Antimony	113	
Arsenic	32.0	Value presented is the Environment Agency Arsenic SGV published in May 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Barium	43.4	
Benzene	0.0493	Based on information within Environment Agency benzene SGVs published in March 2009.
Benzo(a)anthracene	4.52	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1.71 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Benzo(a)pyrene	0.818	
Benzo(b)fluoranthene	7.72	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1.22 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Benzo(g,h,i)perylene	96.2	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.0187 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Benzo(k)fluoranthene	84.4	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.686 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Beryllium	60.3	
Biphenyl	82.8	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 34.1 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Bis (2-ethylhexyl) phthalate	282	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 8.66 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Bromobenzene	0.319	

Author	Atkins
Revision	3
Date	31/03/2011
Title	**SSVs derived using CLEA for 1% SOM, sand soil type, Residential with the consumption of homegrown produce land use**

Compound	SSV mg/kg	Notes
Bromodichloromethane	0.00598	
Bromoform	1.40	
Butyl benzyl phthalate	1410	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 26.1 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Cadmium	10.0	Value presented is the Environment Agency Cadmium SGV published in July 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Carbon disulphide	0.0739	
Carbon tetrachloride	0.00656	
Chlorobenzene	3.49	
Chloroethane	3.05	
Chloroform / Trichloromethane	0.307	
Chloromethane	0.00301	
Chromium III	12800	
Chromium VI	14.2	
Chrysene	585	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.440 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Cis-1,2-dichloroethene	0.0393	
Copper	3970	
Cyanide	34.0	Based on acute exposure for a 0-6 year old child, using 5th percentile bodyweight from CLR10. Information is not available in SR3 and supporting documents regarding the 5th percentile bodyweight of SR3 bodyweight data. It is not considered likely that new data would significantly affect the SSV.
DDD	26.3	
Dibenz(a,h)anthracene	0.838	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.00393 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Dibromochloromethane	0.0623	
Dichloromethane	0.382	

Author Atkins
Revision 3
Date 31/03/2011

Title **SSVs derived using CLEA for 1% SOM, sand soil type, Residential with the consumption of homegrown produce land use**

Compound	SSV mg/kg	Notes
Diethyl phthalate	108	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 12.8 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Di-n-butyl phthalate	12.9	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 4.62 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the approach published by the EIC, the lower of the oral and inhalation assessment criteria has been selected. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Di-n-octyl phthalate	2250	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 32.6 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Dinoseb	0.0477	
Ethylbenzene	38.2	Based on information within Environment Agency ethylbenzene SGVs published in March 2009.
Fluoranthene	822	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 18.9 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Fluorene	615	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 125 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Formaldehyde	1.89	

Author Atkins
Revision 3
Date 31/03/2011

Title **SSVs derived using CLEA for 1% SOM, sand soil type, Residential with the consumption of homegrown produce land use**

Compound	SSV mg/kg	Notes
Hexachloroethane	0.0735	
Indeno(1,2,3-c,d)pyrene	7.31	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.0614 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Iso-propylbenzene	34.4	
Lead	276	
Mercury (elemental)	0.0607	Based on information in the Environment Agency Mercury SGV report published in March 2009.
Mercury (inorganic)	170	Value presented is the Environment Agency inorganic mercury SGV published in March 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Mercury (methyl)	6.28	Based on information within the Environment Agency Mercury SGV report published in March 2009.
Methyl tert-butyl ether	20.0	
Molybdenum	74.6	
m-Xylene	17.9	The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration. Based on information within Environment Agency xylene SGVs published in March 2009. Users must consider total exposure from all xylene isomers and not consider them in isolation. The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration.
Naphthalene	0.585	
Nickel	130	Value presented is the Environment Agency Nickel SGV published in May 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Nicotine	0.0916	
o-Xylene	18.9	The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration. Based on information within Environment Agency xylene SGVs published in March 2009. Users must consider total exposure from all xylene isomers and not consider them in isolation. The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration.
Phenol	162	Based on information within the Environment Agency Phenol SGV report published in July 2009. Derived by comparing oral exposure to the oral HCV and inhalation and dermal exposure to the inhalation HCV.
Prochloraz	8.49	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.116 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Propylbenzene	85.6	
p-Xylene	17.2	The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration. Based on information within Environment Agency xylene SGVs published in March 2009. Users must consider total exposure from all xylene isomers and not consider them in isolation. The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration.
Pyrene	563	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 2.20 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.

Author Atkins
Revision 3
Date 31/03/2011

Title **SSVs derived using CLEA for 1% SOM, sand soil type, Residential with the consumption of homegrown produce land use**

Compound	SSV mg/kg	Notes
Selenium	350	Value presented is the Environment Agency selenium SGV published in March 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Styrene	9.42	
Sum of PCDDs, PCDFs and dioxin-like PCBs	No SSV. Due to publication of the Dioxins, Furans and Dioxin-like PCB SGVs in September 2009, please see the Frequently Asked Questions for more information.	
Tetrachloroethene	0.455	
Toluene	86.9	Based on information within Environment Agency toluene SGVs published in March 2009.
TPH aliphatic C10-C12	1390	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 49.9 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aliphatic C12-C16	5100	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 21.0 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aliphatic C16-C35	145000	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH aliphatic C5-C6	30.1	
TPH aliphatic C6-C8	69.8	
TPH aliphatic C8-C10	9.79	
TPH aromatic C10-C12	57.3	
TPH aromatic C12-C16	142	
TPH aromatic C16-C21	272	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH aromatic C21-C35	888	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH aromatic C5-C7	0.0493	Benzene is the only consituent of this fraction (TPHCWG 1997). Based on information within the Environment Agency benzene SGVs published in March 2009.
TPH aromatic C7-C8	86.9	Toluene is the only consituent of this fraction (TPHCWG 1997). Based on information within the Environment Agency toluene SGVs published in March 2009.
TPH aromatic C8-C10	14.8	
Trans-1,2-dichloroethene	0.0671	
Tributyl tin oxide	0.248	
Trichloroethene	0.0382	
Trichloromethylbenzene	0.000157	
Vanadium	113	
Vinyl chloride	0.000202	
Zinc	16900	

Note:
All values provided are rounded to 3 significant figures.
It is noted for some compounds that the SSV is sufficiently high that free product is likely to be encountered. Please see the Frequently Asked Questions for more advice.
In some instances the risk based value may be lower than the laboratory detection limit. Please see the Frequently Asked Questions for more advice.

APPENDIX G

BaP JUSTIFICATION

Date 2012
Justification on Using ATRISK Soil Screening Value (Revision 1) for B(a)P

ATRISK have produced generic criteria for a number of contaminants. In Revision 1 for a 'residential with plant uptake' land use (1% SOM and sandy soil) the B(a)P SSV was 2.1mg/kg and changed to 0.82mg/kg in Revision 2 (see A1). The website FAQ stated that client feedback suggested altering oral index dose (ID) to that outlined in TOX2[1] for additional conservatism. According to the FAQ ATRISK still considered the previous toxicological approach "would not cause any unacceptable risks to the receptor based on their interpretation of /SR2[2]." LK Consult (LKC) has therefore put forward a case in using the higher values for generic assessments.

Oral toxicity information was taken by ATRISK from an assessment by O'Brian *et.al* (2006)[3] which used data on a long term study on Wistar rats by RIVM[4]. Rats were administered through gavage using pure B(a)P. The primary incidence of dose-related neoplasms (cancers) was contributed to heptocellular tumours (liver) and the forestomach. The derived Benchmark Dose ($BMDL_{10}$) of 2.0 mg/kg bw/day from the study was converted to an ID by dividing by 10,000 to generate an oral ID of **0.2 µg/kg bw/day**. ATRISK considered this value to be suitable, since the authors were renowned experts in their field and followed the protocol in /SR2 for using expert toxicological judgement. Using this ID will give an **SSV of 2.1mg/kg** for a 'residential with plant uptake' end use at 1% SOM and sandy soil (see A2 for chemical input parameters).

The current ATRISK SSV (Revision 2) is based on the TOX 2 report, which LKC considers outdated. The oral ID was based on WHO Drinking Water Standards of 700ng/L converted to an oral ID of **0.02 µg/kg bw/day**. This was to ensure "that the lifetime cancer risk of consuming water of this quality will be of no potential significance." LKC considers the TOX 2 derivation of the ID is outdated since the current guidelines advise using $BMDL_{10}$ from animal or epidemiological studies and dividing by an uncertainty factor (usually 10,000 for animal studies). Using this ID will give an **SSV of 0.82mg/kg** for a 'residential with plant uptake' end use at 1% SOM and sandy soil.

With regards to other studies European food agencies ESFA (2008)[5] and JECFA (2005)[6] have used Culp *et.al* (1998)[7] and a study based on Culp *et.al* (1998) data by Schneider *et.al* (2002)[8]. The Culp study used coal tar mixtures (>80,000mg/kg of total PAHs) fed in food to mice over a two year carcinogenicity study and measured nine cancer types. Dose related responses were found to be significant in all nine neoplasms and the lowest $BMDL_{10}$ was generated on the total incidences of neoplasms (from the Schneider *et.al* (2002) paper) of 0.07mg/kg bw/day, which the HPA[9] have recently advised for B(a)P (July 2010). The HPA chose this $BMDL_{10}$ due to the unknown carcinogenic nature of other PAHs not normally analysed for in the standard USEPA 16 suite and therefore using B(a)P as a surrogate and using total data from all incidences of neoplasms would be protective. By applying the uncertainty factor of 10,000 an oral ID would be calculated as

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1 EA (2002). "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzo(a)pyrene." R&D Publication TOX 2.
2 EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
3 O'Brian, J; Constable, A; Renwick, AG *et.al* (2006). "Approaches to the Risk Assessment of Genotoxic Carcinogens in Food: A Critical Appraisal." *Food and Chemical Toxicology* 44(2006), pp 1613-1635.
4 E.D. Kroese, J.J.A. Muller, G.R. Mohn, P.M. Dortant, P.W. Wester (2001). "Tumorigenic Effects in Wistar Rats Orally Administered Benzo[a]pyrene for Two Years (Gavage Studies). Implications for Human Cancer Risks Associated With Oral Exposure to Polycyclic Aromatic Hydrocarbons." RIVM Report nr. 658603 010.
5 EFSA (2008). "Scientific Opinion of the Panel on Contaminants in the Food Chain on a request from the European Commission on Polycyclic Aromatic Hydrocarbons in Food." *The EFSA Journal (2008)* 724, 1-114.
6 JECFA (2005). "Summary and Conclusions of the sixty-fourth meeting of the joint FAO/WHO Expert Committee on Food Additives."
7 Culp, S; Gaylor, D; Sheldon, W; Goldstein, L and Beland, F (1998). " A Comparison of Tumours Induced by Coal Tar and Benzo-a-pyrene in a 2-Year Biossay." Carcinogenesis. **Vol 19**, no. 1, pp. 117-124.
8 Schneider, K; Roller, M; Kalberlah, F and Schumacher-Wolz, U (2002). "Cancer Risk Assessment for Oral Exposure to PAH Mixtures." *Journal of Applied Toxicology*. **22**, 73-83.
9 HPA (2010). "HPA Contaminated Land Information Sheet: Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs)." Version 3.

0.007µg/kg bw/day. Using this ID will give an **SSV of 0.36mg/kg** for a 'residential with plant uptake' end use at 1% SOM and sandy soil.

Based on the above summary of relevant papers reviewed by both the UK and European bodies LKC will add the following:

1. The Culp *et.al* (1998) paper also examined B(a)P (98% pure) fed mice in a separate study group. After examining incidences of neoplasm in mice the forestomach generated the highest incidences of tumour and even though humans do not possess a forestomach thus could be used to demonstrate gastrointestinal cancer risk in humans. Doses of 0ppm, 5ppm, 25ppm and 100pm of B(a)P was fed to the mice in 100g meals. Assuming the weight of the mice is 30g the adjusted intake is 0mg/kg bw/day, 0.69mg/kg bw/day, 3.45mg/kg bw/day and 13.9mg/kg bw/day respectively. LKC used these values in the USEPA BMDS (V2.1.1) model[10], which is presented in A3.

   A $BMDL_{10}$ of 0.59mg/kg b.w per day was generated based on the best fit model (Log Logistic model p 0.41). LKC considers the standard uncertainty factor (UF) of 10,000 is considered too conservative for the Culp *et.al* (1998) paper. Work by Fitzgerald *et.al* (2004)[11] noted that the data from Culp *et.al* (1998) was very good and that an UF of 4,500 could be used. Therefore, using an UF of 4,500 instead of the 10,000 to derive an ID would generate an oral ID of **0.131µg/kg bw/day.** Using this ID will give an **SSV of 1.98mg/kg** for a 'residential with plant uptake' end use at 1% SOM and sandy soil, which is close to the generated ATRISK SSV based on the O'Brian *et.al* (2006) paper for a different study.

   Incidentally the Fitzgerald *et.al* (2004) paper was undertaken for the Australian authorities and proposed a ingestion B(a)P guideline value of 5mg/kg based on a $BMDL_5$ from data taken from the Culp *et.al* (1998) study.

2. The Culp *et.al* (1998) study was based on coal tar mixtures. The HPA assumed that the carcinogenic risks may not be only from B(a)P alone, but from other PAHs not analysed in the normal USEPA 16 suite (there are hundreds of PAHs) and therefore there may be a carcinogenic additive effect. Although the HPA did say B(a)P would be a good surrogate marker in most soils as long as the more protective $BMDL_{10}$ was used for coal tars.

   The coal tar mixture did generate all nine neoplasms that were dose related, whereas the B(a)P feed only generated four dose related incidences of neoplasms. The HPA suggested the derived $BMDL_{10}$ was protective since it took into account all possible PAH related carcinogens. LKC consider this very conservative, since there are other compounds in coal tars other than PAHs that can cause cancer such as benzene and derivatives (to name one group of carcinogens). This may, in part, be the cause of the other incidences of neoplasms.

   Therefore, if coal tar is present in soil samples then LKC suggest the HPA $BMDL_{10}$ value of 0.07mg/kg bw/day is used. This should be modified by an UF of 4,500 (instead of 10,000) to give an oral ID of **0.016 µg/kg bw/day.** Using this ID will give an **SSV of 0.71mg/kg** for a 'residential with plant uptake' end use at 1% SOM and sandy soil. LKC considers this appropriate for made ground derived from coal tar, but not necessarily for ash and clinker samples, which is not necessarily in a form or have the same chemical composition as coal tar.

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[10] http://www.epa.gov/ncea/bmds/new.html. (2010)

[11] Fitzgerald, JD. Robinson, NI. Pester, BA (2004). "Application of Benzo(a)pyrene and Coal Tar Tumour Dose-Response Data to a Modified Benchmark Dose Method for Guideline Development." *Environmental Health Perspectives*. **Volume 112**, Number 14, pp 1341-1346.

3. Background values of B(a)P vary depending upon the degree of air deposition and composition of the soil analysed. A study on PAHs by the EA[12] in soils and herbage noted a median soil concentration of B(a)P in UK urban areas of 0.714mg/kg (maximum value 31.2mg/kg). Other papers suggest some rural areas are also effected by PAHs with maximum B(a)P values recorded as 1.2mg/kg[13] and 3.7mgkg[14]. The latter was in a Welsh deciduous woodland with high humus content in the industrialised coal mining area of the Upper Taff Valley.

   Sources in both urban and rural settings may not necessarily be from made ground. In particular the rural areas are likely from air deposition and from natural coal deposits, which can be high in PAHs[15].

   Considering the above It is unlikely soils in the UK, even in rural areas would be consistently below any new derived criteria and considering the likely natural background concentration in soils from areas of comprising coal deposits, some practical choices will need to be considered by both government bodies and regulators when deriving a SGV. There is precedence for modifying guideline values to take into account local background/typical concentration. For example lead in Derbyshire and arsenic in Cornwall.

Based on the above LKC considers the generated ATRISK SSV for 1% SOM and sandy soil (Revison 1) to still be suitable and reasonable as an initial screening value for soils. Using Culp *et.al* (1998) data (which was used by the HPA) only for B(a)P and considering a lower UF (4,500) due to good data quality, the generated value is considered more appropriate for ash and clinker material. This generates a similar oral ID to the ATRISK value and calculates a SSV of 1.98mg/kg compared to the ATRISK SSV of 2.1mg/kg, which is comparable.

For coal tar wastes LKC recommend using the HPA $BMDL_{10}$ for B(a)P to take into account the carcinogenic additive effect of other PAHs (as well as other non-PAH compounds). Taking account the lower UF a SSV of 0.71mg/kg would be generated.

<u>Enclosed:</u>

A1 – ATRISK values for 1% SOM and sandy soil (Revision 1 and Revision 2)
A2 – Input Parameters for B(a)P
A3 – Dose-Response Curve to Generate a $BMDL_{10}$ from Culp *et al* (1998) data for B(a)P

[12] EA (2007). "UK Soil and Herbage Pollutant Survey: Environmental Concentrations of Polycyclic Aromatic Hydrocarbons in UK Soil and Herbage." UKSHS Report No 9.
[13] Cousins IT, Krebich H, Hudson LE, Lead WA and Jones KC (1997). "PAHs in soils Contemporary UK Data and Evidence for Potential Contamination Problems Caused by Exposure of Samples to Laboratory Air." Science of the Total Environment, **203**, 141-156.
[14] Jones KC, Stratford JA, Waterhouse KS and Vogt NB (1989). " Organic Contaminants in Welsh Soils: Polycyclic Aromatic Hydrocarbons." Environ. Sci. Technol, **Vol 23**, No5, 540-550.
[15] Achten, C; Hofmann, T (2009). "Native Polycyclic Aromatic Hydrocarbons (PAHs) in Coals – A Hardly Recognised Source of Environmental Contamination." *Science in the Total Environment* 407 (2009) 2461-2473.

A1 – ATRISK values for 1% SOM and sandy soil (Revision 1 and Revision 2)

Author Atkins
Revision 1
Date 18/09/2009

Title **SSVs derived using CLEA v1.04 for 1% SOM, sand soil, Residential with homegrown produce land use**

PLEASE NOTE

Compound	SSV mg/kg	Notes
Arsenic	3.20E+01	Value presented is the Environment Agency Arsenic SGV published in May 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Cadmium	10	Value presented is the Environment Agency Cadmium SGV published in July 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Chromium	1.44E+01	Based on Cr VI
Nickel	1.30E+02	Value presented is the Environment Agency Nickel SGV published in May 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Lead Threshold	1.66E+02	Lead has been modelled as a threshold substance. Should background exposure not be taken into account, the SSV would be 320 mg/kg
Mercury (Elemental)	6.07E-02	Based on inhalation exposure only as per information within the Environment Agency Mercury SGV report published in March 2009
Mercury (inorganic)	1.70E+02	Value presented is the Environment Agency inorganic mercury SGV published in March 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Mercury (methyl)	6.28E+00	Based on information within the Environment Agency Mercury SGV report published in March 2009
Beryllium	6.03E+01	
Selenium	3.50E+02	Value presented is the Environment Agency selenium SGV published in March 2009. As plant concentration factors are used in deriving the SGV, assessment criteria do not change with soil type and SOM.
Vanadium	1.13E+02	
Copper	3.97E+03	
Zinc	1.69E+04	
Antimony	9.76E+01	
Acenaphthene	1.57E+02	The saturated soil concentration has been exceeded in the calculation, but it will not affect the significant exposure pathways. The SSV presented is the lowest of the aqueous or vapour saturation limits. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 588 mg/kg if free product is not observed
Anthracene	3.48E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 8270 mg/kg if free product is not observed.
Benzo(a)anthracene	1.71E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 7.54 mg/kg if free product is not observed.
Benzo(a)pyrene	9.11E-01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 2.10 mg/kg if free product is not observed.
Benzo(b)fluoranthene	1.22E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 1.99 mg/kg if free product is not observed.
Benzo(ghi)perylene	1.87E-02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 234 mg/kg if free product is not observed.
Benzo(k)fluoranthene	6.86E-01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 215 mg/kg if free product is not observed.
Chrysene	4.40E-01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 1490 mg/kg if free product is not observed.
Dibenz(ah)anthracene	3.93E-03	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 1.96 mg/kg if free product is not observed.
Fluoranthene	1.89E+01	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 822 mg/kg if free product is not observed.
Fluorene	1.25E+02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 615 mg/kg if free product is not observed.
Indeno(123-cd)pyrene	6.14E-02	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 19.1 mg/kg if free product is not observed.
Pyrene	2.20E+00	The value presented is the lower of the aqueous or vapour saturation limits. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the combined assessment criterion. Users may wish to consider using the combined assessment criterion given by CLEA of 563 mg/kg if free product is not observed.
Phenol	1.62E+02	Based on information within the Environment Agency Phenol SGV report published in July 2009. Derived by comparing oral exposure to the oral HCV and inhalation and dermal exposure to the inhalation HCV.
2,3,7,8-Tetrachlorodibenzo-p-dioxin	Due to publication of the Dioxins, Furans and Dioxin-like PCB SGVs in September 2009 this SSV will be updated in due course.	
Naphthalene	5.85E-01	
Benzene	4.93E-02	Based on information within Environment Agency benzene SGVs published in March 2009
Toluene	8.69E+01	Based on information within Environment Agency toluene SGVs published in March 2009
Ethylbenzene	3.82E+01	Based on information within Environment Agency ethylbenzene SGVs published in March 2009
o-Xylene	1.89E+01	Based on information within Environment Agency xylene SGVs published in March 2009. Users must consider total exposure from all xylene isomers and not consider them in isolation.
m-Xylene	1.79E+01	Based on information within Environment Agency xylene SGVs published in March 2009. Users must consider total exposure from all xylene isomers and not consider them in isolation.
p-Xylene	1.72E+01	Based on information within Environment Agency xylene SGVs published in March 2009. Users must consider total exposure from all xylene isomers and not consider them in isolation.
Trichloroethene	3.82E-02	
Vinyl chloride	2.02E-04	
1,1,1,2 Tetrachloroethane	3.53E-01	
1,1,2,2 Tetrachloroethane	6.95E-01	
Tetrachloroethene	4.55E-01	
1,1,1 Trichloroethane	2.23E+00	
1,2 Dichloroethane	1.90E-03	
Carbon tetrachloride	6.56E-03	
Chlorobenzene	1.06E+00	
Carbon disulphide	7.39E-02	
TPH aromatic C5-C7	4.93E-02	Benzene is the only consituent of this fraction (TPHCWG 1997). Based on information within the Environment Agency benzene SGVs published in March 2009

Author Atkins
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Date 18/09/2009

Title **SSVs derived using CLEA v1.04 for 1% SOM, sand soil, Residential with homegrown produce land use**

Compound	SSV mg/kg	Notes
TPH aromatic C7-C8	8.69E+01	Toluene is the only consituent of this fraction (TPHCWG 1997). Based on information within the Environment Agency toluene SGVs published in March 2009
TPH aromatic C8-C10	1.59E+00	
TPH aromatic C10-C12	9.58E+00	
TPH aromatic C12-C16	4.77E+01	
TPH aliphatic C5-C6	3.01E+00	
TPH aliphatic C6-C8	7.00E+00	
TPH aliphatic C8-C10	9.77E-01	
TPH aliphatic C10-C12	5.74E+00	
TPH aliphatic C12-C16	2.10E+01	The saturated soil concentration has been exceeded in the calculation. The SSV presented is the lowest of the aqueous or vapour saturation limits. Users may wish to consider using the combined assessment criterion calculated using the approach outlined within SR4, of 2400 mg/kg if free product is not observed.
TPH aromatic C16-C21	2.72E+02	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997)
TPH aromatic C21-C35	8.88E+02	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997)
TPH aliphatic C16-C35	8.82E+04	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997)
Cyanide	3.40E+01	Based on acute exposure for a 0-6 year old child, using 5th percentile bodyweight from CLR10. Information is not available in SR3 and supporting documents regarding the 5th percentile bodyweight of SR3 bodyweight data. It is not considered likely that new data would significantly affect the SSV.

Author Atkins
Revision 3
Date 31/03/2011

SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

Compound	SSV mg/kg	Notes
1,1,1-Trichloroethane	203000	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1380 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
1,1,1,2-Tetrachloroethane	660	
1,1,2,2-Tetrachloroethane	880	
1,1,2-Trichloroethane	506	
1,1-Dichloroethane	57400	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1620 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
1,1-Dichloroethene	1280	
1,2-Dichloroethane	8.05	
1,2,4-Trimethylbenzene	149	
1,2-Dichloropropane	51.7	
2,4-Dichloro-o-cresol	7550	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 861 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2,4-Dimethylphenol	6920	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1330 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2,4-Dinitrotoluene	660	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 132 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2,6-bis(1,1-dimethyl)-4-(1-methylpropyl)-phenol	304	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 18.7 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2,6-Dinitrotoluene	334	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 271 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2-Chloronaphthalene	21300	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 113 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
2-Methylphenol	32500	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. Users must consider total exposure from all methylphenol isomers and not consider them in isolation. In line with the approach published by EIC when assessing total cresols, the lowest SSV of each methylphenol isomer may be chosen to compare to the total methylphenol concentration. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 14200 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.

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SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

PLEASE NOTE

Compound	SSV mg/kg	Notes
3-Methylphenol	32700	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. Users must consider total exposure from all methylphenol isomers and not consider them in isolation. In line with the approach published by EIC when assessing total cresols, the lowest SSV of each methylphenol isomer may be chosen to compare to the total methylphenol concentration. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 25300 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
4-Methylphenol	32500	The dermal approach published by EIC has been followed. In the phenol SGV report, additional consideration was given to localised dermal effects. This may be applicable to phenol derivatives but has not been considered. Users must consider total exposure from all methylphenol isomers and not consider them in isolation. In line with the approach published by EIC when assessing total cresols, the lowest SSV of each methylphenol isomer may be chosen to compare to the total methylphenol concentration. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 25800 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Acenaphthene	18400	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 157 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Anthracene	96600	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 3.48 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Antimony	2740	
Arsenic	138	Derived considering the comparison of the oral and dermal exposure routes with the oral index dose as per information within the Environment Agency Arsenic SGV report published in May 2009.
Barium	5240	
Benzene	42.5	Based on information within the Environment Agency Benzene SGV report published in March 2009.
Benzo(a)anthracene	28.7	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1.71 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Benzo(a)pyrene	3.7	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.911 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Benzo(b)fluoranthene	35.5	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 1.22 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.

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SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

PLEASE NOTE

Compound	SSV mg/kg	Notes
Benzo(g,h,i)perylene	451	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.0187 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Benzo(k)fluoranthene	381	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.686 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Beryllium	903	
Biphenyl	13500	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free phase product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 34.1 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Bis (2-ethylhexyl) phthalate	11400	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 8.66 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Bromobenzene	642	
Bromodichloromethane	22.2	
Bromoform	1930	
Butyl benzyl phthalate	17500	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 26.1 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Cadmium	In the first instance it may be appropriate to use the residential without the consumption of homegrown produce SSV of 83.6 mg/kg.	
Carbon disulphide	844	
Carbon tetrachloride	62.8	
Chlorobenzene	17900	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free phase product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 651 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Chloroethane	988000	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free phase product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 2440 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Chloroform / Trichloromethane	1390	
Chloromethane	48.0	
Chromium III	74500	
Chromium VI	729	
Chrysene	3010	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.44 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Cis-1,2-dichloroethene	254	
Copper	40600	

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SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

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Compound	SSV mg/kg	Notes
Cyanide	34.0	Based on acute exposure for a 0-6 year old child, using 5th percentile bodyweight from CLR10. Information is not available in SR3 and supporting documents regarding the 5th percentile bodyweight of SR3 bodyweight data. It is not considered likely that new data would significantly affect the SSV.
DDD	174	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 49.9 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Dibenz(a,h)anthracene	3.96	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.00393 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Dibromochloromethane	137	
Dichloromethane	971	
Diethyl phthalate	70100	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 12.8 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Di-n-butyl phthalate	1790	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 4.62 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the approach published by the EIC, the lower of the oral and inhalation assessment criterion has been selected. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Di-n-octyl phthalate	13700	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 32.6 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value. In line with the EIC report section 3.7, where the toxicity effects are the same, the potential additivity of phthalates should be considered by assessors when using the SSV for these substances. Guidance on additivity is provided in the Environment Agency for England and Wales SR2 document.
Dinoseb	21.6	
Ethylbenzene	35200	Based on information within the Environment Agency Ethylbenzene SGV report published in March 2009. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 508 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Fluoranthene	13000	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 18.9 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.

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SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

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Compound	SSV mg/kg	Notes
Fluorene	12600	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 125 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Formaldehyde	141	
Hexachloroethane	177	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 8.13 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Indeno(1,2,3-c,d)pyrene	34.4	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.0614 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Iso-propylbenzene	34900	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 388 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Lead	1590	
Mercury (elemental)	4.30	Based on information in the Environment Agency Mercury SGV report published in March 2009. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the lower of the aqueous and the vapour saturation based limit as calculations are based on inhalation exposure only.
Mercury (inorganic)	1010	Based on information within Environment Agency Mercury SGV report published in March 2009
Mercury (methyl)	64.1	Based on information within Environment Agency Mercury SGV report published in March 2009
Methyl tert-butyl ether	85500	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 17400 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Molybdenum	2620	
m-Xylene	58800	Based in information within the Environment Agency Xylene SGV report published in March 2009. Users must consider exposure from all xylene isomers and not consider them in isolation. The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 613 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Naphthalene	5420	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 75 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Nickel	3070	Based on information within the Environment Agency Nickel SGV report published in May 2009. The oral and inhalation assessment criteria are derived independently and the SSV is the lower value of the two.
Nicotine	73.1	
o-Xylene	60800	Based in information within the Environment Agency Xylene SGV report published in March 2009. Users must consider exposure from all xylene isomers and not consider them in isolation. The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 467 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Phenol	686	Based on information within the Environment Agency Phenol SGV report published in July 2009. The SSV presented assumes 1% soil organic matter and uses the linear media partitioning model within the CLEA software which estimates the corresponding soil water concentration for phenol to be 1% by weight. The value presented is based on a threshold protective of direct skin contact with phenol. A long term exposure value of 2510 mg/kg was derived by the CLEA v.1.04 model and is provided for illustration only. Derived by comparing oral exposure to the oral HCV, and dermal and inhalation exposure to the inhalation HCV.

Author Atkins
Revision 3
Date 31/03/2011

SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

Compound	SSV mg/kg	Notes
Prochloraz	1220	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 0.116 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Propylbenzene	35600	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 399 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
p-Xylene	59500	Based in information within the Environment Agency Xylene SGV report published in March 2009. Users must consider exposure from all xylene isomers and not consider them in isolation. The lowest SSV of each xylene isomer may be chosen to compare to the total xylene concentration. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 564 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Pyrene	9710	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the combined assessment criterion calculated by the CLEA software, assuming that free phase product is not present. The inhalation of vapour pathway contributes less than 10% of total exposure which is unlikely to significantly affect the SSV. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 2.2 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Selenium	2320	Based on information within Environment Agency Selenium SGV report published in March 2009.
Styrene	4220	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 607 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Sum of PCDDs, PCDFs and dioxin-like PCBs	No SSV. Due to publication of the Dioxins, Furans and Dioxin-like PCB SGVs in September 2009, please see the Frequently Asked Questions for more information.	
Tetrachloroethene	4340	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 415 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Toluene	79300	Based on information within the Environment Agency Toluene SGV report published in March 2009. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 835 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aliphatic C10-C12	21700	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 49.9 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aliphatic C12-C16	21700	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 21 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aliphatic C16-C35	590000	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH aliphatic C5-C6	≤ 1 kg/kg	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. However at >1 kg/kg free product would be anticipated and further assessment may be required (e.g. this value is unlikely to be protective of dermal contact). Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 327 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aliphatic C6-C8	≤ 1 kg/kg	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. However at >1 kg/kg free product would be anticipated and further assessment may be required (e.g. this value is unlikely to be protective of dermal contact). Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 158 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.

Author	Atkins
Revision	3
Date	31/03/2011

SSVs derived using CLEA for 1% SOM and sand soil type, Open Space land use

PLEASE NOTE

Compound	SSV mg/kg	Notes
TPH aliphatic C8-C10	21600	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 82.5 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aromatic C10-C12	8560	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 370 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aromatic C12-C16	8700	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 155 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aromatic C16-C21	5380	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH aromatic C21-C35	5380	This fraction is not considered volatile and the inhalation of vapour pathways have not been considered (TPHCWG, 1997).
TPH aromatic C5-C7	42.5	Benzene is the only consituent of this fraction (TPHCWG 1997). Based on information within the Environment Agency Benzene SGV report published in March 2009
TPH aromatic C7-C8	79300	Toluene is the only consituent of this fraction (TPHCWG 1997). Based on information within the Environment Agency Toluene SGV report published in March 2009. The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 835 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
TPH aromatic C8-C10	8040	The lower of the aqueous or vapour based saturation limits has been exceeded in the calculation. The SSV presented is the assessment criterion calculated using the approach outlined within SR4, assuming that free product is not present. Users may wish to consider the fact that the lower of the aqueous or vapour based saturation limits is 614 mg/kg and should confirm that free phase product is not observed where measured concentrations exceed this value.
Trans-1,2-dichloroethene	599	
Tributyl tin oxide	31.0	
Trichloroethene	251	
Trichloromethylbenzene	0.115	
Vanadium	1410	
Vinyl chloride	2.45	
Zinc	183000	

Note:
All values provided are rounded to 3 significant figures.
It is noted for some compounds that the SSV is sufficiently high that free product is likely to be encountered. Please see the Frequently Asked Questions for more advice.
In some instances the risk based value may be lower than the laboratory detection limit. Please see the Frequently Asked Questions for more advice.

A2 – Input Parameters for B(a)P

Modelled Parameters for Benzo(a)pyrene (in the form required by CLEA V.1.06)

PARAMETER	VALUE	UNITS	REFERENCE
Chemical name	Benzo(a)pyrene		
Chemical type	organic		
Oral HCV type	ID		
Oral HCV value	2.00E-01	μg kg^{-1}BW day^{-1}	The old TOX 2 report[1] is considered conservative, since it does not use the latest methodology of BMDL10. The more recent approach using BMDL10 of 2.0mg kg^{-1}BW day^{-1} from a two year study on gavage rats, based on expert toxicological judgement[2] and divided by 10,000 as recommended by/SR2[3] to generate an ID of 0.2mg kg^{-1}BW day^{-1} has been used by ATRISK. This value may be considered more reasonable since it uses the latest UK toxicological approach.
Compare oral HCV with oral exposure	Yes		
Compare dermal HCV with oral exposure	Yes		
Compare inhalation HCV with oral exposure	No		
Inhalation HCV type	ID		
Inhalation HCV value	7.00E-05	μg kg^{-1}BW day^{1}	TOX 2[4]
Compare inhalation HCV with oral exposure	No		
Compare inhalation HCV with dermal exposure	No		
Compare inhalation HCV with inhalation exposure	Yes		
Combine oral and inhalation AC	Yes		
Oral MDI for adults	NR	μg day^{-1}	ID used
Inhalation MDI for adults	NR	μg day^{-1}	ID used
Air-water partition coefficient (K_{aw})	1.76E-06	cm^3 cm^{-3} (dim)	Science report SC050021/SR7[5] (Table 3.9). Temperature adjusted to 283K using the enthalpy vaporisation and Clausius-Clapeyron Equations.
Diffusion coefficient in air	4.38E-06	m^2 s^{-1}	Science report SC050021/SR7 (Table 3.9). Temperature adjusted to 283K.
Diffusion coefficient in water	3.67E-10	m^2 s^{-1}	Science report SC050021/SR7 (Table 3.9). Temperature adjusted to 283K.
Relative Molecular Mass	252.31	g mol^{-1}	Science report SC050021/SR7 (Table 3.9).
Vapour Pressure	2.0E-08	Pa	Science report SC050021/SR7 (Table 3.9). Temperature adjusted to 283K.
Water solubility	3.8E-03	mg L^{-1}	Science report SC050021/SR7 (Table 3.9). Temperature at 298K.
K_{oc}	5.11E+00	Log (cm^3 g^{-1})	Science report SC050021/SR7 (Table 3.9). Estimate linear regression of K_{ow}.
K_{ow}	6.18E+00	Log (dim)	Science report SC050021/SR7 (Table 3.9).
Kd	NR	$cm^{-3}.g^{-1}$	Applicable only for inorganics
Dermal absorption fraction	1.30E-01	dim	CLEA[6] (pp107)
Soil-plant availability correction	NR	dim	
Root-shoot correction factor	NR	dim	
Root-root store correction factor	NR	dim	
Root-tuber correction factor	NR	dim	
Root- fruit correction factor	NR	dim	
Soil-to-plant concentration factor (green veg)	0	$mg.g^{-1}$ (FW or DW)	modelled
Soil-to-plant concentration factor (root veg)	0	$mg.g^{-1}$ (FW or DW)	modelled
Soil-to-plant concentration factor (tuber veg)	0	$mg.g^{-1}$ (FW or DW)	modelled
Soil-to-plant concentration factor (herbaceous veg)	0	$mg.g^{-1}$ (FW or DW)	modelled
Soil-to-plant concentration factor (shrub veg)	0	$mg.g^{-1}$ (FW or DW)	modelled
Soil-to-plant concentration factor (tree veg)	0	$mg.g^{-1}$ (FW or DW)	modelled
Soil-to-dust transport factor	0.5	g g^{-1} DW	Default CLEA V1.04 based on airborne lead research (altered from pp58 of 70%). PRIMARY PARAMETER FOR INHALATION OF INDOOR DUST
Sub-surface soil to indoor air concentration factor	1	dim	Default without site specific data
Bioaccessability Fraction - Soil	1	dim	Default without site specific data
Bioaccessability Fraction – Airborne Dust	1	dim	Default without site specific data

[1] EA (2002). "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzo(a)pyrene." R&D Publication TOX 2.
[2] O'Brian, J; Constable, A; Renwick, AG *et.al* (2006). "Approaches to the Risk Assessment of Genotoxic Carcinogens in Food: A Critical Appraisal." *Food and Chemical Toxicology* 44(2006) 1613-1635.
[3] EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
[4] EA (2002). "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzo(a)pyrene." R&D Publication TOX 2.
[5] EA (2008). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science Report SC050021/SR7.
[6] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.

CLEA Software Version 1.06

Report generated	04/02/2013
Report title	BaP 1% SOM
Created by	Paul Quimby at LK Consult

BASIC SETTINGS

Land Use	Residential with homegrown produce							
Building	Small terraced house							
Receptor	Female (res)	Start age class	1	End age class	6	Exposure Duration	6	years
Soil	Sand							

Exposure Pathways

Direct soil and dust ingestion	✓	Dermal contact with indoor dust	✓	Inhalation of indoor dust	✓
Consumption of homegrown produce	✓	Dermal contact with soil	✓	Inhalation of soil dust	✓
Soil attached to homegrown produce	✓			Inhalation of indoor vapour	✓
				Inhalation of outdoor vapour	✓

Environment Agency

Land Use Residential with homegrown produce

Age Class	Exposure Frequencies (days yr^{-1}) Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Occupation Periods (hr day^{-1}) Indoors	Outdoors	Soil to skin adherence factors (mg cm^{2}) Indoor	Outdoor	Direct soil ingestion rate (g day^{-1})
1	180	180	180	180	365	365	23.0	1.0	0.06	1.00	0.10
2	365	365	365	365	365	365	23.0	1.0	0.06	1.00	0.10
3	365	365	365	365	365	365	23.0	1.0	0.06	1.00	0.10
4	365	365	365	365	365	365	23.0	1.0	0.06	1.00	0.10
5	365	365	365	365	365	365	19.0	1.0	0.06	1.00	0.10
6	365	365	365	365	365	365	19.0	1.0	0.06	1.00	0.10
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00

Receptor Female (res)

Age Class	Body weight (kg)	Body height (m)	Inhalation rate (m^3 day^{-1})	Max exposed skin factor: Indoor (m^2 m^{-2})	Max exposed skin factor: Outdoor (m^2 m^{-2})	Total skin area (m^2)	Consumption rates (g FW kg^{-1} BW day^{-1}): Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	5.60	0.7	8.5	0.32	0.26	3.43E-01	7.12	10.69	16.03	1.83	2.23	3.82
2	9.80	0.8	13.3	0.33	0.26	4.84E-01	6.85	3.30	5.46	3.96	0.54	11.96
3	12.70	0.9	12.7	0.32	0.25	5.82E-01	6.85	3.30	5.46	3.96	0.54	11.96
4	15.10	0.9	12.2	0.35	0.28	6.36E-01	6.85	3.30	5.46	3.96	0.54	11.96
5	16.90	1.0	12.2	0.35	0.28	7.04E-01	3.74	1.77	3.38	1.85	0.16	4.26
6	19.70	1.1	12.2	0.33	0.26	7.94E-01	3.74	1.77	3.38	1.85	0.16	4.26
7	22.10	1.2	12.4	0.22	0.15	8.73E-01	3.74	1.77	3.38	1.85	0.16	4.26
8	25.30	1.2	12.4	0.22	0.15	9.36E-01	3.74	1.77	3.38	1.85	0.16	4.26
9	27.50	1.3	12.4	0.22	0.15	1.01E+00	3.74	1.77	3.38	1.85	0.16	4.26
10	31.40	1.3	12.4	0.22	0.15	1.08E+00	3.74	1.77	3.38	1.85	0.16	4.26
11	35.70	1.4	12.4	0.22	0.14	1.19E+00	3.74	1.77	3.38	1.85	0.16	4.26
12	41.30	1.4	13.4	0.22	0.14	1.29E+00	3.74	1.77	3.38	1.85	0.16	4.26
13	47.20	1.5	13.4	0.22	0.14	1.42E+00	3.74	1.77	3.38	1.85	0.16	4.26
14	51.20	1.6	13.4	0.22	0.14	1.52E+00	3.74	1.77	3.38	1.85	0.16	4.26
15	56.70	1.6	13.4	0.21	0.14	1.60E+00	3.74	1.77	3.38	1.85	0.16	4.26
16	59.00	1.6	13.4	0.21	0.14	1.63E+00	3.74	1.77	3.38	1.85	0.16	4.26
17	70.00	1.6	14.8	0.33	0.27	1.78E+00	2.94	1.40	1.79	1.61	0.22	2.97
18	70.90	1.6	12.0	0.33	0.27	1.80E+00	2.94	1.40	1.79	1.61	0.22	2.97

Environment Agency

Building Small terraced house

Building footprint (m^2)	2.80E+01
Living space air exchange rate (hr^{-1})	5.00E-01
Living space height (above ground, m)	4.80E+00
Living space height (below ground, m)	0.00E+00
Pressure difference (soil to enclosed space, Pa)	3.10E+00
Foundation thickness (m)	1.50E-01
Floor crack area (cm^2)	4.23E+02
Dust loading factor ($\mu g\ m^{-3}$)	5.00E+01

Soil Sand

Porosity, Total ($cm^3\ cm^{-3}$)	5.40E-01
Porosity, Air-Filled ($cm^3\ cm^{-3}$)	3.00E-01
Porosity, Water-Filled ($cm^3\ cm^{-3}$)	2.40E-01
Residual soil water content ($cm^3\ cm^{-3}$)	7.00E-02
Saturated hydraulic conductivity ($cm\ s^{-1}$)	7.36E-03
van Genuchten shape parameter *m* (dimensionless)	3.51E-01
Bulk density ($g\ cm^{-3}$)	1.18E+00
Threshold value of wind speed at 10m ($m\ s^{-1}$)	7.20E+00
Empirical function (F_x) for dust model (dimensionless)	1.22E+00
Ambient soil temperature (K)	2.83E+02

Soil pH	7.00E+00
Soil Organic Matter content (%)	1.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	5.80E-03

Effective total fluid saturation (unitless)	3.62E-01
Intrinsic soil permeability (cm^2)	9.83E-08
Relative soil air permeability (unitless)	7.68E-01
Effective air permeability (cm^2)	7.54E-08

Environment Agency

Soil - Vapour Model

Depth to top of source (no building) (cm)	0
Depth to top of source (beneath building) (cm)	65
Default soil gas ingress rate?	Yes
Soil gas ingress rate ($cm^3 s^{-1}$)	2.50E+01
Building ventilation rate ($cm^3 s^{-1}$)	1.87E+04
Averaging time surface emissions (yr)	6
Finite vapour source model?	No
Thickness of contaminated layer (cm)	200

Air Dispersion Model

Mean annual windspeed at 10m ($m s^{-1}$)	5.00
Air dispersion factor at height of 0.8m *	2400.00
Air dispersion factor at height of 1.6m *	0.00
Fraction of site cover ($m^2 m^{-2}$)	0.75

* Air dispersion factor in g $m^{-2} s^{-1}$ per kg m^{-3}

Soil - Plant Model

	Dry weight conversion factor	Homegrown fraction Average	Homegrown fraction High	Soil loading factor	Preparation correction factor
	g DW g^{-1} FW	dimensionless		g g^{-1} DW	dimensionless
Green vegetables	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	0.103	0.06	0.40	1.00E-03	1.00E+00
Tuber vegetables	0.210	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.06	0.40	1.00E-03	6.00E-01
Shrub fruit	0.166	0.09	0.60	1.00E-03	6.00E-01
Tree fruit	0.157	0.04	0.27	1.00E-03	6.00E-01

Gardener type Average

Report generated	04-Feb-13
Report title	BaP 1% SOM
Created by	Paul Quimby at LK Consult

RESULTS

Environment Agency

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?	
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal
1	Benzo[a]pyrene	1.21E+01	2.65E+00	2.17E+00	0.18	0.82	1.00	9.11E-01 (vap)	No	No
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Environment Agency

		Soil Distribution				Media Concentrations													
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	Benzo[a]pyrene	100.0	0.0	0.0	100.0	2.17E+00	5.11E-06	1.08E+00	9.24E-10	0.00E+00	6.40E-09	9.93E-09	0.00E+00	5.43E-03	2.89E-02	2.05E-02	0.00E+00	0.00E+00	3.40E-05
2																			
3																			
4																			
5																			
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11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

Environment Agency

		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	Benzo[a]pyrene	1.61E-05	9.15E-06	1.07E-05	5.11E-08	6.34E-09	0.00E+00	0.00E+00	44.65	25.37	29.82	0.14	0.02	0.00	0.00	0.00
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		Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})		Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	Benzo[a]pyrene	ID	**0.2**	ID	0.00007	NR	NR	1.76E-06	4.38E-06	3.67E-10	5.11	6.18	0.13	0.5	1	1	1
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		Soil-to-water partition coefficient (cm^3 g^{-1})	Vapour pressure (Pa)	Water solubility (mg L^{-1})	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
1	Benzo[a]pyrene	7.47E+02	2.00E-08	3.80E-03	model	model	model	model	model	model
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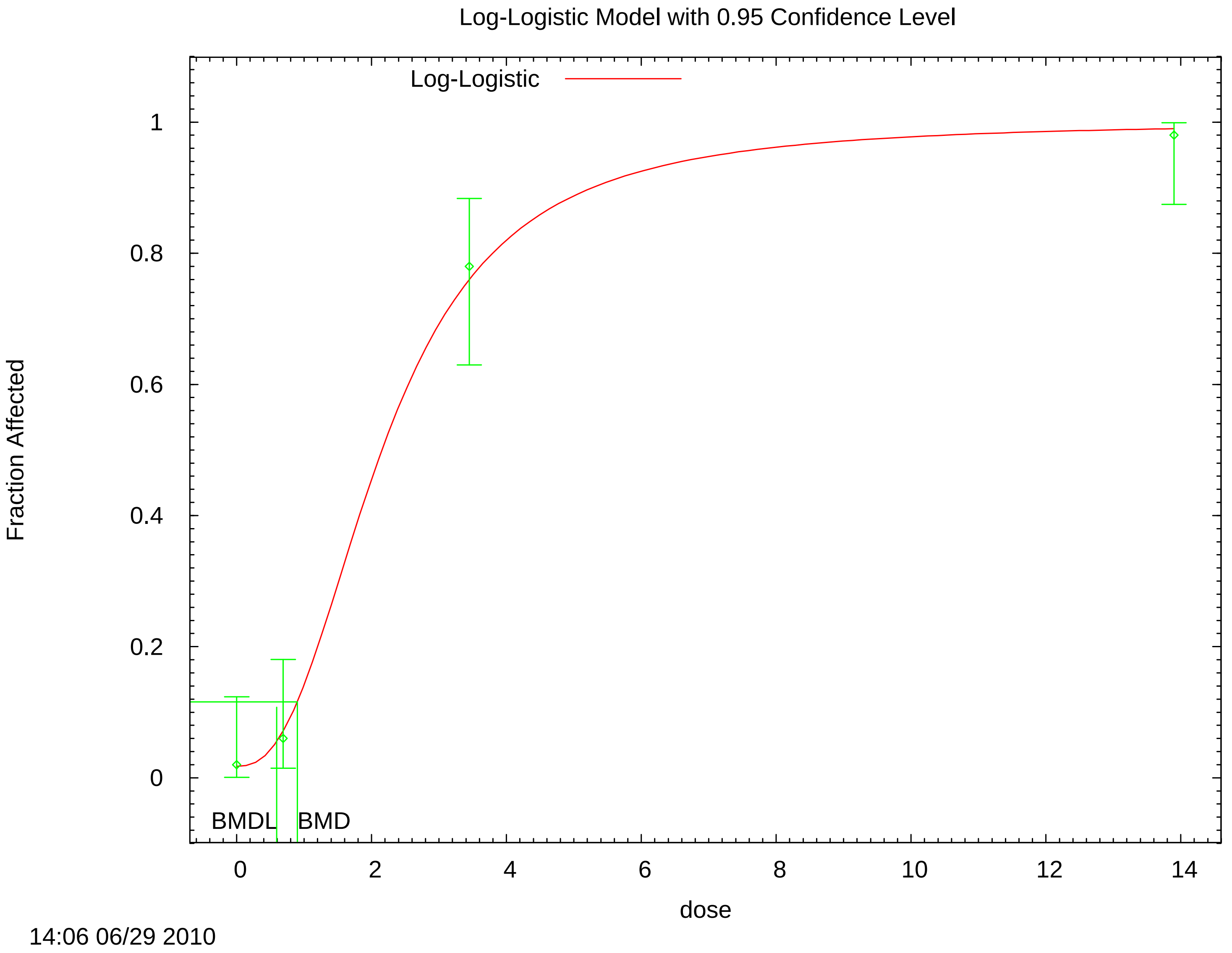
A3 – Dose-Response Curve to Generate a $BMDL_{10}$ from Culp *et al* (1998) data for B(a)P

Dichotomous

Model Name	Data File Name	Option File Name	Initial/Specified Intercept	AIC	Inputs+Estimates+Scaled Res.	Chi-square	P-value	Specified Effect	Risk Type	Confidence Level	BMD	BMDL	Scaled Residual of Interest
LogLogistic	LKCulp.dax	LKCulp.opt	-2.09029	95.0172	Array	0.68	0.4088	0.1	Extra risk	0.95	0.897801	0.594252	-0.302

A: LogLogistic - Culp 1998 data for BaP (incidence of forestomach cancer)



Bury Business Centre
Kay Street, Bury BL9 6BU

Tel: 0161 763 7200
Fax: 0161 763 7318

The Corn Exchange, Fenwick Street
Liverpool L2 7QL

Tel: 0151 235 8716

Unit 121, Wright Business Centre
1 Longmay Road, Glasgow G33 4EL

Tel: 0141 773 6269

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