LK CONSULT LIMITED

PART OF THE LK GROUP

LAND AT GLEBE COURT, WESTWOOD NEW ROAD, TANKERSLEY

GEO-ENVIRONMENTAL INVESTIGATION AND RISK ASSESSMENT



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1 INTRODUCTION

1.1 Background

LK Consult Ltd (LKC) has been commissioned by Lancaster Maloney to carry out a geo-environmental investigation and risk assessment for land at Glebe Court, Westwood New Road, Tankersley. The investigation was undertaken in support of a future planning application to develop the site for residential use and a community park. Information is required on the ground conditions beneath the site to allow a geotechnical and contamination assessment to be undertaken.

A Preliminary Risk Assessment (PRA) report has previously been undertaken by LKC (Ref: CL-602-CL1902-01, dated January 2012) and summarised in Section 2. This report should be read in conjunction with this report.

1.2 Site Details

The site is located on Westwood New Road in the area of Tankersley and is centred at National Grid Reference 434479E 399964N (Figure 1-1). The site is bounded by Glebe Court and residential properties to the north and east, the A61 to the south and Westwood New Road to the west. It is understood that the site has most recently been used for Horse Grazing.

The site is approximately 0.68ha in size (see Figure 1-2). The site generally falls in a north-easterly direction. The highest point on the site is 153.16m AOD in the western part of the site. The lowest point on the site is 148.86m AOD in the eastern part of the site. The site proposed layout is indicated in Figure 1-3 and comprises twenty residential dwellings (including driveways, garage/shed, private gardens, soft and hard landscaping) with a roadway and village green.

1.3 Disclaimer

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

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

This report is prepared solely for the benefit of Lancaster Maloney. It may not be relied upon by, or submitted to a third party for their reliance for the purposes of valuation, mortgage, insurance and regulatory approval, until all invoices have been settled in full.

Those using this information in subsequent assessments or evaluations do so at their own risk.

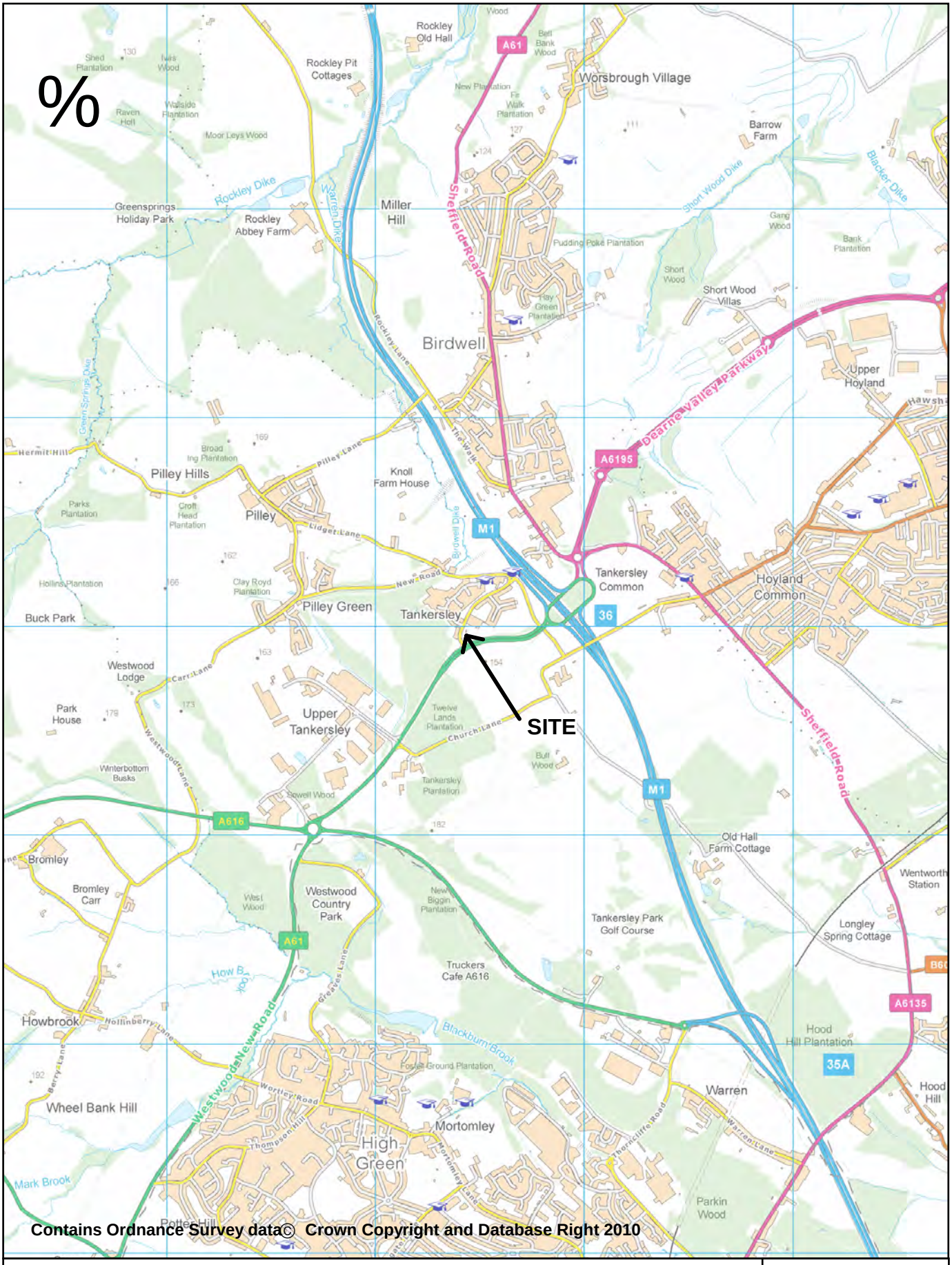
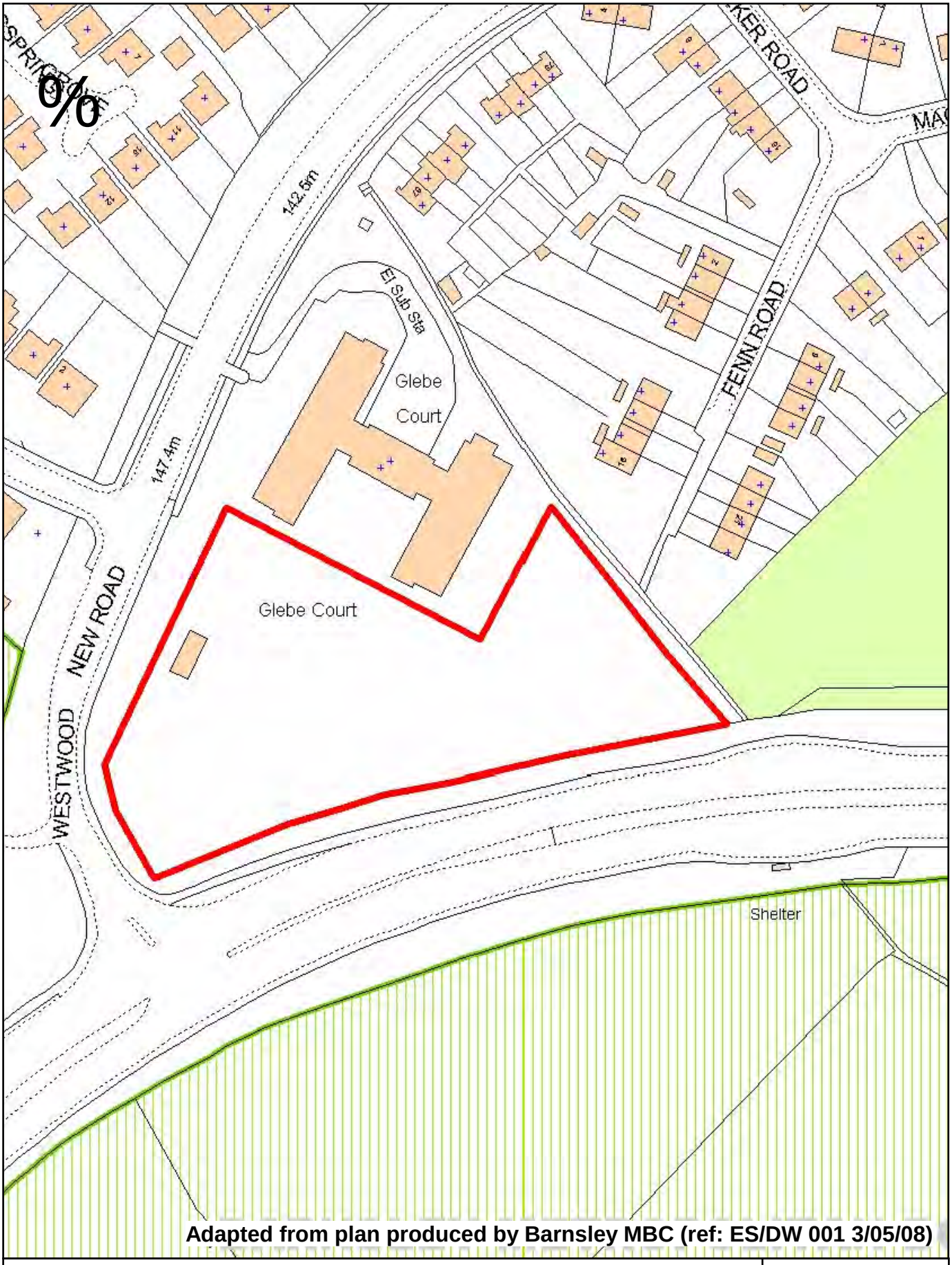


Figure 1-1 Location Plan, Westwood New Road, Tankersley

Drawn: March 2012 Scale: 1:25,000 @ A4

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Adapted from plan produced by Barnsley MBC (ref: ES/DW 001 3/05/08)

Figure 1-2 Site Plan, Westwood New Road, Tankersley

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Adapted from plan produced by Bowker Sadler (ref: 110-48 100 24/01/12)

Figure 1-3 Proposed Plan Plan, Westwood New Road, Tankersley

Drawn: March 2012 Scale: 1:1,000 @ A4

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2 PREVIOUS WORK

2.1 Site History

Site Features	Location	Map Dates Present	Comments
Footpath	On eastern boundary	1893-present	Leading from Rectory Farm to Birdwall station.
Field	Whole Site	All	
Surrounding Area Features	**Distance/ Location**	**Map Dates Present**	**Comments**
Old Quarry	250m NW	1893- 1957	
Embankment	Adjacent to western boundary	1931-present	Embankment sloping down from site to renamed Westwood Main Road (originally called Moor Lane). Likely to be associated with construction of road.
Tank	Adjacent to eastern boundary	1931-1948	Tank no longer present in 1957 mapping. Use of the tank unknown. Residential houses east of tank by 1931.
Pond	220m NW	1957-present	
Tip	130m W	1931-1989	Situated in Potter Holes plantation. Excavations commenced in 1931. Shown as 'Tip (disused)' from 1970. No longer shown on 1992 mapping.
Electricity Sub-station	70m NE	1993-present	
Embankment	Adjacent to southern boundary	1970-present	Embankment slopes down from site to road (A61). Likely to be associated with construction of road.
Glebe Court	5m NE	1980-present	Residential houses 50m north of site from 2006 mapping.

2.2 Environmental Settings

Summary of Environmental Settings			
Geology	Superficial		-Absent
	Bedrock		-Haigh Moor Rock, Middle Coal Measures. -Pennine Middle Coal Measures Formation extreme western extent of site.
	Faulting		Fault ~10m SW, striking NW-SE, downthrow unknown.
	BGS logs		-Nearest 250m NE: Made ground to 3mbgl, weathered Sandstone and Mudstone to 9.85mbgl, including coal at 4.70-5.15mbgl.
Hydrogeology	Aquifer Designation	Superficial	-No data available.
		Bedrock	-Secondary A.
	Groundwater vulnerability		-Soils of High Leaching Potential (H3).
	Groundwater abstractions		-None within 500m.
Hydrology	Nearest surface water		-Pond 232m west -Birdwell Dike 260m northwest, flowing to the north.
	Flooding		-No risk.
	Surface water abstractions		-None within 500m.
	Discharge consent		-Two within 500m, nearest 308m NW (trade effluent)
	Pollution Incidents		-None within 250m.

Summary of Environmental Settings		
Mining*	Coal Mining Referral Area	-Standing Advice. A Referral Area is present to the north west of Westwood New Road.
	Coal Authority Report	-8 Coal seams at 30m to 310m deep, last worked 1965. Any ground movement from these coal workings should have stopped by now. -Coal believed to be at or close to the surface which may have been worked at some time in the past. -Not in the likely influence of any present underground coal workings. -No shafts present within 20m of the site.
	Mineral Abstraction	-13 mineral extractions within 1km of the site. Nearest 359m NW (opencast).
Landfill sites (within 250m)	Known/Registered	None.
	Potential	-Old Quarry 250m NW of the site, no longer shown on 1957 mapping. - Tip 130m west.
Radon		-Probability of <1% of homes above Action Level. -No further action required.
Designated Sites		-Adopted Green Belt 33m S. - Local Nature Reserve (Potter Holes Plantation) 45m W. - Site is in Nitrate Vulnerable zone
Contemporary Trade Directory		-None within 250m, nearest 491m NE (Gunsmiths).

* Geological mapping identified a coal seam subcropping to the west of the site (opposite side of the Westwood New Road). This is likely to be the reason that the Coal Mining Report refers to potential shallow mining. However the Coal Mining Development Referral Plan does not indicate the site is within a Coal Mining Referral Area, the referral area is restricted to the location of the coal seam suggesting only a restricted area of potential workings.

2.3 Site Reconnaissance

A site reconnaissance was carried out by LKC on the 16th January 2012. The area of the proposed development site is currently vacant and is overgrown with vegetation. It is understood that the previous land activity is likely to have been a paddock for horse grazing. The base of a former building was observed in the west of the site with surrounding tarmaced area which may have been a stable.

An embankment was observed (a fall of 2m or more) adjacent the western boundary of the site towards Westwood New Road. The site was observed to be falling in a north-easterly direction towards Glebe Court and Fenn Road.

2.4 Preliminary Contamination Conceptual Model

Pollutant Linkage No.	Contaminant					Pathway	Receptor
	ACM	Gases		Contaminants			
		Hazardous	Ground	Organic	Inorganic		
PL1	x	x	x	?	?	-Dermal contact. -Ingestion of soils and vegetables. -Inhalation of contaminated soil, dust.	-Future site residents. -Future site users.
PL2	x	x	x	x	x	-Inhalation of vapours. -Vapour migration through permeable strata.	-Future site residents. -Future site users.
PL3	x	x	?	x	x	-Inhalation of hazardous / ground gas. -Migration through permeable strata. -Migration through nearby fault.	-Future site residents. -Future site users. -Offsite receptors (if gas is generated on site).
PL4	x	x	x	x	x	-Groundwater migration through permeable strata (inc fractures, workings, faults). -Perched waters migration on site.	- Secondary A Aquifer. - Pond. - Birdwell Dike.
PL5	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. -Future site users. -Pipework.
PL7	x	x	x	x	?	-Root uptake of phytotoxic contaminants.	-Flora in future landscaping.

Table 5-1 Contamination Conceptual Model for the Glebe Court, Westwood New Road, Tankersley.
(Key: ? – pollutant linkage possible; x – pollutant linkage unlikely)

Pollutant linkage 1 refers to the potential heavy metals and organic contaminants (such as PAHs) coming into direct contact with future site residents. This is considered possible in the garden areas where future site users may come into contact with the soils.

Potential pollutant linkage 2 refers to possible inhalation of vapours affecting the future site users and residents from potential volatile contaminants. This pollutant linkage is considered unlikely on the site based on the historical assessment.

Potential pollutant linkage 3 refers to possible ground gas (from the Middle Coal measures) underlying the site affecting the future site users and residents and possible migration of hazardous gas from infilled areas on the site and offsite.

Migration of ground gas is considered possible to and from the site given the geology on site.

The possibility of hazardous gas from infilled areas on site is considered small as it is unlikely that significant quantities of putrescible material are present on site. The migration of hazardous gas from infilled areas offsite is considered unlikely due distance, size of features and date since infilling.

Pollutant Linkage 4 refers to the risk to controlled waters. The history of the site does not suggest that significant concentrations of mobile contaminants are likely at the site. The Secondary A Aquifer is unlikely to be a significant source of groundwater and no groundwater abstractions have been identified within influencing distance of the site. The Birdwell Dike is over 250m from the site, therefore is unlikely to be affected by the site. Taking all the above into account, LKC consider pollutant linkage 4 to be unlikely.

Potential pollutant linkage 5 refers to the possible deleterious effects that sulphate may have on building materials such as concrete, water pipes and building structures. In addition, methane may potentially build up within confined spaces and cause an

explosion. Given that the site underlies the Middle Coal Measures and possibility of Made Ground on site, this pollutant linkage is considered possible.

Potential pollutant linkage 6 refers to the possible contaminants permeating potable water pipes and consumption by the future site users and residents of the tainted water supply. Given that there may be made ground on site, this linkage is considered possible.

Potential pollutant linkage 7 refers to the possible phytotoxic contaminants affecting plant growth. Given that there may be made ground onsite, this linkage is also considered possible.

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

3 GROUND INVESTIGATION

3.1 Site Investigation Design and Methodology

In order to investigate the potential pollutant linkages identified in the preliminary contamination conceptual model and to provide an appraisal of the ground conditions, an intrusive investigation was undertaken in February 2012.

The intrusive site investigation involved the drilling of eight window sample boreholes (referenced WS101-WS108) to depths of 1.95-2.45 metres below ground level (mbgl). Standard Penetration Tests (SPTs) were undertaken approximately every 1m in natural ground and bulk and disturbed samples were collected for contamination and geotechnical testing.

The split spoon sampler used to determine SPTs was used to penetrate as far as possible into weathered bedrock.

Monitoring wells were installed in all wells to allow sampling of groundwater, gas monitoring and falling head tests to be undertaken.

The number of sampling points corresponds to one location per 28m square centres (approximate herringbone pattern). This is considered appropriate given the site history and heterogeneous ground conditions encountered.

All borehole locations are shown in Figure 3-1 and profile logs (in line with BS5930[1]) are provided in Appendix A.

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[2,3]. 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 twelve representative soil samples were selected for chemical contamination analysis including ten made ground samples and two natural ground samples. The samples were subjected to the following analysis:

- Arsenic, cadmium, total chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, water soluble sulphate, pH, USEPA speciated polycyclic aromatic hydrocarbons (PAHs) and organic matter.

No visual or olfactory evidence of hydrocarbon or volatile contaminants were identified therefore these contaminants were not included.

[1] British Standard (1999). “Code of Practice for Site Investigations. “ BS5930:1999
[2] EA (2000). “Technical Aspects of Site Investigation. Volume 1 (of 2) Text Supplements Research and Development Technical Report.” P5-065/Tr.
[3] EA (2000). “Technical Aspects of Site Investigation. Volume 2 (of 2) Text Supplements Research and Development Technical Report.” P5-065/Tr.

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)[4].

With regards to asbestos containing material (ACM), the engineer onsite examined soil for obvious ACM. In addition, the laboratory screen samples routinely to identify the presence or absence of ACM. If ACM is identified then bulk analysis is undertaken.

Many of the tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix B and discussed further in Section 6.2.

3.2.2 Water Sample Collection

Insufficient groundwater was encountered to collect samples for analysis. Given the ground conditions encountered and the results of the soil analysis it was considered that the risk to controlled waters was negligible and therefore no further action required. This is discussed in further detail in Section 6.3.

3.2.3 Gas Monitoring

To date, one gas monitoring visit has been carried out. Gas monitoring was carried out on all borehole wells. A further five visits are intended to be carried out.

Installation details for this site are typical for gas monitoring wells as described in CIRIA C665[5] generally comprising 1m plain pipe and a length of slotted pipe work surrounded by pea gravel and sealed at the base with bentonite and at the top with bentonite and concrete. Shallower plain pipe was used in some wells to allow specific strata to be targeted and to maximise the capacity of gas to enter the borehole.

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 will include periods of falling barometric pressure and heavy rainfall to demonstrate worst atmospheric conditions.

The gas monitoring results are summarised in Section 6.4.

3.2.4 Geotechnical Testing

In-situ geotechnical tests were performed in the eight boreholes to further characterise the sub-soil conditions. In total, sixteen Standard Penetration Tests (SPTs) were performed on the underlying sub-soils. A summary of these results is provided in Section 5.

Three plasticity tests were also carried out on natural clay deposits. Laboratory analysis sheets are provided in Appendix C and discussed in Section 5.

[4] Palmer, CD and Roberts, WP (1994). "Natural Attenuation of Hexavalent Chromium in Groundwater and Soils." EPA Issue EPA/540/5-94/505.
[5] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665

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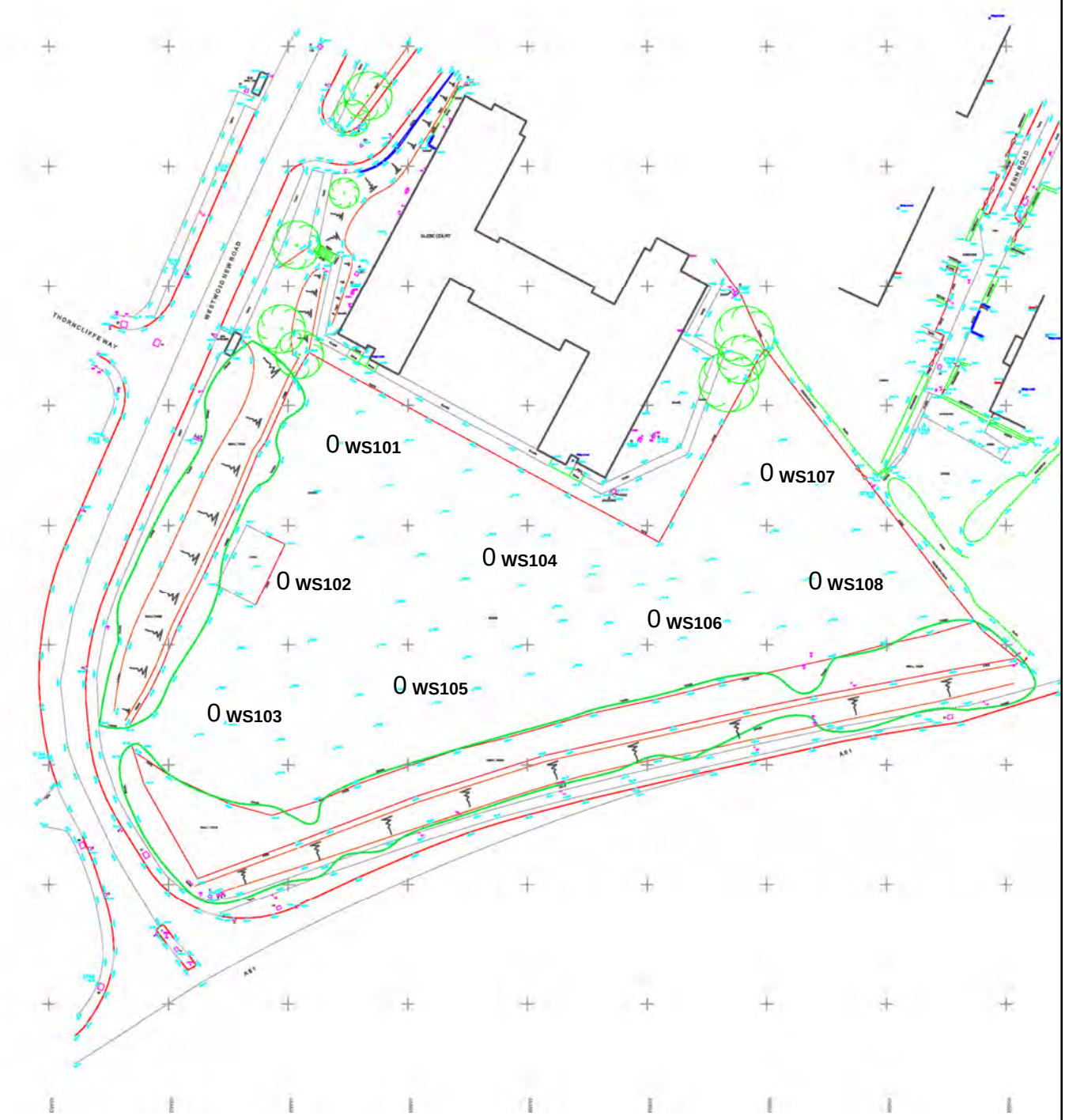


Figure 3-1 Sampling Location Plan, Westwood New Road, Tankersley

Drawn: February 2012 Scale: 1:1,000 @ A4

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4 GROUND CONDITIONS

4.1 Introduction

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	0.4 to 0.8	0.4 to 0.8	**MADE GROUND:** Brown slightly gravelly silt/clay with rare cobble of brick and roots. Gravel fine to medium, subangular to angular of natural stone with occasional brick and ash.
0.4 to 0.8	1.5 to 2.0	1.0 to 1.5	**SUPERFICIAL:** Firm to very stiff orange/brown/grey CLAY with occasional organic inclusions and sand pockets. Gravel fine to medium, angular to subangular of mudstone and sandstone.
1.5 to 2.0	>2.0 to >2.55	>0.08 to >1.05	**BEDROCK:** Weak, thinly laminated grey/black weathered MUDSTONE (WS101-107). Possible thinly laminated SANDSTONE (WS108).

Table 4-1: Summary of ground conditions for land at Glebe Court, Westwood New Road, Tankersley.

4.2 Groundwater

Groundwater was not encountered in any boreholes during drilling. To date, one groundwater monitoring visit has been undertaken, a further five visits will be undertaken in total. Results are summarised in Table 4-2.

BH Ref	Response Zone	Depth to top of groundwater (mbgl)		No. Visits	Hydrocarbon Odours (No. Visits)
		Min	Max		
WS101	0.2-0.7 (MG/C)	dry	dry	1	0
WS102	0.4-0.9 (MG/C)	dry	dry	1	0
WS103	0.7-2.2 (C/MS)	1.86	1.86	1	0
WS104	1.05-1.85 (C)	1.7	1.7	1	0
WS105	2.0-2.5 (MS)	2.39	2.39	1	0
WS106	0.7-1.7 (C/MS)	dry	dry	1	0
WS107	0.2-0.7 (MG/C)	dry	dry	1	0
WS108	1.2-1.9 (C/SS)	dry	dry	1	0

Table 4-2: Summary of water strike depths within boreholes for land at Glebe Court, Westwood New Road, Tankersley.

Response Zones:

MG=Made Ground; C=Clay; MS=Mudstone; SS = Sandstone

Groundwater was encountered in only three of the boreholes at a depth of approximately 1.7-2.4mbgl. No groundwater flow direction could be estimated from these results.

5 GEOTECHNICAL APPRAISAL

5.1 Standard Penetration Tests

Sixteen 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
1.0-1.45	26 (C)	26 (C)	18 (C)	12 (C)	31 (C)	15 (C)	13 (C)	13 (C)
1.5-2.45*	80R (MS)	92R (MS)	66 (MS)	50R (C/MS)	60R (MS)	67R (C/MS)	R (MS)	R (C/MS)

Table 5-1: Summary of SPT (N) values recorded for land at Glebe Court, Westwood New Road, Tankersley.
C=Clay; MS=Mudstone; R=Refusal (in bedrock)
*SPT depth varies between boreholes.

5.2 Concrete Specification

The concentrations of soluble sulphate in the made ground when contrasted to BRE Digest 2005[6] categorise the concrete requirement as DS-1 AC-1. Therefore no sulphate resistant concrete should be required at the site.

5.3 Atterberg Limits and Moisture Content

Three samples of natural clay from WS101 (0.8-0.9mbgl), WS105 (0.9-1.2mbgl) and WS108 (0.9-1.0mbgl) were subjected to Atterberg Limits and Moisture Content testing and the results are summarised in Table 5-2 below. Laboratory results can be viewed in Appendix C.

BH	Depth (mbgl)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Class	Passing 425 micron (%)
WS101	0.8-0.9	10	38	20	18	CI	58
WS105	0.9-1.2	23	46	20	26	CI	97
WS108	0.9-1.0	20	43	18	25	CI	97

Table 5-2: Summary of moisture content and plasticity index tests for land at Glebe Court, Tankersley.

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%

Therefore the modified plasticity index for this site for WS101 is 10.44%, WS105 is 25.22% and WS108 is 24.25%. This characterises the clay as having a low to intermediate volume change potential.

Various trees have been identified on the western and southern boundaries of the site. The minimum distance from the proposed development is 5m however the majority of plots are over 10m.

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

In accordance with guidance given in NHBC Standards Appendix 4.2H the minimum foundation depth with respect to shrinkability may be calculated as follows:

Volume Change Potential	The modified Plasticity Indices of the clay samples are 10.44-25.22% giving a **LOW TO MEDIUM** volume change potential.
Establish Species	A number of different species are present. It is therefore assumed that they will have a high water demand. LKC assumes that the majority of these trees are to remain.
Establish Tree Zone of Influence	The proposed foundations may be within the zone of influence of these trees.
Establish Appropriate Tree Height (H)	A maximum mature height of 24m has been be used as a conservative height.
Establish Distance (D)	The majority of trees on site are over 7m from the proposed development however a plot in the east is approximately 5m from the existing trees.
Calculate Distance (D)/Height (H)	5m D/H = (5 / 24) = 0.21 10m D/H = (7 / 24) = 0.41
Determine Foundation Depth	Using Chart 3 in Appendix 4.2B gives a foundation depth of: 5m distance from tree = >2.5m 10m distance from tree = 2.3m
Adjust the depth according to climatic zone	Figure 13 indicates a reduction of 150mm foundation depth would be appropriate. **Minimum Final Foundation Depth:** **5m distance from tree = >2.5m** **7m distance from tree = 2.1m**

Table 5-3: Foundation Depth Calculation for land at Glebe Court, Tankersley .

Given the presence of trees on site and the modified plasticity indices of the underlying clay soils it has been calculated that the minimum final foundation depth at the site should be over 2.5m below the original ground level if within 5m of trees and 2.1m if within 10m of trees. This has been based on 'worst case' values in the absence of an arboricultural survey.

5.4 Outline Foundation Considerations

5.4.1 Anticipated Foundation Loads

No foundation loads for the proposed new buildings on the site have been provided. The proposed site layout is shown in Figure 1-3. The proposed buildings occupy the majority of the site; as such the data from all of the boreholes is considered relevant.

The geological sequence encountered within the boreholes is consistent and comprises a made ground to 0.4-0.8mbgl, firm to very stiff clay to 1.5-2.0mbgl and bedrock below.

Proposed buildings comprise two-storey dwellings.

5.4.2 Made Ground

Due to the depth and density of the made ground this strata is unlikely to be suitable for supporting structural loads.

5.4.3 Natural Clay

Clay strata encountered from 0.4-0.8mbgl to 1.5-2.0mbgl returned SPT 'N' values of between 12 and 31 characterising these strata as firm to very stiff.

Based upon the finding of the geotechnical investigation an appropriate minimum bearing pressure would be approximately 120kN/m^2 in the clay strata.

5.4.4 Bedrock

Bedrock comprising mudstone across the majority of the site and possible sandstone in the eastern corner was encountered from 1.5-2.0mbgl. The majority of the SPT refused in the bedrock with the exception of WS103 which gave an N Value of 66.

No laboratory testing was undertaken on the bedrock however it is assumed to have an undrained compressive strength of >350kN/m^2.

5.4.5 Foundation Solution Options

Given the strength and depth to the clay it is expected that traditional concrete trench fill foundations constructed upon the pervasive clay layer will be appropriate.

Consideration should be given to the volume change potential associated with the presence of trees on the site. Until an arboricultural survey is undertaken, foundations over 2mbgl are assumed to be required where trees are within 10m.

5.5 Road and Pavement Design

No CBRs were carried out as part of this investigation, however based on the nature of the clay encountered and plasticity index, it is recommended that for design purposes a CBR value of at least 3% is assumed.

5.6 Falling Head Tests

LKC undertook falling head permeability tests in general accordance with guidance given in BS5930[7]. The tests were carried out in monitoring wells installed within the boreholes.

Groundwater levels were measured prior to undertaking the tests. Water was added to the well to a known depth and falling water levels were measured over time.

BS5930 indicates that if 'Ho' is taken as the groundwater 'Head' above baseline conditions following the addition of water at the start of the permeability test and 'H' is the measured groundwater 'Head' above baseline conditions at any given time during the test then the time taken to reach a head ratio (H/Ho) of 0.37 is used to calculate the permeability of the soils.

Where slow progress was observed and H/Ho of 0.37 could not be reached in the field, the data was extrapolated.

Where no water was encountered (WS106) baseline conditions were taken as the base of the monitoring wells.

Repeat tests were carried out in WS105 and WS106 however due to the slow draining in WS103 and WS104, only one test was carried out.

Full monitoring details and permeability calculations are provided in Appendix D and are summarised in Table 5-4 below.

[7] BSI (1999). "Code of Practice for Site Investigations".

BH	Test No.	Response Zone (mbgl)	Initial water level (mbgl)	Basic Time Lag (where H/Ho=0.37)	Permeability (k) m/sec
WS103	1	0.7-2.0 Clay 2.0-2.2 Mudstone	1.82	8hrs*	2.5×10^{-8}
WS104	1	1.05-1.85 Clay	1.7	5hrs 40mins*	5.3×10^{-8}
WS105	1	2-2.5 Mudstone	2.21	7 secs	2.1×10^{-4}
	2			7.5 secs	1.9×10^{-4}
WS106	1	0.7-1.6 Clay 1.6-1.7 Mudstone	Dry	7.75 secs	1.2×10^{-4}
	2			7.5 secs	1.3×10^{-4}

Table 5-4 Summary of falling head tests and permeability for land at Glebe Court, Tankersley.

*Extrapolated data where H/Ho was not reached in the field.

The falling head tests carried out in WS103 and WS104 encountered a permeability with an order of magnitude of 10^{-8}m/sec. The response zones within these wells are predominantly within the clay deposits, however the base of WS103 lies within the saturated zone of the mudstone.

The falling head test carried out in WS105 and WS106 encountered a permeability with an order of magnitude on 10^{-4}m/sec. The response zone for WS105 is within the mudstone, partially unsaturated and WS106 is within the clay strata and unsaturated mudstone.

Based on the results the clay encountered has a typical permeability for this type of deposit and would be classified as an aquiclude based on Figure 7.3 of Sarsby[8].

The results of WS105 and WS106 suggest that the mudstone is more permeable and could be classified as an aquifer based on Figure 7.3 of Sarsby. However this is not reflected in WS103 where part of the response zone is within the mudstone.

[8] Sarsby (2005). "Environmental Geotechnics".

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[9]). 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[10] based on 1% and 6% soil organic matter (SOM) and are considered scientifically robust and conservative. All these criteria now follow current UK methodology[11,12,13,14].

The SOM values range between 0.62% and 8.1% therefore the SSVs for 1% have been used as a conservative approach.

A summary of the ATRISK SSVs (Revision 3) for 1 % SOM and for residential with plant uptake is presented in Appendix E.

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.

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[15] 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[16,17] and naphthalene the most volatile and soluble[18]. These determinands will be used to establish the risk from PAHs,

[9] EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.
[10] EA (2008). "CLEA Software (Version 1.05) Handbook." Science Report – SC050021/SR4.
[11] EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.
[12] EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.
[13] EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.
[14] EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.
[15] EA (2002). "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Chromium." R&D Publication TOX 4.
[16] EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.
[17] USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."
[18] EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5- 079/TR1.

although high concentrations of other PAHs will be compared to appropriate generic values, where appropriate.

All analysis sheets are presented in Appendix B.

When laboratory results were compared against relevant SGVs and SSVs, no elevated contaminants were identified.

6.2.1 Direct Contact Risk – Pollutant Linkage 1

No elevated contaminants were identified in the soil samples therefore LKC consider Pollutant Linkage 1 to be incomplete.

6.2.2 Inhalation Risk – Pollutant Linkage 2

No volatile PAHs were identified within soil samples. Furthermore, no visual or olfactory evidence of hydrocarbons or volatile contamination was observed during the site investigation. Therefore consider Pollutant Linkage 2 to be incomplete.

6.3 Controlled Water Assessment

Negligble groundwater was encountered during monitoring therefore no groundwater sampling was undertaken. The preliminary conceptual model did not identify a likely pollutant linkage with respect to controlled waters. This was further substantiated by the ground conditions encountered during the investigation work.

No elevated contaminants were identified within the soils on site. Furthermore pervasive clay layer was identified across the site which would impede the majority of groundwater migration.

It is therefore confirmed that there is unlikely to be a risk posed to controlled waters and pollutant linkage 4 is incomplete.

6.4 Gas Risk Assessment

To date, one gas monitoring visit has been undertaken on the study site. A summary of the findings are provided within Table 6-1 below. Further monitoring will be undertaken and discussed in the final report.

Following guidance set out in CIRIA C665[19] and BS8485:2007[20] 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).

[19] CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665
[20] BSI (2007). "Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments." BS8485:2007.

Borehole Ref:	Monitoring Results					Max GSV (l/hr)	CS/TL
	Peak CH_4 (%v/v)	Steady CO_2 (%v/v)	Peak Flow (l/h)	Groundwater (mbgl)	Pressure (mb)		
WS101	0.1	0.1	0.1	Dry	994	0.0001	CS1/Green
WS102	0.1	0.1	0.1	1.91		0.0001	CS1/Green
WS103	0.1	0.9	0.1	1.86		0.0009	CS1/Green
WS104	0.1	0.4	0.1	1.7		0.0004	CS1/Green
WS105	0.1	1.7	0.2	2.39		0.0034	CS1/Green
WS106	0.1	0.3	0.2	Dry		0.0006	CS1/Green
WS107	0.1	0.2	0.3	Dry		0.0006	CS1/Green
WS108	0.1	0.2	0.1	Dry		0.0002	CS1/Green

Table 6-1: Summary of ground gas monitoring for land at Glebe Court, Westwood New Road, Tankersley.

Notes:

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

CS – Characteristic Situation; TL= Traffic Light

In accordance with current guidance CIRIA C665 a Gas Screening Value (GSV) may be calculated.

Based on the results to date, assuming worst case scenario maximum concentrations and flow for methane and carbon dioxide generated GSVs of 0.0003 l/hr and 0.0051 l/hr respectively placing the gas risk within a Characteristic Situation (CS) 1 / Green Traffic Light System.

Further monitoring and risk assessment is required before the presence / absence pollutant linkage 3 and 5 (methane) can be confirmed.

6.5 Additional Risk Assessment

The concentrations of soluble sulphate in the soil when contrasted to BRE Digest[21] 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 (sulphate only) is incomplete and no sulphate resistant concrete is required for the proposed building.

Yorkshire Water guidelines have been recently replaced with new guidance[22], where sampling may be required for contaminants that include speciated petroleum hydrocarbons, chlorinated compounds, BTEX compound, SVOCs and VOCs. However the conceptual model for this site does not indicate the likely presence of these contaminants.

Considering the historical setting of the site, composition of the made ground onsite and the likelihood that any pipework will be in natural strata LKC does not consider protective water supply pipework is required for this site. Therefore, pollutant linkage 6 is considered incomplete.

No analysed soil concentrations are considered phytotoxic as outlined in BS3882[23]. Therefore, no remedial measures will be required for any areas of soft landscaping and gardens to protect flora. Therefore, pollutant linkage 7 is considered incomplete.

[21] BRE (2005)."Concrete in Aggressive Ground." Special Digest 1.
[22] Yorkshire Water (2011). "Contaminated Land Assessment Form"
[23] 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 6-2. 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		
PL3	x	x	?	x	x	-Inhalation of hazardous / ground gas. -Migration through permeable strata. -Migration through nearby fault.	-Future site residents. -Future site users. -Offsite receptors (if gas is generated on site).
PL5	x	x	?	x	x	-Contact with potential hazards.	-Site buildings.

Table 6-2: Revised Contamination Conceptual Model for land at Glebe Court, Westwood New Road, Tankersley.
Key: ✓ – pollutant linkage identified; ? – pollutant linkage possible, x – pollutant linkage unlikely

6.6.1 Pollutant Linkage 3

Potential pollutant linkage 3 refers to possible ground gas migrating to and from the site. Initial readings indicate low concentrations of gas that require no protection measures. However, the presence / absence of this pollutant linkage will be confirmed on completion of the gas monitoring.

6.6.2 Pollutant Linkage 5

Potential pollutant linkage 5 refers to the possible deleterious effects that sulphate may have on building materials such as concrete and building structures and where ground gas such as methane may potentially build up within confined spaces and cause an explosion.

Sulphate concentrations were below the requirements for protective concrete there this pollutant linkage with respect to inorganic contaminants within the soil is considered incomplete.

Initial gas monitoring readings indicate low concentrations of methane (below detection limits). However, the presence / absence of this pollutant linkage with respect to methane will be confirmed on completion of the gas monitoring.

7 CONCLUSIONS

7.1 Conclusions and Recommendations

An investigation was carried out to confirm the presence/absence of potential pollutant linkages identified in the Preliminary Risk Assessment as well as providing geotechnical information for foundation design.

The investigation comprised drilling eight window sample holes, installation of monitoring wells and collection of soil samples. Falling head tests were undertaken in the wells and gas monitoring undertaken. Soil samples were tested for contaminants identified within the preliminary conceptual model and based on ground conditions observed on site.

Ground conditions comprised made ground to 0.4-0.8mbgl, clay to 1.5-2.0 and bedrock (mudstone/sandstone) below.

The clay is expected to be a suitable founding strata for standard shallow foundations (e.g. strip footing). 'N' values within the clay were recorded as 12-31 for which LKC estimate an allowable bearing pressure of at least 120kN/m^2.

Plasticity Index tests were undertaken on the natural clay and recorded values of 18-25%.

A CBR of at least 3% is assumed for the site based on the nature of the clay encountered.

Permeability calculated from falling head tests identified a magnitude of 10^{-8}m/sec for clay deposits and 10^{-4}m/sec within mudstone deposits.

Soil sample results were compared to generic values to assess the risk to human health (residential), potable water, and building material (concrete). No elevated contaminants were identified.

To date one gas monitoring visits have been undertaken. Maximum values were recorded as 1.7%v/v for carbon dioxide, 0.1%v/v for methane and 0.3l/hr for flow. A worst case gas screening value was calculated as 0.0051l/hr which corresponds to Characteristic Situation 1 / Green. Further gas monitoring is to be carried out to confirm the risk from ground gas.

Until the remaining gas monitoring is undertaken, is it assumed that pollutant linkages 3 and 5 may be present. No further pollutant linkages are present.

Once the additional gas monitoring is undertaken, remedial recommendations will be confirmed. If pollutant linkages 3 and 5 are considered to be complete, gas protection measures may be required. If the pollutant linkages are considered to be incomplete no remediation will be required.

If remediation is required, validation work and a site completion report will need to be completed and approved by the local authority.

7.2 Additional Considerations

7.2.1 Re-use / Importation of soils in soft landscaping

The soils on site are considered to be suitable for use within the garden / landscaping areas. This is subject to the soils being a suitable growing medium and potentially subject to further validation testing in line with local authority requirements.

If soils are to be imported for use within soft landscaping, validation testing will also be required to confirm suitability.

7.2.2 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.

APPENDIX A

PROFILE LOGS

LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	**Site** Glebe Court, Tankersley	**Number** **WS101**	
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd	**Job Number** CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.20	D1				(0.40)	MADE GROUND: Firm brown gravelly silt. Gravel is fine to medium subangular to angular of natural stone and occasional brick and ash.			
					0.40				
0.80-0.90	D2					Stiff orangey grey CLAY. Gravel is fine to medium, subangular to angular of mudstone and sandstone.			
1.00-1.45	SPT N=26		6,7/6,5,6,9		(1.30)				
1.70-2.00	SPT 80/150		8,14/30,50 Refusal		1.70	Thinly laminated, weak, grey MUDSTONE.			
					(0.30)				
					2.00	Complete at 2.00m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS101

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	**Site** Glebe Court, Tankersley	**Number** **WS102**	
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd	**Job Number** CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.30	D1				(0.50)	MADE GROUND: Soft brown gravelly silt with occasional root fragments. Gravel is fine to medium subangular to angular of natural stone and occasional ash.			
0.50-0.60	D2				0.50	Stiff orange grey gravelly CLAY. Gravel is fine to medium, subangular to angular and of mudstone.			
1.00-1.45	SPT N=26		2,3/5,7,7,7		(1.20)				
1.20-1.40	B1								
1.70-2.08	SPT 92/225		9,14/19,23,50 Refusal		1.70	Thinly laminated weak grey MUDSTONE.			
					(0.38)				
					2.08	Complete at 2.08m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS102

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	**Site** Glebe Court, Tankersley	**Number** **WS103**	
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd	**Job Number** CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.30	D1				(0.50)	MADE GROUND: Firm brown slightly gravelly silt with rare brick cobble.			
0.50-0.60	D2				0.50	Stiff orange grey gravelly CLAY. Gravel is subangular to angular, fine to medium and of mudstone.			
1.00-1.45	SPT N=18		3,4/4,4,5,5						
1.20-1.40	B1				(1.50)				
2.00-2.45	SPT N=66		17,25/25,10,14,17		2.00	Thinly laminated weak grey MUDSTONE.			
					(0.45)				
					2.45	Complete at 2.45m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS103

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	Site Glebe Court, Tankersley	Number **WS104**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Lancaster Maloney Ltd	CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.20	D1				(0.50)	MADE GROUND: Firm brown grey gravelly silt with rare brick cobble. Gravel is fine to medium, subangular to angular of natural stone and occasional ash.			
0.40-0.50	D2				0.50	Firm orange grey mottled CLAY with occasional organic inclusions.			
1.00-1.45	SPT N=12		3,3/3,3,3,3		(1.35)	From 1.0m with gravel of mudstone, fine to medium and sub-angular to angular.			
1.70-1.93	SPT 50/75		7,6/50 Refusal		1.85 (0.08) 1.93	Thinly laminated weak grey MUDSTONE. Complete at 1.93m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS104

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com				Site Glebe Court, Tankersley	Number WS105
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**		**Client** Lancaster Maloney Ltd	**Job Number** CL1902
	Location	**Dates** 08/02/2012		**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.30	D1				(0.50)	MADE GROUND: Firm brown gravelly silt. Gravel of natural stone and occasional brick and ash.			
					0.50				
0.90-1.20	D2					Very stiff very gravelly orange CLAY. Gravel is fine to medium subangular to angular and of mudstone.			
1.00-1.45	SPT N=31		2,4/6,7,9,9		(1.00)				
					1.50				
2.00-2.45	SPT N=60		8,9/9,14,15,22		(1.05)	Thinly laminated grey black weak weathered MUDSTONE.			
					2.55				
						Complete at 2.55m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS105

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	Site Glebe Court, Tankersley	Number WS106

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Lancaster Maloney Ltd	CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20-0.40	D1				(0.40) 0.40	MADE GROUND: Brown slightly gravelly silt with occasional rootlets. Gravel is fine to medium, subangular to angular of natural stone and occasional ash.			
1.00-1.45	SPT N=15		2,2/2,3,3,7		(1.20)	Firm orange brown sandy mottled slightly gravelly CLAY. Gravel is fine to medium subangular to angular and of mudstone.			
1.50-1.80	SPT 67/150		8,14/17,50 Refusal		1.60 (0.20) 1.80	Weak thinly laminated grey MUDSTONE.			
						Complete at 1.80m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS106

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	**Site** Glebe Court, Tankersley	**Number** **WS107**	
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd	**Job Number** CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.20	D1				(0.60)	MADE GROUND: Brown gravelly silt with occasional clay pockets and rootlets. Gravel is fine to medium, subangular to angular of natural stone and occasional brick.			
0.40-0.60	D2				0.60				
					(0.20)	Soft mottled orange grey slightly gravelly CLAY. Gravel is fine to medium, subangular to angular.			
					0.80				
1.00-1.45	SPT N=13		4,4/4,3,3,3		(1.20)	Stiff orange grey mottled slightly gravelly CLAY with occasional sand pockets and occasional organic inclusions. Gravel is fine to medium, subangular to angular.			
2.00-2.15	SPT		11,50/ Refusal		2.00				
					(0.15)	Weak orange grey thinly laminated mudstone.			
					2.15	Complete at 2.15m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS107

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LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com	**Site** Glebe Court, Tankersley	**Number** **WS108**	
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)**	**Client** Lancaster Maloney Ltd	**Job Number** CL1902
	Location	**Dates** 08/02/2012	**Engineer** R Bonney	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20-0.30	D1				(0.80)	MADE GROUND: Firm brown orange gravelly clayey silt. Gravel is fine to medium subangular to angular of natural stone and occasional brick and ash.			
0.50-0.60	D2				0.80 (0.10) 0.90	Firm orange grey mottled sandy CLAY with occasional organic inclusions.			
0.90-1.00	B1								
1.00-1.45	SPT N=13		1,2/3,3,3,4		(0.90)	Stiff slightly gravelly orange grey CLAY. Gravel is fine to medium subangular to angular and of mudstone.			
1.50-1.60	B2								
1.80-1.88	SPT 50*/75		50/ Refusal		1.80 (0.08) 1.88	Thinly laminated sandstone. Complete at 1.88m			

Remarks

Scale (approx)	Logged By
1:20	RB

Figure No.
CL1902.WS108

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APPENDIX B

SOIL LABORATORY ANALYSIS RESULTS

Chemtest
The right chemistry to deliver results

Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070

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

FAO Catherine Baranek
16 February 2012

Dear Catherine Baranek

Test Report Number **200451**

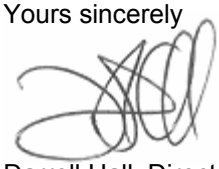
Your Project Reference **CL1800 - Glebe Court, Tankersley**

Please find enclosed the results of analysis for the samples received 10 February 2012.

All soil samples will be retained for a period of one month and all water samples will be retained for 7 days following the date of the test report. Should you require an extended retention period then please detail your requirements in an email to customerservices@chemtest.co.uk. Please be aware that charges may be applicable for extended sample storage.

If you require any further assistance, please do not hesitate to contact the Customer Services team.

Yours sincerely



Darrell Hall, Director

UKAS TESTING
2183

ISO 14001 sira
UKAS ENVIRONMENTAL MANAGEMENT

Notes to accompany report:

- *The sign < means 'less than'*
- *Tests marked 'U' hold UKAS accreditation*
- *Tests marked 'M' hold MCertS (and UKAS) accreditation*
- *Tests marked 'N' do not currently hold UKAS accreditation*
- *Tests marked 'S' were subcontracted to an approved laboratory*
- *n/e means 'not evaluated'*
- *i/s means 'insufficient sample'*
- *u/s means 'unsuitable sample'*
- *Comments or interpretations are beyond the scope of UKAS accreditation*
- *The results relate only to the items tested*
- *All results are expressed on a dry weight basis*
- *The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, phenols*
- *For all other tests the samples were dried at < 37°C prior to analysis*
- *Uncertainties of measurement for the determinands tested are available upon request*
- *None of the test results included in this report have been recovery corrected*

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

FAO Catherine Baranek

LABORATORY TEST REPORT

Results of analysis of 12 samples received 10 February 2012

CL1800 - Glebe Court, Tankersley

Chemtest
The right chemistry to deliver results

Report Date 16 February 2012

Login Batch No					200451							
Chemtest LIMS ID					AG98583	AG98584	AG98585	AG98586	AG98587	AG98588	AG98589	AG98590
Sample ID					WS101	WS102	WS102	WS103	WS104	WS104	WS105	WS106
Sample No					C1	C1	C2	C1	C1	C2	C1	C1
Sampling Date					08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012
Depth					0.1m - 0.2m	0.1m - 0.3m	0.5m - 0.6m	0.1m - 0.3m	0.1m - 0.2m	0.4m - 0.5m	0.1m - 0.3m	0.2m - 0.4m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*								
2625	Organic matter		%	M	8.1	5.2	0.62	5.7	1.9	1.3	5.2	4.8
2120	Sulfate (2:1 water soluble) as SO4	14808798	g l-1	M	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
2490	Chromium (hexavalent)	18540299	mg kg-1	N	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg-1	M	16	17	8.4	15	9.2	8.1	13	6.8
	Cadmium	7440439	mg kg-1	M	0.24	0.21	<0.10	0.24	<0.10	<0.10	0.25	0.13
	Chromium	7440473	mg kg-1	M	21	22	25	21	50	17	19	13
	Copper	7440508	mg kg-1	M	39	36	26	35	31	23	28	25
	Mercury	7439976	mg kg-1	M	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	0.14	<0.10
	Nickel	7440020	mg kg-1	M	20	24	21	19	39	22	16	12
	Lead	7439921	mg kg-1	M	47	39	17	45	19	13	51	30
	Selenium	7782492	mg kg-1	M	0.51	0.95	0.69	0.47	<0.20	0.48	<0.20	<0.20
	Vanadium	7440622	mg kg-1	M	18	25	16	19	15	16	16	<5.0
	Zinc	7440666	mg kg-1	M	88	92	66	82	67	48	88	59
2700	Naphthalene	91203	mg kg-1	M	< 0.1	< 0.1	< 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	< 0.1	< 0.1
	Acenaphthene	83329	mg kg-1	M	< 0.1	< 0.1	< 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	< 0.1	< 0.1
	Phenanthrene	85018	mg kg-1	M	0.7	0.41	< 0.1	0.59	< 0.1	< 0.1	0.56	0.78
	Anthracene	120127	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Fluoranthene	206440	mg kg-1	M	0.8	0.63	< 0.1	0.58	< 0.1	< 0.1	0.69	0.7
	Pyrene	129000	mg kg-1	M	0.92	0.41	< 0.1	0.38	< 0.1	< 0.1	0.59	0.77
	Benzo[a]anthracene	56553	mg kg-1	M	0.39	0.25	< 0.1	0.22	< 0.1	< 0.1	0.35	0.2
	Chrysene	218019	mg kg-1	M	0.36	0.13	< 0.1	0.16	< 0.1	< 0.1	0.28	0.11
	Benzo[b]fluoranthene	205992	mg kg-1	M	0.39	0.19	< 0.1	< 0.1	< 0.1	< 0.1	0.14	0.31
	Benzo[k]fluoranthene	207089	mg kg-1	M	0.17	0.19	< 0.1	< 0.1	< 0.1	< 0.1	0.11	0.16
	Benzo[a]pyrene	50328	mg kg-1	M	0.25	0.11	< 0.1	0.11	< 0.1	< 0.1	0.23	0.13
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

All tests undertaken between 10/02/2012 and 16/02/2012

* 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 Catherine Baranek

LABORATORY TEST REPORT

Results of analysis of 12 samples received 10 February 2012

CL1800 - Glebe Court, Tankersley

Report Date 16 February 2012

Login Batch No					**200451**			
Chemtest LIMS ID					AG98591	AG98592	AG98593	AG98594
Sample ID					WS107	WS107	WS108	WS107
Sample No					C1	C2	C	C
Sampling Date					08/02/2012	08/02/2012	08/02/2012	08/02/2012
Depth					0.1m - 0.2m	0.4m - 0.6m	0.2m - 0.3m	0.6m - 0.7m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓					
2625	Organic matter		%	M	4.8	5.0	5.0	0.78
2120	Sulfate (2:1 water soluble) as SO4	14808798	g l-1	M	<0.01	<0.01	<0.01	0.11
2490	Chromium (hexavalent)	18540299	mg kg-1	N	<0.5	<0.5	<0.5	<0.5
2450	Arsenic	7440382	mg kg-1	M	10	16	9.5	9.3
	Cadmium	7440439	mg kg-1	M	0.16	0.27	0.17	<0.10
	Chromium	7440473	mg kg-1	M	24	24	48	26
	Copper	7440508	mg kg-1	M	37	36	26	32
	Mercury	7439976	mg kg-1	M	<0.10	0.12	<0.10	<0.10
	Nickel	7440020	mg kg-1	M	21	19	27	26
	Lead	7439921	mg kg-1	M	34	51	83	23
	Selenium	7782492	mg kg-1	M	<0.20	0.81	0.29	<0.20
	Vanadium	7440622	mg kg-1	M	7.6	16	7.7	5.6
	Zinc	7440666	mg kg-1	M	80	100	70	64
2700	Naphthalene	91203	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthylene	208968	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthene	83329	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1
	Fluorene	86737	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1
	Phenanthrene	85018	mg kg-1	M	0.6	0.8	0.51	< 0.1
	Anthracene	120127	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1
	Fluoranthene	206440	mg kg-1	M	0.76	0.86	0.6	< 0.1
	Pyrene	129000	mg kg-1	M	0.55	0.72	0.42	< 0.1
	Benzo[a]anthracene	56553	mg kg-1	M	0.17	0.42	0.23	< 0.1
	Chrysene	218019	mg kg-1	M	0.1	0.4	0.19	< 0.1
	Benzo[b]fluoranthene	205992	mg kg-1	M	0.19	0.18	0.24	< 0.1
	Benzo[k]fluoranthene	207089	mg kg-1	M	0.13	0.12	< 0.1	< 0.1
	Benzo[a]pyrene	50328	mg kg-1	M	0.14	0.33	0.17	< 0.1
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1

* Accreditation status

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Leyden Kirby
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FAO Catherine Baranek

LABORATORY TEST REPORT

Results of analysis of 12 samples received 10 February 2012

CL1800 - Glebe Court, Tankersley

Report Date 16 February 2012

					200451							
					AG98583	AG98584	AG98585	AG98586	AG98587	AG98588	AG98589	AG98590
					WS101	WS102	WS102	WS103	WS104	WS104	WS105	WS106
					C1	C1	C2	C1	C1	C2	C1	C1
					08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012	08/02/2012
					0.1m - 0.2m	0.1m - 0.3m	0.5m - 0.6m	0.1m - 0.3m	0.1m - 0.2m	0.4m - 0.5m	0.1m - 0.3m	0.2m - 0.4m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	< 0.1	< 0.1	< 0.1	0.17	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	0.21	< 0.1	< 0.1	0.18	< 0.1	< 0.1	< 0.1	< 0.1
	Total (of 16) PAHs		mg kg-¹	M	4.2	2.3	< 2	2.4	< 2	< 2	3	3.2
2010	pH			M	7.4	7.5	7.4	6.1	7.5	7.6	6.8	7.0
2030	Moisture		%	n/a	17.8	15.1	12.8	17.5	15.9	15	16.4	18.3
	Stones content (>50mm)		%	n/a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2040	Soil colour			n/a	brown	brown	brown	brown	brown	brown	brown	brown
	Soil texture			n/a	clay	clay	clay	clay	clay	clay	clay	clay
	Other material			n/a	stones	stones	stones	stones	stones	stones	stones	stones

All tests undertaken between 10/02/2012 and 16/02/2012

* Accreditation status

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

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BL9 6BU

FAO Catherine Baranek

LABORATORY TEST REPORT

Results of analysis of 12 samples received 10 February 2012

CL1800 - Glebe Court, Tankersley

Report Date 16 February 2012

					200451			
					AG98591	AG98592	AG98593	AG98594
					WS107	WS107	WS108	WS107
					C1	C2	C	C
					08/02/2012	08/02/2012	08/02/2012	08/02/2012
					0.1m - 0.2m	0.4m - 0.6m	0.2m - 0.3m	0.6m - 0.7m
					SOIL	*SOIL*	*SOIL*	*SOIL*
2700	Indeno[1,2,3-cd]pyrene	193395	mg kg-¹	M	< 0.1	0.19	< 0.1	< 0.1
	Benzo[g,h,i]perylene	191242	mg kg-¹	M	< 0.1	0.11	< 0.1	< 0.1
	Total (of 16) PAHs		mg kg-¹	M	2.6	4.1	2.4	< 2
2010	pH			M	7.4	7.6	7.5	7.7
2030	Moisture		%	n/a	17.8	16.2	17.7	15.8
	Stones content (>50mm)		%	n/a	<0.02	<0.02	<0.02	<0.02
2040	Soil colour			n/a	brown	brown	brown	brown
	Soil texture			n/a	clay	clay	clay	clay
	Other material			n/a	stones	stones	stones	stones

APPENDIX C

PLASTICITY TESTS

MURRAY RIX
CONSULTANCY, SITE INVESTIGATION
CONSTRUCTION MATERIALS TESTING

TEST REPORT

Client LK Consult Ltd

Address Kay Street
Bury
BL9 6BU

Contract Glebe Court
Tankersley

Job Number MRN 1704/61
Date of Issue 20 February 2012
Page 1 **of** 4

Approved Signatory

S J Hutchings, A W Hutchings, A Richardson

Notes

1 All remaining samples and remnants from this contract will be disposed 28 days from the date of this report unless you notify us to the contrary.

2 Result certificates, in this report, not bearing a UKAS mark, are not included in our UKAS accreditation schedule.

3 Opinions and interpretations expressed herein are outside the scope of our UKAS accreditation

4 Certified that the samples have been examined and tested in accordance with the terms of the contract/order and unless otherwise stated conform to the standards/specifications quoted. This does not, however, guarantee the balance of the materials from which the tested samples have been taken to be of equal quality.

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

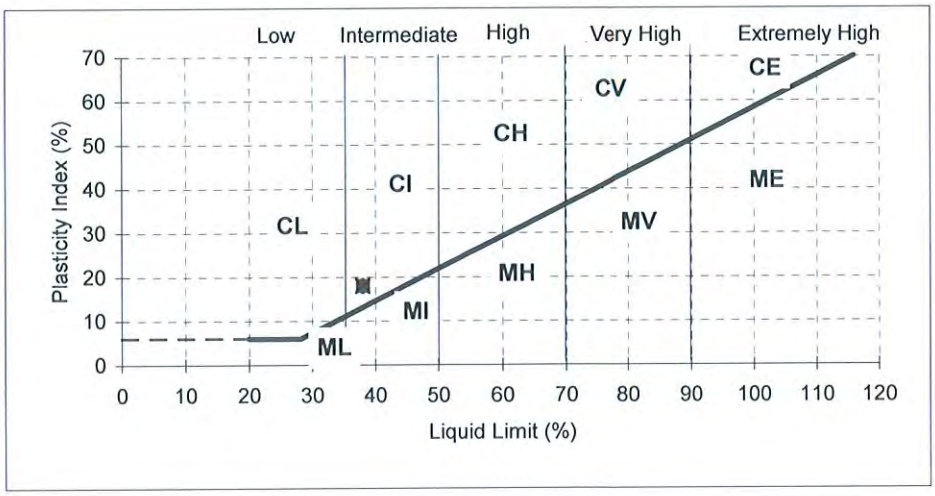
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Glebe Court, Tankersley
JOB NUMBER	MRN 1704/61

SAMPLE LABEL	WS-101-0.8-0.9m	DATE SAMPLED	N/A
SAMPLE No.	52620	DATE RECEIVED	10-Feb-12
DATE TESTED	13-Feb-12	SAMPLED BY	Client

MATERIAL	Dry Light brown Clay with much gravel
ADVISED SOURCE	Site

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
10	38	20	18	58



REMARKS
Sample was tested after wet sieving

SIGNED

NAME A Richardson DATE 20-Feb-12
(Deputy Laboratory Manager)

MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
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UKAS TESTING 1580

TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

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

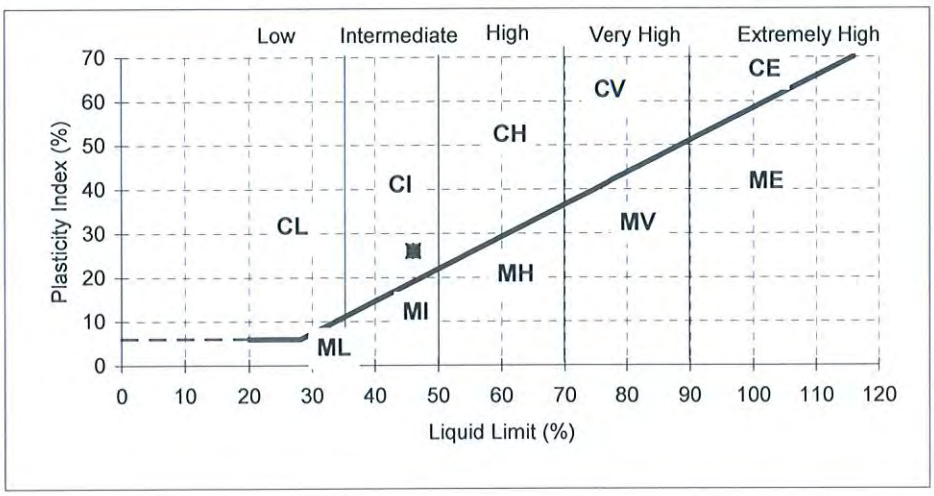
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Glebe Court, Tankersley
JOB NUMBER	MRN 1704/61

SAMPLE LABEL	WS-105-0.9-1.2m	DATE SAMPLED	N/A
SAMPLE No.	52621	DATE RECEIVED	10-Feb-12
DATE TESTED	13-Feb-12	SAMPLED BY	Client

MATERIAL	Brown Clay with some gravel
ADVISED SOURCE	Site

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
23	46	20	26	87



REMARKS
Sample was tested after wet sieving

SIGNED

NAME A Richardson DATE 20-Feb-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
1680

TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

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

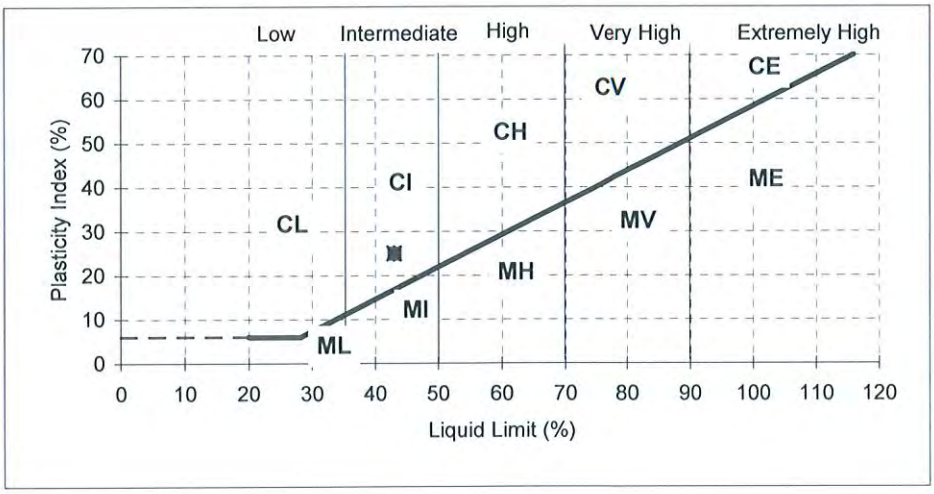
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Consult Ltd
SITE	Glebe Court, Tankersley
JOB NUMBER	MRN 1704/61

SAMPLE LABEL	WS-108-0.9-1.0m	DATE SAMPLED	N/A
SAMPLE No.	52622	DATE RECEIVED	10-Feb-12
DATE TESTED	13-Feb-12	SAMPLED BY	Client

MATERIAL	Brown Clay with trace gravel
ADVISED SOURCE	Site

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
20	43	18	25	97



REMARKS
Sample was tested in natural condition

SIGNED

NAME A Richardson DATE 20-Feb-12
(Deputy Laboratory Manager)

APPENDIX D

FALLING HEAD TESTS

VARIABLE HEAD PERMEABILITY TEST

SITE	**Glebe Court, Tankersley**	
REF	**CL1902**	
BH REF	**WS103**	**Test 1**

TYPE OF TEST	FALLING HEAD
STRATA	Clay/Mudstone
DATE OF TEST	22nd February 2012
STAFF	CB

CONDITIONS OF TEST ZONE (BS5930:1999 Figure 6)

Select 'Case' from Figure 6: D

Diameter of Borehole (D)	100	mm
Length of Response Zone - Dip Base (L)	1500	mm
Intake Factor (F)	2.7701	

Initial GW Depth	1.82	mbgl
Base of Installation	2.26	mbgl
Standpipe Diameter	50	mm
Standpipe X sec Area (A)	1.97E-03	m2
Depth to response zone	0.76	m
BASIC TIME LAG (T) to get H/H_0 of 0.37 (Plot)	28800	seconds

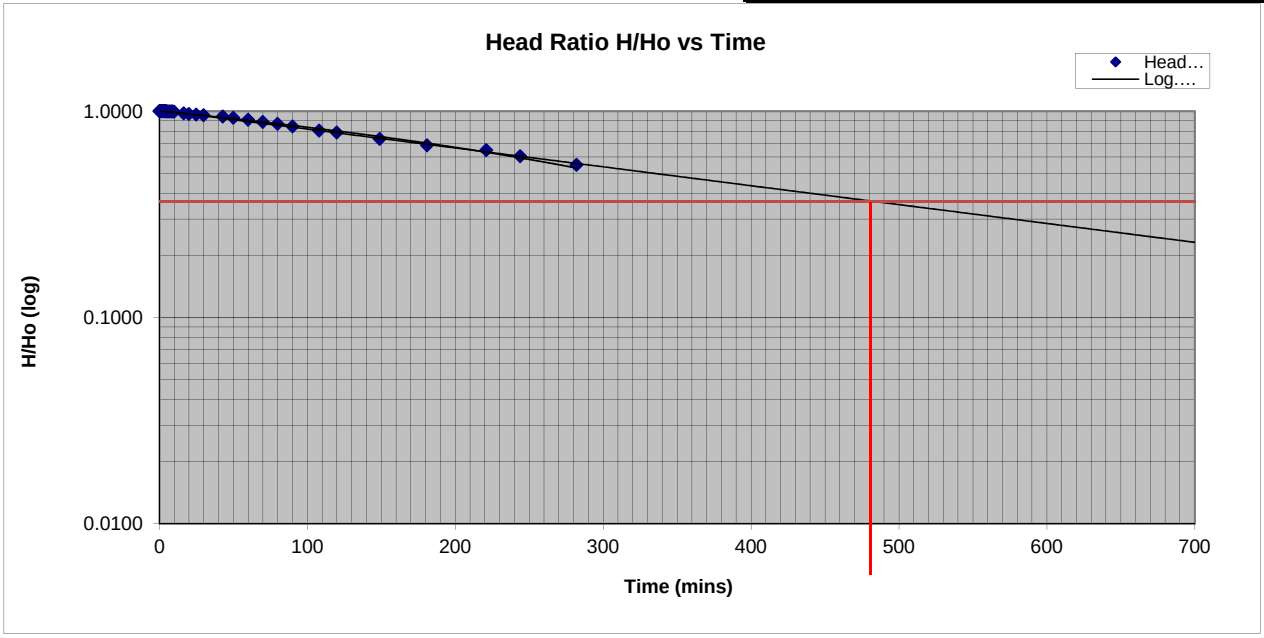
CALCULATED VALUES

Permeability k = A/F x T

k = 2.5E-08 m/sec

FIELD MEASUREMENTS

Time	Depth	Head H	Head Ratio
mins	mbgl	m	H/Ho
0	0.18	1.640	1.0000
0.50	0.18	1.640	1.0000
1	0.18	1.640	1.0000
1.5	0.18	1.640	1.0000
2	0.18	1.640	1.0000
2.5	0.18	1.640	1.0000
3	0.18	1.640	1.0000
3.5	0.18	1.640	1.0000
4	0.18	1.640	1.0000
4.5	0.18	1.640	1.0000
5	0.185	1.635	0.9970
6	0.185	1.635	0.9970
7	0.185	1.635	1.00
8	0.185	1.635	1.00
9	0.185	1.635	1.00
10	0.19	1.63	0.99
16.5	0.22	1.6	0.98
20	0.23	1.59	0.97
25	0.245	1.575	0.96
30	0.255	1.565	0.95
43	0.28	1.54	0.94
50	0.3	1.52	0.93
60	0.33	1.49	0.91
70	0.37	1.45	0.88
80	0.4	1.42	0.87
90	0.44	1.38	0.84
108	0.5	1.32	0.80
120	0.53	1.29	0.79
149	0.62	1.2	0.73
181	0.7	1.12	0.68
221	0.76	1.06	0.65
244	0.83	0.99	0.60
282	0.92	0.9	0.55



VARIABLE HEAD PERMEABILITY TEST

SITE	**Glebe Court, Tankersley**	
REF	**CL1902**	
BH REF	**WS104**	**Test 1**

TYPE OF TEST	FALLING HEAD
STRATA	Clay
DATE OF TEST	22nd February 2012
STAFF	CB

CONDITIONS OF TEST ZONE (BS5930:1999 Figure 6)

Select 'Case' from Figure 6: D

Diameter of Borehole (D)	100	mm
Length of Response Zone - Dip Base (L)	800	mm
Intake Factor (F)	1.8104	

Initial GW Depth	1.7	mbgl
Base of Installation	1.85	mbgl
Standpipe Diameter	50	mm
Standpipe X sec Area (A)	1.97E-03	m2
Depth to response zone	1.05	m
BASIC TIME LAG (T) to get H/H_0 of 0.37 (Plot)	20400	seconds

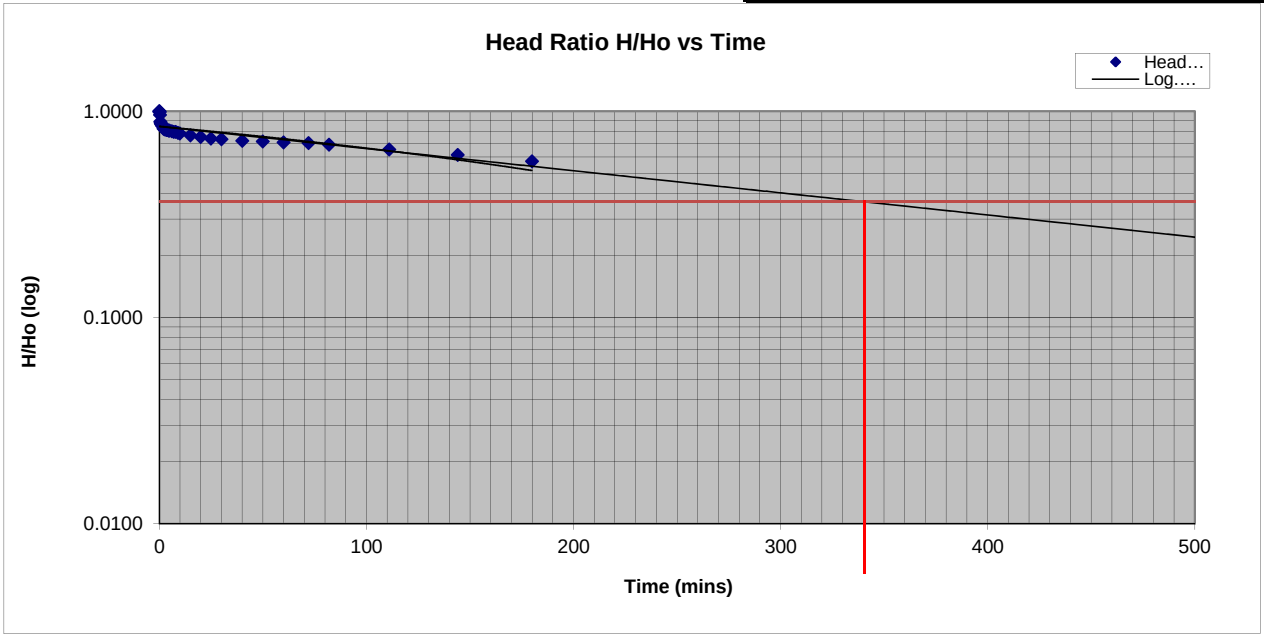
CALCULATED VALUES

Permeability k = A/F x T

k = 5.3E-08 m/sec

FIELD MEASUREMENTS

Time	Depth	Head H	Head Ratio
mins	mbgl	m	H/Ho
0	0.07	1.630	1.0000
0.08	0.08	1.620	0.9939
0.17	0.09	1.610	0.9877
0.33	0.14	1.560	0.9571
0.50	0.25	1.450	0.8896
0.67	0.27	1.430	0.8773
0.83	0.28	1.420	0.8712
1	0.3	1.400	0.8589
1.5	0.32	1.380	0.8466
2	0.36	1.340	0.8221
2.5	0.37	1.330	0.8160
3	0.37	1.330	0.8160
3.5	0.38	1.320	0.81
4	0.38	1.320	0.81
4.5	0.39	1.310	0.80
5	0.39	1.31	0.80
6	0.4	1.3	0.80
7	0.41	1.29	0.79
8	0.41	1.29	0.79
9	0.42	1.28	0.79
10	0.43	1.27	0.78
15	0.46	1.24	0.76
20	0.48	1.22	0.75
25	0.5	1.2	0.74
30	0.51	1.19	0.73
40	0.53	1.17	0.72
50	0.54	1.16	0.71
60	0.55	1.15	0.71
72	0.56	1.14	0.70
82	0.58	1.12	0.69
111	0.64	1.06	0.65
144	0.7	1	0.61
180	0.77	0.93	0.57



VARIABLE HEAD PERMEABILITY TEST

SITE	**Glebe Court, Tankersley**	
REF	**CL1902**	
BH REF	**WS105**	**Test 1**

TYPE OF TEST	FALLING HEAD
STRATA	Mudstone
DATE OF TEST	27th February 2012
STAFF	RB

CONDITIONS OF TEST ZONE (BS5930:1999 Figure 6)

Select 'Case' from Figure 6: D

Diameter of Borehole (D)	100	mm
Length of Response Zone - Dip Base (L)	500	mm
Intake Factor (F)	1.3586	

Initial GW Depth	2.21	mbgl
Base of Installation	2.5	mbgl
Standpipe Diameter	50	mm
Standpipe X sec Area (A)	1.97E-03	m2
Depth to response zone	2	m
BASIC TIME LAG (T) to get H/H_0 of 0.37 (Plot)	7	seconds

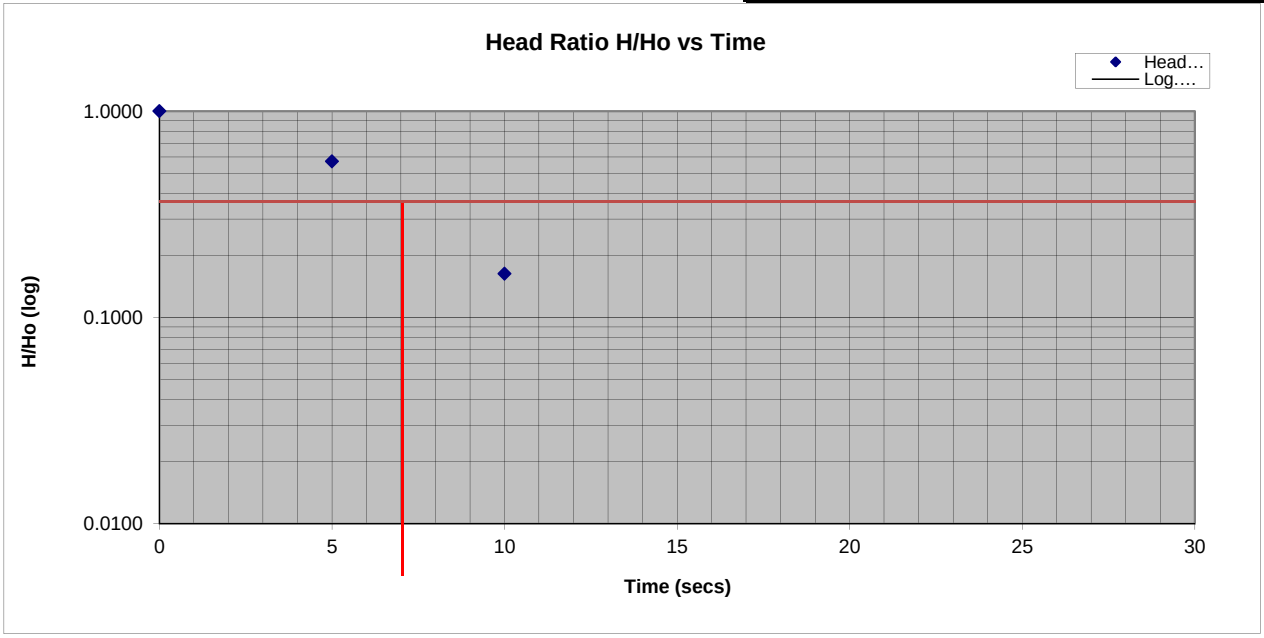
CALCULATED VALUES

Permeability k = A/F x T

k = 2.1E-04 m/sec

FIELD MEASUREMENTS

Time	Depth	Head H	Head Ratio
secs	mbgl	m	H/Ho
0	0	2.210	1.0000
5	0.95	1.260	0.5701
10	1.85	0.360	0.1629
20	2.21	0.000	0.0000



VARIABLE HEAD PERMEABILITY TEST

SITE	**Glebe Court, Tankersley**	
REF	**CL1902**	
BH REF	**WS105**	**Test 2**

TYPE OF TEST	FALLING HEAD
STRATA	Mudstone
DATE OF TEST	27th February 2012
STAFF	RB

CONDITIONS OF TEST ZONE (BS5930:1999 Figure 6)

Select 'Case' from Figure 6: D

Diameter of Borehole (D)	100	mm
Length of Response Zone - Dip Base (L)	500	mm
Intake Factor (F)	1.3586	

Initial GW Depth	2.21	mbgl
Base of Installation	2.5	mbgl
Standpipe Diameter	50	mm
Standpipe X sec Area (A)	1.97E-03	m2
Depth to response zone	2	m
BASIC TIME LAG (T) to get H/H_0 of 0.37 (Plot)	7.5	seconds

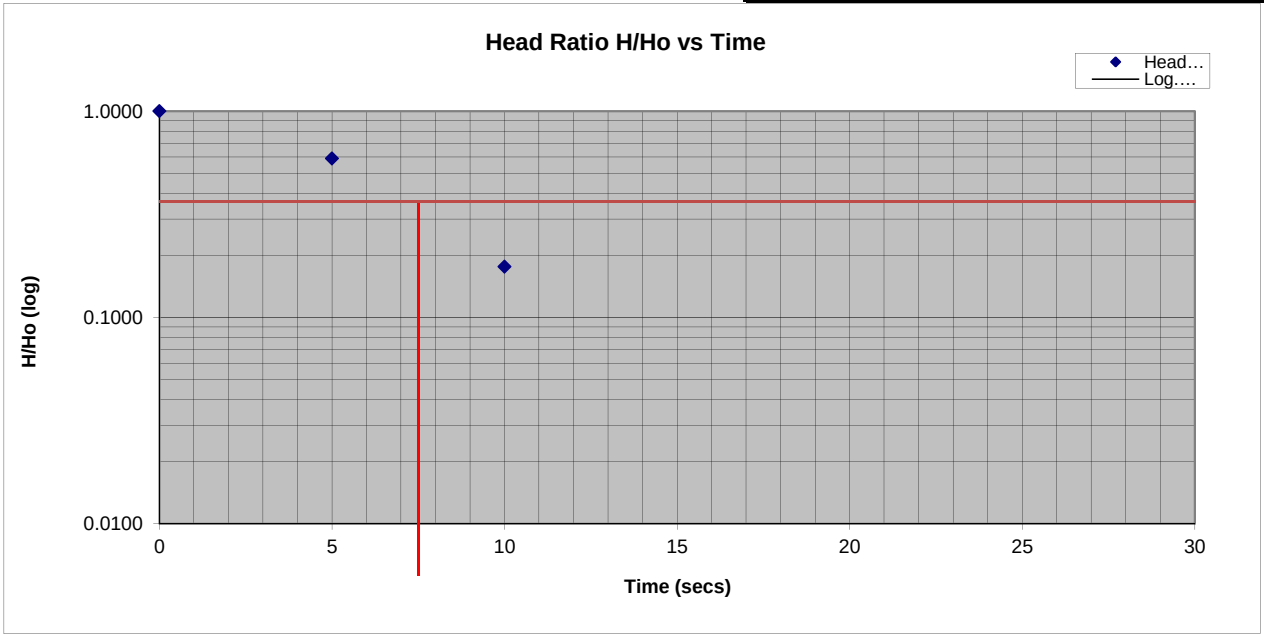
CALCULATED VALUES

Permeability k = A/F x T

k = 1.9E-04 m/sec

FIELD MEASUREMENTS

Time	Depth	Head H	Head Ratio
secs	mbgl	m	H/Ho
0	0	2.210	1.0000
5	0.91	1.300	0.5882
10	1.82	0.390	0.1765
20	2.21	0.000	0.0000



VARIABLE HEAD PERMEABILITY TEST

SITE	**Glebe Court, Tankersley**	
REF	**CL1902**	
BH REF	**WS106**	**Test 1**

TYPE OF TEST	FALLING HEAD
STRATA	Clay/Mudstone
DATE OF TEST	27th February 2012
STAFF	RB

CONDITIONS OF TEST ZONE (BS5930:1999 Figure 6)

Select 'Case' from Figure 6: D

Diameter of Borehole (D)	100	mm
Length of Response Zone - Dip Base (L)	1000	mm
Intake Factor (F)	2.0956	

Initial GW Depth	Dry	mbgl
Base of Installation	1.72	mbgl
Standpipe Diameter	50	mm
Standpipe X sec Area (A)	1.97E-03	m2
Depth to response zone	0.72	m
BASIC TIME LAG (T) to get H/H_0 of 0.37 (Plot)	7.75	seconds

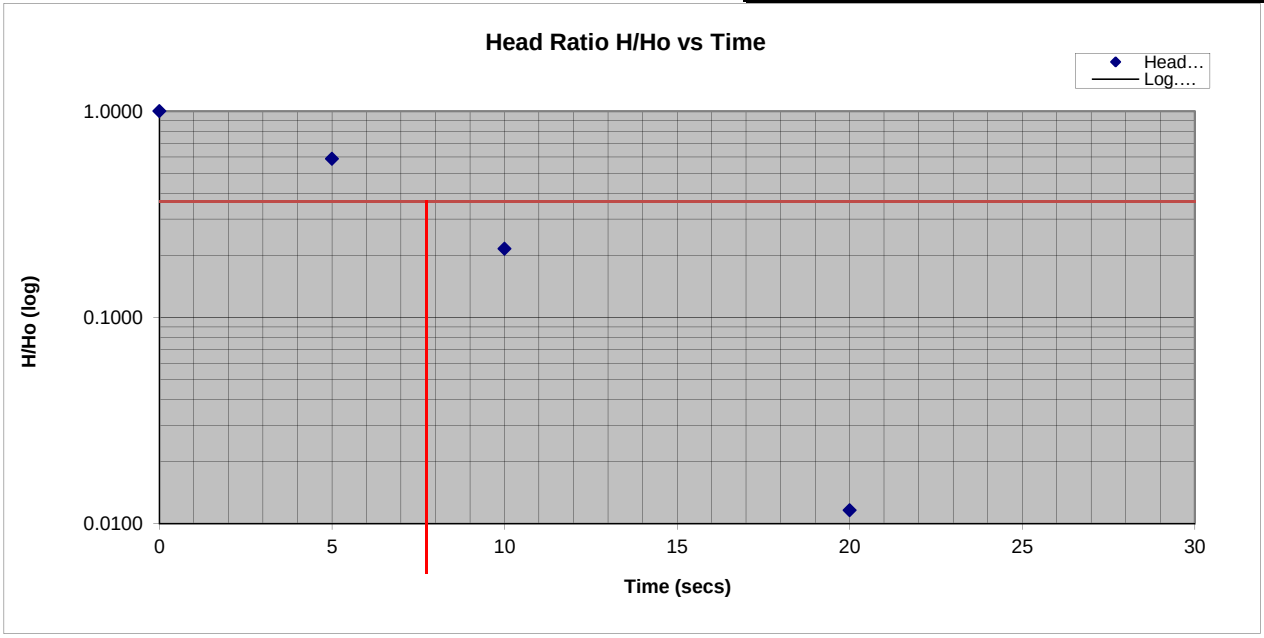
CALCULATED VALUES

Permeability k = A/F x T

k = 1.2E-04 m/sec

FIELD MEASUREMENTS

Time	Depth	Head H	Head Ratio
secs	mbgl	m	H/Ho
0	0	1.720	1.0000
5.00	0.71	1.010	0.5872
10.00	1.35	0.370	0.2151
20.00	1.7	0.020	0.0116
30.00	1.72	0.000	0.0000



VARIABLE HEAD PERMEABILITY TEST

SITE	**Glebe Court, Tankersley**	
REF	**CL1902**	
BH REF	**WS106**	**Test 2**

TYPE OF TEST	FALLING HEAD
STRATA	Clay/Mudstone
DATE OF TEST	27th February 2012
STAFF	RB

CONDITIONS OF TEST ZONE (BS5930:1999 Figure 6)

Select 'Case' from Figure 6: D

Diameter of Borehole (D)	100	mm
Length of Response Zone - Dip Base (L)	1000	mm
Intake Factor (F)	2.0956	

Initial GW Depth	1.72	mbgl
Base of Installation	1.72	mbgl
Standpipe Diameter	50	mm
Standpipe X sec Area (A)	1.97E-03	m2
Depth to response zone	0.7	m
BASIC TIME LAG (T) to get H/H_0 of 0.37 (Plot)	7.5	seconds

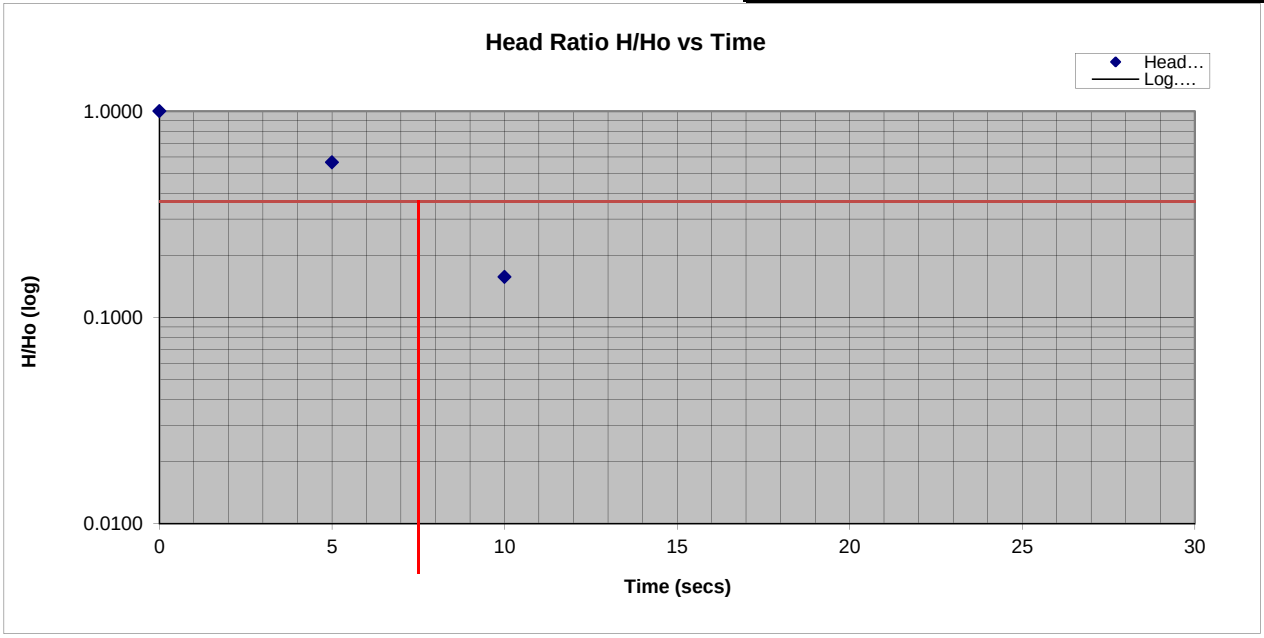
CALCULATED VALUES

Permeability k = A/F x T

k = 1.3E-04 m/sec

FIELD MEASUREMENTS

Time	Depth	Head H	Head Ratio
secs	mbgl	m	H/Ho
0	0	1.720	1.0000
5.00	0.75	0.970	0.5640
10.00	1.45	0.270	0.1570
20.00	1.72	0.000	0.0000



APPENDIX E

ATRISK SSV VALUES

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**

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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.

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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**

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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
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Date 31/03/2011

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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	

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Revision	3
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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	

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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**

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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.

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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**

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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.