

LAND ADJACENT TO HOLY TRINITY CE SCHOOL MANCHESTER

GEO-ENVIRONMENTAL INVESTIGATION, RISK ASSESSMENT AND REMEDIATION STRATEGY

Job Number: LKC 20 1205
Date: February 2020
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1 Introduction

1.1 Background

LK Consult Ltd (LKC) has been commissioned by Holy Trinity CE School to carry out a Geo-Environmental Investigation, Risk Assessment and Remediation Strategy on a parcel of land adjacent to the school grounds. The investigation was undertaken in support of a planning application (reference number 125530/FO/2019) to develop the site for an allotment/garden area, with the installation of a polytunnel and a 2.4m boundary fence.

This investigation has been undertaken to confirm the shallow ground conditions below the site and to allow a contamination assessment to be undertaken.

The investigation will aim to confirm the risks of the potential pollutant linkages identified in Section 2 and recommend further assessment / remediation, as required.

1.2 Site Details

A summary of the site details is presented in Table 1-1. Figures 1 and 2 indicate the site location and boundary. Figure 3 indicates the proposed development layout as obtained from the planning portal.

Location	End of Beverly Street, to the north of Holy Trinity CE School, off Moston Lane, Manchester, M9 4DU. National Grid Reference 386188N 402052E.
Area	395m ² .
Topography	86 metres above ordnance datum (AOD). Site is approximately level.
Land Use	<u>Site</u> Rough grassland across the whole site, knee high fencing around the perimeter and a large ornamental sandstone boulder in the centre. <u>Surrounding Area</u> North: Residential properties and an access blocked road. East: Residential properties and Beverly Street. South: Holy Trinity CE School. West: Dalbeattie Street and residential properties.
Proposed Development	Allotment/garden area, with the installation of a polytunnel and a 2.4m boundary fence.

Table 1-1. Summary of site details.

2 Summary of Existing Information

LKC have reviewed publicly available historical mapping held in the public domain and in our archives as well as public domain aerial photography. Information has also been gathered from public domain sites including the Environment Agency, Magic England, and the Coal Authority.

The information has been utilised to provide the site history, environmental setting and to produce a preliminary conceptual model for the site.

2.1 Site History

A summary of the site history is provided in Table 2-1.

Site Features	Location	Map Dates Present	Comments
Vacant Land	Whole site	1848-1895	
Residential Properties	Whole site	1910-1966	- Terraced housing. - No longer present by 1975 mapping.
Vacant Land adjoining Beverly Street	Whole site	1975-Present	
Surrounding Area Features	Distance / Location	Map Dates Present	Comments
Ponds	90m NW 136m E	1891 1838-1909	- No longer mapped by 1909 mapping. Potentially infilled. - No longer present by 1922 mapping. Potentially infilled.
Reliance works and two associated tanks	74m W	1950-1956	- No longer annotated by 1978 mapping.
School	Adj S	1978-Present	
Beverly Street	N boundary	1975-Present	- Present day access through to Beverley Street from Dalbeattie Street.

Table 2-1: Summary of significant historical features.

2.2 Environmental Setting

The environmental setting is summarised in Table 2-2.

Categories			Details
Geology	Artificial		- None recorded on site.
	Superficial		- Till, Devensian (diamicton).
	Bedrock		- Manchester Marls (mudstone) across the majority of the site - Chester Formation (sandstone) in the N of site.
	BGS logs		- 160m SSW BH Ref: SD80SE900: Cobblestone to 0.2m, mod compact sandy clay with ash cinder, and brick (fill). Soft-firm organic loam to 1.15m. Soft to firm dark brown yellow and grey mottled silty sandy clay to 3.25m. Firm-stiff silty clay with sand seams to 6.15m. Soft dark brown silt with bands of firm silty clay to 9.0m. Compact-very dense mid brown slightly silty sand with bands of fine to medium grain sand to 10m. Compact to very dense mid-brown slightly silty sand with band of fine sand to 12.25m.
Hydro-geology	Aquifer Designation	Superficial	- Secondary Aquifer – Undifferentiated.
		Bedrock	- Principal Aquifer.
	Source Protection Zone (SPZ)		- Site is not within an SPZ.
Hydrology	Nearest Surface Water		- Boggart Hole Brook 451m N.
	Water Quality Data		- No water quality data.
	Flooding		- No risk of flooding from rivers or sea.
Minerals / Mining	Coal Mining Development High Risk Area (DHRA)		- Not within DHRA.
	Cheshire Brine Compensation District		- Not within site area.
Ground Stability ¹ (on-site)	Landslide		- No hazard.
Landfill sites	Known/Registered		- 1 within 250m: 205m SW – ‘Land at Bankfield Street’. No further data available.
	Potential		- 2 ponds within 250m: 90m NW, 136m E, infilled by 1922 and 1909 mapping respectively.
Radon			- Probability of 1-3% of homes at or above Action Level. No further action required.
Designated Sites			- 200m N: Local Nature Reserves.
Fuel Station Entries			- None within 100m. Nearest 238m SW Asda Petrol, active.

Table 2-2: Summary of the environmental setting.

2.3 Site Reconnaissance

The site comprises a small area of rough grassland, in the centre is a sandstone block with a plaque on the side. There is also knee-high fencing on the border of the site. It is surrounded by roads and residential housing on the north, east and west, with the school to the south.

2.4 Contamination Sources / Pathways and Receptors

Potential contamination sources are detailed in Table 2-3.

Source	Contaminants
Onsite former buildings	- Asbestos Containing Material (ACM).
Onsite Made Ground (former building demolition, general made ground)	- Ash and clinker (e.g. from hearths and boilers, often historically used for site raising / levelling): Heavy metals, sulphates and PAHs. - Other unknown inorganic / organic contaminants (dependant on fill material source). - If significant depth of organic / putrescible material: Hazardous gas (principally carbon dioxide and methane).
Surrounding Industries (Reliance works, tanks)	- Metals, inorganic compounds and organic compounds. - Not expected to be a significant source of contamination due to distance from site.

Table 2-3: Potential contamination sources

Potential receptors are detailed in Table 2-4.

Receptors	
Human Health	- Future site users (including residents, visitors and site workers). - Offsite land users.
Controlled Waters	- Principal Aquifer (bedrock) and Secondary Undifferentiated Aquifer (superficial). - Boggart Hole Brook 451m N considered to be a viable receptor due to its distance from the site.
Buildings and structures.	
Potable water pipes.	
Flora within future gardens/landscaping.	

Table 2-4: Potential receptors

Potential pathways are detailed in Table 2-5.

Pathways		
Soil	Human Health ¹ (allotment gardens and open space to be used by the school).	- Ingestion of soil. - Ingestion of soil-derived indoor dust. - Dermal contact with soil. - Dermal contact with soil-derived indoor dust. - Inhalation of soil-derived outdoor dust. - Inhalation of soil-derived indoor dust. - Inhalation of vapours outside. - Inhalation of vapours inside.
		Where cultivation is to occur: - Ingestion of contaminated vegetables. - Ingestion of soil attached to vegetables.
		- Windblown dust / fibres to adjacent receptors.
		- Root uptake.
Water	- Site is relatively flat and grassed; therefore, surface run-off will be limited.	
	- Infiltration into the ground, through potentially contaminated material (contamination possibly going into solution).	
	- Site is predominantly flat and grassed; therefore, infiltration is likely to occur.	
	- Migration through potentially permeable strata and preferential pathways.	
	- Superficial (Till) likely to be low permeability. - Bedrock (mudstone, sandstone) likely to variable permeable.	

Table 2-5: Potential pathways.

¹ EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.

Pathways	
Gas	- Migration through potentially permeable strata and preferential pathways. - Superficial (Till) likely to be low permeability. - Bedrock (mudstone, sandstone) likely to variable permeable. - Preferential pathways: services. - Migration into buildings (e.g. via services) and accumulation of gases in confined

Table 2-5 (continued): Potential pathways.

2.5 LKC Preliminary Contamination Conceptual Model

The preliminary contamination conceptual model in the following section has been done in line with LKC current risk assessment methodology (detailed below).

The preliminary contamination conceptual model using contaminant-pathway-receptor linkages based on guidance in CLR11² has been summarised in Table 2-6.

The aim of the conceptual model is to provide a preliminary assessment of the likelihood of a pollutant linkage for each potential combination of contaminant, pathway and receptor. A conceptual model can be used to make an informed decision on the contamination risks associated with the site and determine what site investigation work is required.

The preliminary contamination conceptual model has identified five generic potential pollutant linkages. Each linkage is described along with an assessment of the risk based upon guidance on probabilities and consequences outlined in CIRIA C552³.

In order to assess the potential risk for each pollutant linkage, an assessment of the magnitude of the potential consequence (severity) of the risk occurring and the magnitude of the probability (likelihood) of the risk occurring has been considered and classified. This is based on the guidance provided in CIRIA C552 and further details including a risk matrix is provided in Appendix A.

Where LKC identified a low to very low risk, limited intrusive investigation work, a watching brief (during construction work) or no investigation work will be recommended. This will be dependent on the nature of the site and the proposed development.

Where the risk falls into the moderate/low risk, LKC will undertake an assessment to establish what category the pollutant linkage will fall into (i.e. moderate or low risk will be chosen).

Where LKC identifies a moderate or higher risk, intrusive work or precautionary remedial measures will be recommended.

The conceptual model is based on the future use of the site (post development), in line with proposed development scheme.

It should be noted that there may be risk from short term exposure from contaminated soil to site workers during development work. The Preliminary Contamination Conceptual Model deals with long term exposure to key receptors associated with the future use of the site. Acute risks can be easily mitigated by good environmental management of the site during site works. Standard health and safety precautions (as

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

³ CIRIA (2001). "Contaminated land risk assessment: A guide to good practice". C552.

per HSE guidance⁴) should be adopted by all workers involved with site enabling and construction works. Therefore, this receptor is not considered in the contamination conceptual model.

2.6 Recommendations

Based upon the Preliminary Contamination Conceptual Model a site investigation was recommended to assess the potential pollutant linkages further.

⁴ HSE (1991). "Protection of Workers and the General Public During Development of Contaminated Land" London HMSO.

Pollutant Linkage	Pathway	Receptor	Contaminant (source)	Probability	Consequence	Risk	Assessment and Recommendations
PL1	- Dermal contact. - Inhalation of soil, fibres and dust. - Ingestion of soils, dust, vegetables, soil attached to vegetables. - Windblown dust.	- Future site users. - Offsite receptors.	- ACM (former buildings, potentially in made ground). - Heavy metals - PAHs (made ground, former buildings).	Likely	Medium	Moderate	- Likely given site history, unknown ground conditions and potential pathway to receptors in gardens / allotments. - Recommendation: Low level intrusive investigation required to include soil sampling.
PL2	- Inhalation of vapours. - Migration through permeable strata and preferential pathways.	- Future site users. - Offsite receptors.	- Volatile Contaminants such as hydrocarbons (made ground).	Unlikely	Medium	Low	- Unlikely as no significant source of contamination anticipated. No obvious contamination from hydrocarbons identified during the site walkover. - Recommendation: No testing required unless evidence of volatile contaminants identified in the ground.
PL3	- Inhalation of gas. - Migration through permeable strata and preferential pathways. - Explosion in confined spaces.	- Future site users. - Buildings (Polytunnel). - Offsite land users.	- Methane, carbon dioxide. - (potentially infilled features 250m of the site).	Unlikely	Severe	Moderate / Low	- Unlikely given no significant viable sources of hazardous gas identified. - Low risk assumed due to low sensitivity of development. - Recommendation: No further assessment required.
PL4	- Surface run-off. - Migration through permeable strata and preferential pathways - Perched waters migration.	- Groundwater (Principal Aquifer). - Surface water (Boggart Hole Brook).	- Mobile contaminants such as metals, PAHs, hydrocarbons, volatile compounds (made ground, former buildings).	Low	Medium	Moderate / Low	- Low likelihood, as even though potential sources of contamination identified, underlying cohesive superficial deposits likely to limit migration of mobile contaminants. - Moderate risk assumed at this stage due to unknown ground conditions and sensitivity of underlying Principal Aquifer. - Recommendation: No testing required unless evidence of significant mobile contamination is identified in the soil.
PL5	- Direct Contact (plant uptake).	- Flora.	- Phytotoxic Contaminants (made ground).	Low Likelihood	Minor	Very Low	- Low likelihood as contamination considered possible, which may be taken up by flora in soft landscaping / gardens. - Recommendation: Limited investigation work as part of PL1.

Table 2-6. Preliminary Contamination Conceptual Model.

3 Ground Investigation

3.1 Site Investigation Design and Methodology

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

The investigation was carried out on 16th January 2020 and comprised the following:

➤ 4no. hand pits (using hand auger / spade) excavated to 0.48-0.75mbgl

All site investigation locations are shown in Figure 4.

The locations were chosen to allow a good spread across the site as well as target areas of concern. Table 3-1 details the targeted and general coverage (non-targeted) site investigation locations.

Site Investigation Locations	Rationale
HD101-103	General site coverage.
HD104	Target area of proposed polytunnel.

Table 3-1: Summary of sampling locations.

All profile logs are provided in Appendix B and are in line with BS14688-1⁵ and BS5930⁶.

3.2 Sampling Protocol

3.2.1 Soil Sampling (Contamination)

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation⁷.

Soil was collected for onsite testing. A plastic zip bag was half filled with soil allowing a suitably sized headspace. The bag was sealed and stored for at least 20 minutes before being tested for total volatile organic compounds (TVOCs) using a PhoCheck Tiger photoionisation detector (PID). Results of the PID readings are presented on the profile logs (Appendix B). The on-site monitoring was carried out in line CIRIA C665⁸ to aid in screening samples for volatile analysis.

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 for chemical testing. 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.

⁵ British Standards (2002) Geotechnical investigation and testing – Identification and Classification of Soil. Part 1: Identification and description. BS EN ISO 14688-1:2002.

⁶ British Standard (2015). "Code of Practice for Ground Investigations". BS5930:2015.

⁷ EA (2000). "Technical Aspects of Site Investigation. Volumes 1 & 2 Text Supplements Research and Development Technical Report." P5-065/Tr.

⁸ CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.

Many of the contamination tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix C. Table 3-2 shows the soil testing undertaken.

Suites and Contaminants	No. Samples	Location & Depth	Justification
Metals / metalloids, pH, water soluble sulphate, speciated PAHs, SOM and asbestos screen	2	HD101 D 0.3-0.7m HD104 0.2-0.6m	A basic suite with a broad selection of contaminants tested on samples across the site where no significant evidence of contamination was identified (with the exception of occasional ash and coal).
Metals / metalloids, pH, water soluble sulphate, cyanide suite, phenol, TPHCWG, BTEX, MTBE, speciated PAHs, SOM and asbestos screen.	2	HD101 D 0.0-0.3m HD104 0.2-0.58m	Although no evidence of contamination identified, detailed suite undertaken to confirm the absence of contamination.

Table 3-2. Summary of soil sample testing undertaken.

Notes:

If asbestos present during screen identification and quantification will be undertaken.

Metal/metalloids=arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; TPHCWG=carbon banded and aromatic/aliphatic split petroleum hydrocarbons; PAH=polycyclic aromatic hydrocarbons, BTEX=benzene, toluene, ethylbenzene and xylenes; MTBE=Methyl tert-butyl ether, SOM=Soil Organic Matter.

3.2.2 Water Sampling / Leaching Testing

Groundwater sampling / leaching testing was not carried out as part of this investigation.

A low risk was identified in the preliminary contamination conceptual model for controlled waters (pollutant linkage 4) and further action was only recommended if significant soil contamination was identified on site. Based on the ground conditions encountered, LKC did not consider testing to be required. This is discussed further in Section 5.4.

4 Ground Conditions

4.1 Geology – Generalised Sequence

The ground conditions beneath the site comprised made ground underlain by natural sandy clay. Natural ground was only established in one location. A summary section of the logs is provided in Plate 4-1, with additional comments below.

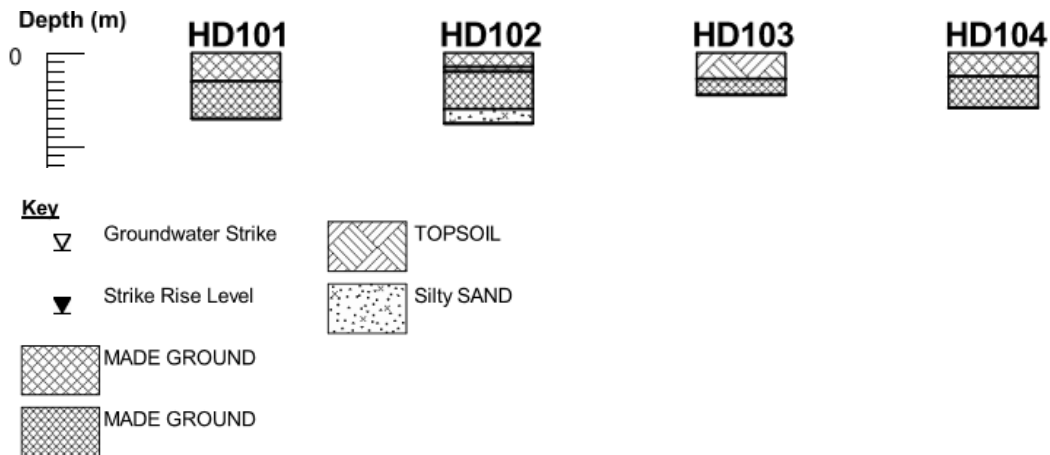


Plate 4-1: Summary of ground conditions.

Additional information on ground conditions:

- » In each sampling location a reworked topsoil with rootlets and anthropogenic inclusions was encountered to depths of 0.15-0.30mbgl over made ground including demolition materials ash, clinker, pottery and glass. Exceptions to this were:
 - HD102 0.15-0.20mbgl – made ground comprising sandy gravel (probable MOT layer).
 - Painted tarmac fragments were noted in HD101 (0.30-0.70mbgl), HD103 (0.28-0.58mbgl) and HD104 (0.20-0.58mbgl).
- » Two locations refused at shallow depth on sandstone slabs – HD103 (0.48mbgl) and HD104 (0.58mbgl).
- » No visual / olfactory evidence of hydrocarbons or volatile contaminants in any locations.
- » All trial hole locations were recorded as stable.

4.2 Groundwater

4.2.1 Groundwater Levels

All trial hole locations were recorded as dry during the investigation, and groundwater monitoring was not carried out as part of the assessment.

5 Generic Risk Assessment

5.1 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 (CLR11⁹). Information gathered from the risk assessment has been collated in the revised contamination conceptual model in Section 5.5.

5.2 Soil Risk Assessment

5.2.1 Methodology

With regards to the soil risk assessment LKC will use the following hierarchy:

- Category 4 Screening Levels (C4SLs).
- LQM Suitable 4 Use Levels (S4ULs).
- ATRISK Soil Screening Values (SSVs) and CL:AIRE Generic Assessment Criteria (GACs).

C4SLs were published in 2013^{10,11}. The recent change to the contaminated land guidance has changed the evaluation of risk from 'minimal' (referred to as Health Criteria values (HCVs))¹² used to generate Soil Guideline Values (SGVs) to 'low' (referred to as Lowest Level of Toxicological Concern (LLTCs)). The policy companion document and supporting letter by Defra, dated 3rd September 2014, states that C4SLs '*could be used under the planning regime, as well as within Part 2A*'. Based on these comments LKC considers the justifications and assumptions used to generate 'low' risk are suitable for the planning regime.

Where no C4SLs have been generated LKC will use the LQM S4ULs¹³. Similar assumptions and land uses to C4SLs have been used. However, toxicological information has been based on 'minimal risk' as per previous guidelines and assumptions^{14,15,16,17}.

If contaminants are not present as C4SLs and S4ULs then LKC will use ATRISK SSVs or CL:AIRE GACs¹⁸. These follow the 'minimal' risk principle and more stringent exposure parameters and will be conservative.

LKC consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P) and naphthalene. This is due to B(a)P possibly being a carcinogen and most toxic of the

⁹ EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

¹⁰ Defra (2014). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Policy Companion Document."

¹¹ CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."

¹² EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.

¹³ LQM (2014). "The LQM/CIEH S4ULs for Human Health Risk Assessment."

¹⁴ EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.

¹⁵ EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.

¹⁶ EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.

¹⁷ EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.

¹⁸ CL:AIRE (2009). "The Soil Generic Assessment Criteria for Human Health Risk Assessment."

PAHs^{19,20} and naphthalene the most volatile and soluble²¹. The new C4SLs indicate B(a)P as a surrogate marker for carcinogenic PAHs, if it falls within appropriate limits, since the risk from other non-carcinogenic PAHs are considered negligible²². For B(a)P to be used as a surrogate marker it should follow the profile described by the HPA (2008)²³ and CL:AIRE (2013). Naphthalene will be treated separately using the LQM S4ULs.

The proposed development is for open space which will be used by the school. Therefore, areas for cultivation will be contrasted to the assessment criteria for allotments and the areas not for cultivation will be contrasted to assessment criteria for residential without plant uptake (RwoPu).

All criteria have been generated using the CLEA V1.06 model²⁴ based either on 1%, 2.5% and 6% Soil Organic matter (SOM). Results will be compared to the nearest appropriate SOM.

A summary of the generic assessment criteria is provided in Appendix D. ATRISK SSVs and CL:AIRE GACs were not required for this dataset and have not been included.

B(a)P as Surrogate Marker

Based on the above assumption for PAHs, LKC undertook an assessment of the data for the site with regards to using B(a)P as a surrogate marker for carcinogenic PAHs as per HPA and CL:AIRE guidelines. The primary toxicological study related to Culp *et al.*²⁵, which was based on coal tar mixtures (>80,000mg/kg of total PAHs) fed in food to mice over a two-year carcinogenicity study.

Graph 5-1 summarises the study site data with respect to how the ratios of carcinogenic PAHs relate to B(a)P, within the confidence limits provided in the HPA document.

¹⁹ EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.

²⁰ USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."

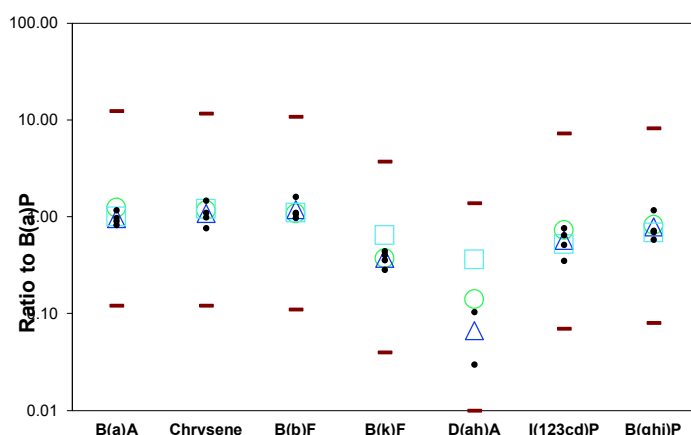
²¹ EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5- 079/TR1.

²² CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."

²³ HPA (2010). "HPA Contaminated Land Information Sheet: Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs)." Version 3.

²⁴ EA (2008). "CLEA Software (Version 1.05) Handbook." Science Report – SC050021/SR4.

²⁵ Culp, S; Gaylor, D; Sheldon, W; Goldstein, L and Beland, F (1998). "A Comparison of Tumours Induced by Coal Tar and Benzo-a-pyrene in a 2-Year Bioassay." Carcinogenesis. **Vol 19**, no. 1, pp. 117-124.



Graph 5-1: The ratio of PAH to B(a)P in soil for all available data at the site based on 4 samples (where values were >LOD to allow the calculation of a ratio).

Notes:

B(a)P = Benzo(a)pyrene; D(ah)A = Dibenzo(ah)anthracene; B(a)A = Benzo(a)anthracene; B(b)F = Benzo(b)fluoranthene;
B(k)F = benzo(k)fluoranthene; I(123cd)P = Indeno(123cd)pyrene; B(ghi)P = Benzo(ghi)perylene
● = Ratio to B(a)P for all data ○ = Mean ratio to B(a)P for Culp data ▲ = Mean ratio to B(a)P from all data at the site
□ = Mean ratio to B(a)P for UK data presented by HPA — = Upper and Lower limits (order of magnitude from Culp data).

All the data points that could be used to calculate ratios fall inside the upper or lower limits.

Based on this distribution of data LKC considers B(a)P can be used as a surrogate marker for carcinogenic PAHs and the C4SL criteria is suitable for this dataset.

5.2.2 Soil Results Comparison against Assessment Criteria

All analysis sheets are presented in Appendix C. All the data has been compared to relevant assessment criteria and is presented in Appendix D. Elevated and pertinent results are presented in Table 5-1.

Results have been compared to the relevant assessment criteria and no elevated contaminants were identified.

Contaminant	Units	No. of samples	Elevated Results	Sample Location	Criteria (1%/2.5%/6%)	Source of Criteria
Metals						
Lead	mg/kg	4	99	HD101 (0.0-0.3m)	80 & 310	C4SL Allotments & RwoPu
			250	HD101 (0.3-0.7m)		
			170	HD102 (0.2-0.6m)		
			650	HD104 (0.2-0.58m)		
TPHs						
Aromatic C21-35	mg/kg	4	1800	HD102 (0.2-0.6m)	1,600 (6%)	S4UL Allotments
SVOCs						
GENERAL						
pH	pH	4	Range 7.4-8.7			
SOM	%	4	Range 3.1-16			

Table 5-1: Summary of elevated and pertinent analytical results.

Notes:

Only results that exceeded assessment criteria have been shown and results from **all depths** are noted. Results have been compared to the nearest appropriate SOM.

No asbestos was identified in any of the soil samples analysed.

5.2.3 Direct Contact Risk – Pollutant Linkage 1

Elevated heavy metals (lead) have been identified on site, given the number and location of elevated samples, the contamination is considered likely to be site wide in the demolition rubble / made ground below the existing topsoil covering.

The source of the contamination is expected to the ash, clinker, coal and tarmac inclusions noted in the made ground.

At the concentrations identified, the contaminants are considered to pose a potential risk to future site users in the allotments areas and where underlying made ground may be exposed across the remainder of the site. The principal pathways are the ingestion pathways (soil, dust and vegetables) and dermal contact.

The probability of metal contamination affecting site users is likely. With a medium consequence, the risk is considered to be moderate and remediation is recommended.

No asbestos was identified in any of the samples; therefore, the probability of asbestos affecting future site users is considered to be unlikely. With a severe consequence, the risk is low. At this stage, a low risk is assumed (as no asbestos identified) and remediation is not required. However, as a precaution, construction workers should be and vigilant for any suspected ACM during groundworks (discussed further in Section 7.1).

Petroleum Hydrocarbons

Elevated aromatic C21-35 was identified in HD102 (0.2-0.6mbgl). No visual or olfactory evidence of hydrocarbon contamination was identified during the investigation. The laboratory interprets the GC trace as “heavy oil; however, LKC consider it is likely due to a fragment of tarmac.

Therefore, given the nature of the ground conditions encountered, further small pockets of elevated heavy end aromatic hydrocarbon contamination could be present.

LKC considers the probability of hydrocarbon contamination affecting site users (via ingestion and dermal contact) as likely. Given a medium consequence a moderate risk is considered appropriate and remediation is recommended.

5.2.4 Risk from Inhalation of Vapours – Pollutant Linkage 2

No significant source identified by PRA. No visual / olfactory or PID evidence of volatile contaminants was identified during the investigation.

LKC therefore consider the probability of volatile contaminants affecting site users as unlikely. The consequence is expected to be medium, giving a low risk and no remediation is required with respect to pollutant linkage 2.

5.3 Controlled Water Assessment

The PRA identified a low risk with respect to controlled waters as no significant source of mobile contamination was anticipated.

No evidence of significant mobile contamination was identified on the site. Although elevated metals were identified within the soils, the source is anticipated to be ash and

clinker noted within the made ground. Contamination associated with ash and clinker is not anticipated to be mobile due to the residual crystalline nature of the matrix.

The site investigation did not identify any significant sources of likely mobile contamination within the soils. This confirms an unlikely probability of onsite contamination affecting controlled waters. With a medium consequence the risk is anticipated to be low and no remediation is required.

5.4 Additional Risk Assessments

5.4.1 Phytotoxicity (Pollutant Linkage 5)

Soil results were compared to phytotoxic guideline values as outlined in BS3882²⁶.

No elevated contaminants were identified therefore the probability of phytotoxic contaminants affecting vegetation is considered to be unlikely. With a minor consequence, the risk (pollutant linkage 5) is anticipated to be very low.

5.5 Revised Contamination Conceptual Model

The preliminary contamination conceptual model (Table 2-8) has been revised following the risk assessments undertaken in Sections 5.1-5.4. The revised contamination conceptual model follows the same methodology and guidance used in the preliminary contamination conceptual model. The risk matrix is provided in Appendix A.

The revised contamination conceptual model is presented in Table 5-2.

Where a very low risk is identified no specific remediation is required.

Where a low risk is identified, some form of remediation may be required depending on the pollutant linkage, the type and concentration of contaminants present and the proposed development.

Where there is a moderate/low risk is identified, an assessment will be undertaken to establish what category the pollutant linkage will fall into.

Where LKC identifies a moderate or higher risk, remediation or further investigation work is recommended.

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

²⁶ BS (2015). "Specifications for Topsoil and Requirements for Use." BS3882:2015.

Pollutant Linkage	Pathway	Receptor	Contaminant	Probability	Consequence	Risk	Assessment
PL1	- Dermal contact. - Inhalation of soil, fibres and dust. - Ingestion of soils, dust, vegetables, soil attached to vegetables. - Windblown dust.	- Future residents. - Site users. - Offsite receptors.	ACM: -None identified	Unlikely	Medium	Low	- Unlikely as no ACM identified on site. - Recommendation *1 *2: No further assessment required.
			Heavy metals: - Lead Hydrocarbons: - Aro C21-35.	Likely	Medium	Moderate	- Likely as elevated lead and Aro C21-35 identified on site. - Recommendation : Remediation required. Likely to include either cover system or raised beds in cultivated / allotment areas. Existing topsoil cover to be maintained elsewhere on site.
PL2	- Inhalation of vapours. - Migration through permeable strata and preferential pathways.	- Future residents. - Site users	Volatile Contaminants - None identified.	Unlikely	Medium	Low	- No elevated volatile contaminants across the site. - Recommendation : No remediation required.
PL3	- Inhalation of gas. - Migration through permeable strata and preferential pathways. - Explosion in confined spaces.	- Future site users. - Buildings (Polytunnel). - Offsite land users.	- Methane, carbon dioxide. (potentially infilled features 250m of the site).	Unlikely	Severe	Moderate / Low	- Unlikely given ground conditions encountered. No significant putrescible material identified therefore low risk considered appropriate. - Recommendation : No remediation required.
PL4	- Surface Run-off. - Migration through permeable strata and preferential pathways - Perched waters migration.	- Groundwater (Principal Aquifer). - Surface Water (No significant receptor)	Mobile contaminants: - Metals.	Unlikely	Medium	Low	- Although slightly elevated metals identified, given the environmental settings and ground conditions encountered not considered to pose a significant risk to groundwater. - Recommendation : No remediation required.
PL5	- Direct Contact (plant uptake).	- Flora.	Phytotoxic Contaminants: - None identified	Unlikely	Minor	Very Low	- No elevated contaminants identified. - Recommendation *3: No remediation required.

Table 5-2: Revised Contamination Conceptual Model.

Notes

*1 Although no ACM identified, contractors should be vigilant during earthworks of any potential ACM. This is discussed further in Section 7.

*2 The conceptual model only takes into consideration the future use of the site and long-term exposure. Consideration should also be given to the short-term exposure of construction workers and nearby land users to ACM containing soils during groundworks. This is discussed further in Section 7.

*3 Although no phytotoxic contaminants identified in soils, the characteristics of the made ground should also be taken into account if it is to be used as a topsoil / growing medium for flora. The material should be assessed against the parameters outlined in Table 1 of BS3882 (not included within this assessment).

6 Conclusions

The site has historically been developed for terraced housing which has subsequently been demolished.

The ground investigation identified a topsoil with anthropogenic inclusions over made ground including inclusions of ash, clinker, coal, tarmac and demolition rubble. LKC consider that following demolition of the previous housing on site that the area was levelled, and a covering of topsoil was placed as a growing medium.

Soil testing indicates the presence of elevated concentrations of lead and heavy end aromatic hydrocarbons in the made ground below the existing topsoil when contrasted to allotments assessment criteria. Therefore, remediation is recommended in proposed allotment / cultivated areas.

A revised contamination conceptual model has been produced by LKC which is summarised in Table 6-1 below (more detailed model provided in Section 5).

	Pollutant Linkage	Risk	Recommendations
1	Contaminants posing a risk to site users, future site users, offsite receptors via dermal contact, ingestion and inhalation (of soil, dust, fibres and vegetables).	Low	- No asbestos identified. Recommendations: No remediation required.
		Moderate (lead and Aro C21-C35)	- Elevated lead and Aro C21-35 in the made ground below the topsoil. Recommendations: Remediation required in cultivated / allotment areas. Likely to include cover system or raised beds. Existing topsoil cover to be maintained elsewhere on site.
2	Volatile contaminants posing a risk to site users future site users, offsite receptors via the inhalation of vapours.	Low	- No elevated volatile contaminants identified. Recommendations: No remediation required.
3	Gas posing a risk to buildings and site users, buildings via the migration of gas into building causing explosion and asphyxiation.	Low	- No further assessment required based on ground conditions encountered. Recommendations: No remediation required.
4	Mobile contamination posing a risk to controlled waters via the migration through permeable strata.	Low	- No groundwater sampling undertaken as no significant risk posed to controlled waters based on ground conditions. Recommendations: No remediation required.
5	Phytotoxic metals posing a risk to flora via root uptake.	Very Low	- No phytotoxic metals above generic criteria. Recommendations: No remediation required.

Table 6-1: Summary Risk Table.

Remedial recommendations are presented in Section 7.

7 Recommendations and Remedial Strategy

The recommendations provided below are considered appropriate for the site based on the site investigation work undertaken. LKC should stress that no remediation, enabling works or designing works should take place until Regulatory approval has been obtained.

7.1 General Requirements

The site may be considered as 3 Zones based upon proposed use and surfacing.

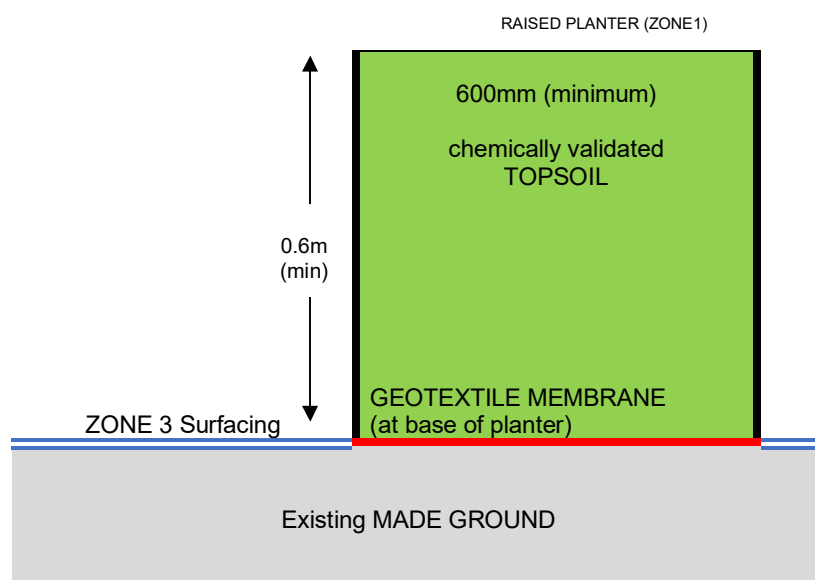
- Zone 1: Areas for Cultivation / Allotments
- Zone 2: Grassed areas NOT for cultivation
- Zone 3: "Hard" Landscaping / surfaced areas.

7.1.1 Zone 1: Areas for Cultivation and Allotments

These areas require a minimum 600mm depth of clean soils in order. This may include the removal of 600mm of material and replacement with suitable validated topsoil or the creation of the required depth using raised planters. The latter is considered appropriate for the site as it will negate the removal and off-site disposal of soil and will allow easier access during gardening activities.

The raised planters may be placed directly on to the site made ground. If the planters do not have an integral base then a separation woven geotextile membrane (such as Terram Hi-Viz) must be placed at the base to prevent any mixing (by garden activities or bioturbation) between the planter soil and the underlying made ground.

The planters should allow 600mm depth of soil to allow the cultivation of root vegetables.



Validation should include:

- Measuring soil depth using a staff and providing photographic evidence.
- Photographic evidence of the geotextile layer.
- Chemical validation of imported soils: See Table 7-2.

The area between the raised beds should be hardstood or surfaced as per Zone 3 (See Section 7.1.3).

7.1.2 *Zone 2: Grassed Areas NOT for Cultivation*

LKC recommend that these areas retain the current depth of topsoil cover above the made ground below.

This may be validated by photographic evidence.

7.1.3 *Zone 3: "Hard Landscaped" and Surfaced Areas*

No specific remediation is required in these areas such as around the raised planters subject to the placement of a semi permanent "hard" surfacing such as paving stones, erosion control surfacing such as, grasscrete or porous plastic paving. Examples of such are provided in Appendix E.

7.1.4 *Earthworks Inspections / 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 (including asbestos containing material) be encountered at the site, LKC and the Local Authority should be informed, and further assessment of the material may be required.

Should asbestos be identified during groundworks, precautions should be taken to ensure the safety of the construction workers and nearby land users. It would be advisable to introduce an asbestos management strategy in line with CIRIA C733²⁷.

Validation works would include a log of work undertaken including photographs and details of any sampling undertaken and validation of any potential additional remedial work.

7.2 **Validation of Topsoil**

Chemical validation of all imported soils to be used on site in any soft landscaping areas should be undertaken. Imported soils should be accompanied by a certificate of analysis and source details.

A summary of the required imported material sampling requirements is presented in Table 7-1. Ideally, the material should be sampled at source to prevent double handling if soil fails, with confirmatory sampling undertaken on importation to site. However, where this is not possible then material imported should be segregated based on source and soil type. Validation samples should be taken prior to placement in gardens to ensure suitability for use.

²⁷ CIRIA (2014). "Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks". C733.

Material Type	Source	Suite of Analysis	Sampling Rate*
Topsoil	Greenfield	Suite A	1 sample per 50m ³
	Brownfield / Unknown	Suite B	

Table 7-1: Sampling requirements for imported soils.

Notes:

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

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

*Minimum sampling rate of 3 samples per source.

Any soil with visual or olfactory evidence of hydrocarbons should be rejected.

In addition, it should be ensured that the matrix of the topsoil is suitable as a growing medium and no undesirable material is present (in line with BS3882²⁸). LKC advise this information is provided by the supplier before material is imported onto site.

Imported material to be used on site in soft landscaping areas will be compared to remedial target criteria are presented in Appendix D (Allotments or RwoPu).

7.3 Site Completion Report

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

- » Provision of any waste transfer documents.
- » Evidence of the placement of 600mm soil in raised planters (Zone 1).
- » Evidence of maintaining existing topsoil cover in not cultivated soft landscaped areas (Zone 2).
- » Evidence of the placement of hard surfacing or erosion control between planters (Zone 3).
- » Verification testing of all imported topsoil.
- » Details of any unexpected contamination identified onsite, suitably risk assessed and / or validated.

The Site Completion Report will assist the Local Authority in the discharge of any future relevant planning condition.

²⁸ BS (2015). "Specifications for Topsoil and Requirements for use." BS3882:2015.

Figures

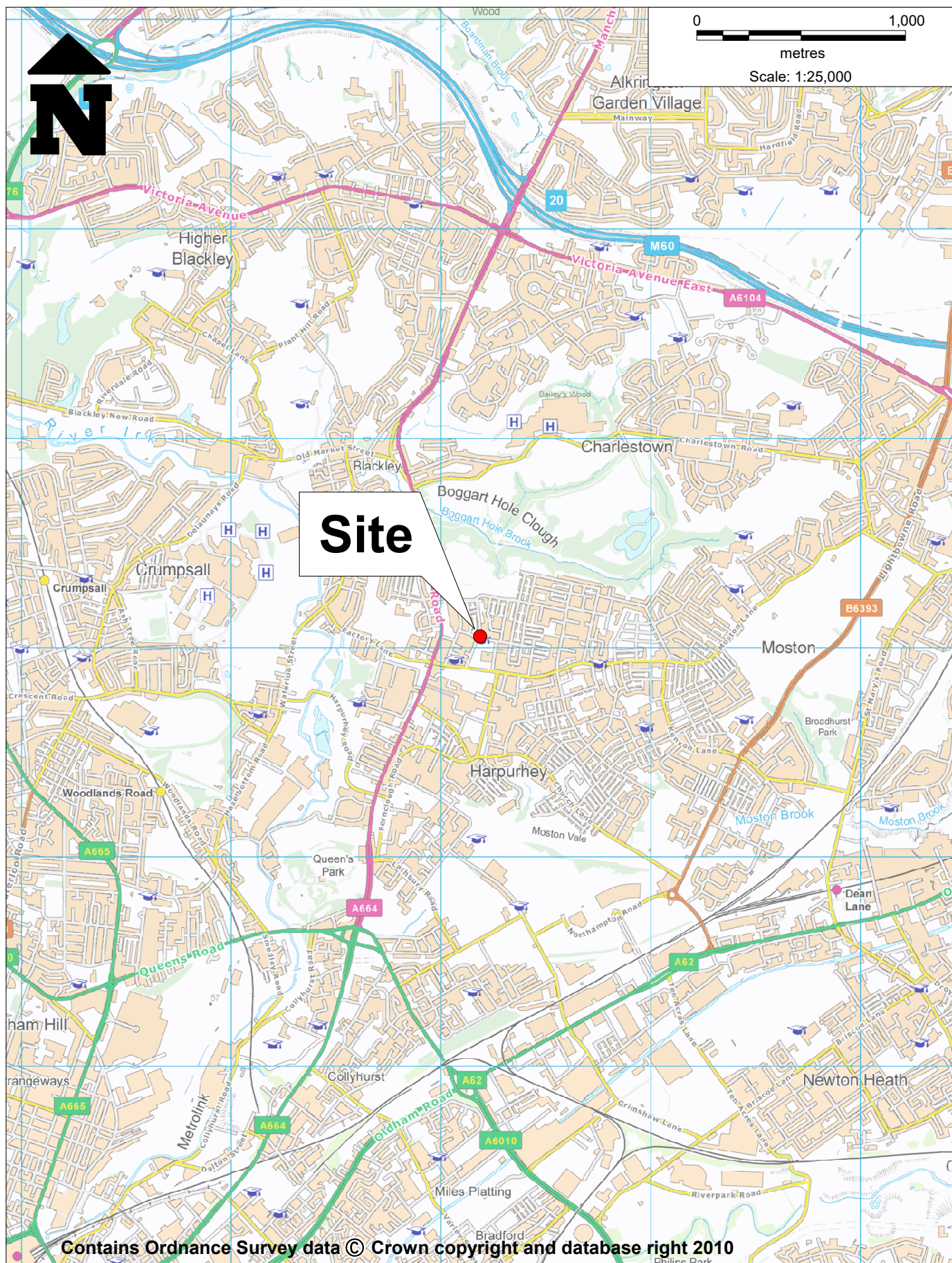


Figure 1: Site Location Plan, Land Off Holy Trinity CE School, Manchester

Drawn: February 2020 Scale: 1:25,000 @ A4 (see scale bar)



Extract from: Google Maps
Drawing Ref: Site Location

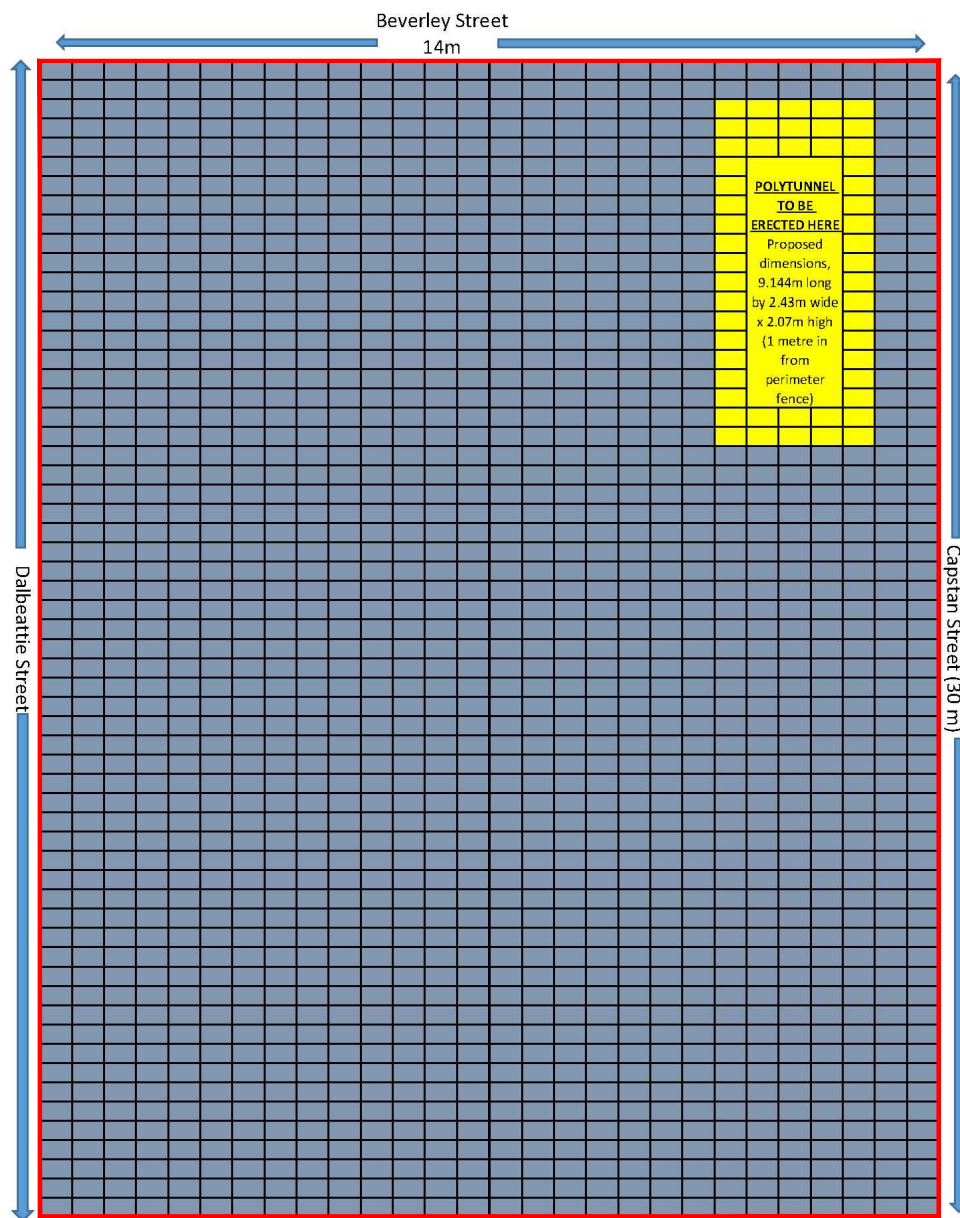
KEY

 Site Boundary

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.

LK
CONSULT LIMITED

Client:				Holy Trinity CE School			
Site:				Land Off Holy Trinity CE School, Manchester			
Title:				Site Boundary Plan			
Job No.:	LKC 20 1205	Scale (See Scale Bar):	1:500 @ A4	Figure:	2		
Drawn By:	AC	Checked By:	NJ	Drawn:			
				Feb 2020			



KEY



Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



Client: Holy Trinity CE School			
Site: Land Off Holy Trinity CE School, Manchester			
Title: Proposed Site Use			
Job No.: LKC 20 1205	Scale (See Scale Bar): NTS	Figure: 3	Revision:
Drawn By: AC	Checked By: NJ	Drawn: Feb 2020	

Extract from: Plan Supplied by Client
Drawing Ref: Polytunnel Dimensions/Layout Plan



Extract from: Google Maps
Drawing Ref: Site Location

KEY

-  Site Boundary
-  Hand Dug Trial Pit (HD)

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



Client:			
Holy Trinity CE School			
Site:			
Land Off Holy Trinity CE School, Manchester			
Title:			
Site Investigation Location Plan			
Job No.:	Scale (See Scale Bar):	Figure:	Revision:
LKC 20 1205	1:250 @ A4	4	
Drawn By:	Checked By:	Drawn:	
AC	NJ	Feb 2020	

Appendix A

Risk Matrix

Risk Evaluation

The method for risk evaluation is a qualitative method of interpreting the output from the risk estimation stage of the assessment, based on CIRIA 552²⁹. It involves the classification of the:

- » Magnitude of the potential consequence (severity) of the risk occurring (Table A).
- » Magnitude of the probability (likelihood) of the risk occurring (Table B).

Consequence (Severity)		
Classification	Definition	Example
Severe	- Short term (acute) risk to human health likely to results in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. - Short term risk of pollution (note: water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. - Catastrophic damage to buildings/properties. - A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definition of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	- High Concentrations of cyanide on the surface of an informal recreation area. - Major spillage of contaminants from site into controlled waters. - Explosion, causing building collapse (can also equate to short term human health risk if buildings are occupied).
Medium	- Chronic damage to Human Health ('significant harm' as defined in DETR, 2000). - Pollution of sensitive water resources (note Water Resources Act contains no scope for considering significance of pollution). - A significant change in a particular ecosystem, or organism forming part of such ecosystem.	- Concentrations of a contaminant from site exceed generic, or site-specific assessment criteria. - Leaching of contaminants from a site to a major or minor aquifer (Principal and Secondary). - Death of a species within a designated nature reserve.
Mild	- Pollution of non-sensitive water resources. - Significant damage to crops, buildings, structures and services ('significant harm' as defined in DETR, 2000). - Damage to sensitive buildings/structures/services or the environment.	- Pollution of non-classified groundwater. - Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	- Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. - Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). - Easily repairable damage to buildings, structures and services.	- The presence of contaminants at such concentrations that protective equipment is required during site works. - The loss of plants in a landscaping scheme. - Discoloration of concrete.

Table A. Classification of Consequence

Probability (Likelihood)	
Classification	Definition
High Likelihood	- There is a pollutant linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	- There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. - Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	- There is a pollutant linkage and circumstances are possible under which an event could occur. - However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term.
Unlikely	- There is a pollutant linkage, but circumstances are such that it is improbable that an event would occur in the very long term.

Table B. Classification of Probability.

²⁹ CIRIA C552 (2001) Contaminated Land Risk Assessment - A Guide to Good Practice.

These classifications are then compared to indicate the risk presented by each pollutant linkage (Table C). It is important that this classification is only applied where there is a possibility (which can range from high likelihood to unlikely) of a pollutant linkage existing.

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table C. Comparison of Consequence against Probability

Once the risk has been determined the corresponding action can be assessed (Table D).

Risk	Action Required
Very High Risk	- There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. - This risk, if realised, is likely to result in a substantial liability. - Urgent investigation (if not already undertaken) and remediation are likely to be required.
High Risk	- Harm is likely to arise to a designated receptor from an identified hazard. - Realisation of the risk is likely to present a substantial liability. - Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate Risk	- It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. - Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	- It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	- There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table D. Description of the Classification and Likely Action Required.

Where a very low risk is identified no specific remediation is required.

Where a low risk is identified, some form of remediation may be required depending on the pollutant linkage, the type and concentration of contaminants present and the proposed development.

Where there is a moderate/low risk identified, an assessment will be undertaken to establish what category the pollutant linkage will fall into.

Where LKC identifies a moderate or higher risk, remediation or further investigation work is recommended.

Appendix B

Profile Logs

Excavation Method

Hand dug trial pit excavated to 0.70mbgl.

Dimensions

0.20m x 0.20m x 0.70m

Ground Level (mOD)

86.00

Client

Holy Trinity CE, Manchester

**Job
Number**

LKC 20 1205

Location (Observed measurements)

386190 E 402043 N

Dates

16/01/2020

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1 PID=<0.1ppm				(0.30)	MADE GROUND: Blackish brown gravelly silty SAND with frequent rootlets, occasional brick fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded, comprising sandstone, coal, and shale.		
0.30-0.70	D2 PID=<0.1ppm			85.70	0.30	MADE GROUND: Blackish brown gravelly silty SAND with frequent brick fragments, concrete, painted tarmac, occasional ash, clinker, pottery fragments, glass fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subangular comprising coal, sandstone.		
					(0.40)			
				85.30	0.70	Complete at 0.70m		


Remarks

Elevation estimated from <https://www.freemaptools.com/elevation-finder.htm>.
National Grid Reference estimated from <https://gridreferencefinder.com/> accurate to 3.0-5.0m.
Hand dug dry and stable.

Scale (approx)

1:20

Logged By

NJ

Figure No.

LKC 20 1205.HD101

Excavation Method

Hand dug trial pit excavated to 0.75mbgl.

Dimensions

0.20m x 0.20m x 0.75m

Ground Level (mOD)

86.00

Client

Holy Trinity CE, Manchester

**Job
Number**

LKC 20 1205

Location (Observed measurements)

386183 E 402048 N

Dates

16/01/2020

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20-0.60	D1 PID=<0.1ppm			85.85 85.80	(0.15) 0.15 0.20	MADE GROUND: Blackish brown gravelly silty SAND with frequent rootlets, occasional brick fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded, comprising sandstone, coal, and shale.		
					(0.40)	MADE GROUND: Grey sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium, angular comprising sandstone and limestone. Probable MOT.		
				85.40 85.25	0.60 (0.15) 0.75	MADE GROUND: Blackish brown gravelly silty SAND with frequent brick fragments, occasional ash, clinker, pottery fragments, glass fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subangular comprising coal, sandstone.		
						Soft consistency brownish grey sandy CLAY. Sand is fine to medium.		
						Complete at 0.75m		


Remarks

Elevation estimated from <https://www.freemaptools.com/elevation-finder.htm>.
National Grid Reference estimated from <https://gridreferencefinder.com/> accurate to 3.0-5.0m.
Hand dug dry and stable.

Scale (approx)

1:20

Logged By

NJ

Figure No.

LKC 20 1205.HD102

Excavation Method

Hand dug trial pit excavated to 0.48mbgl.

Dimensions

0.20m x 0.20m x 0.48m

Ground Level (mOD)

86.00

Client

Holy Trinity CE, Manchester

**Job
Number**

LKC 20 1205

Location (Observed measurements)

386190 E 402043 N

Dates

16/01/2020

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20-0.48	D1 PID=<0.1ppm				(0.28) 85.72 0.28 (0.17) 85.55 0.45	MADE GROUND: Blackish brown gravelly silty SAND with frequent rootlets, occasional brick fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded, comprising sandstone, coal, and shale. MADE GROUND: Blackish brown gravelly silty SAND with frequent brick fragments, concrete, painted tarmac, occasional ash, clinker, pottery fragments, glass fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subangular comprising coal, sandstone. Refusal on sandstone slab. Probable historic flooring. Complete at 0.48m	 	


Remarks

Elevation estimated from <https://www.freemaptools.com/elevation-finder.htm>.
National Grid Reference estimated from <https://gridreferencefinder.com/> accurate to 3.0-5.0m.
Hand dug dry and stable.
Refusal on sandstone slab.

Scale (approx)

1:20

Logged By

NJ

Figure No.

LKC 20 1205.HD101

Excavation Method

Hand dug trial pit excavated to 0.58mbgl.

Dimensions

0.20m x 0.20m x 0.58m

Ground Level (mOD)

86.00

Client

Holy Trinity CE, Manchester

**Job
Number**

LKC 20 1205

Location (Observed measurements)

386183 E 402048 N

Dates

16/01/2020

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20-0.58	D1 PID=<0.1ppm			85.75	0.25	MADE GROUND: Blackish brown gravelly silty SAND with frequent rootlets, occasional brick fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded, comprising sandstone, coal, and shale.		
				85.42	0.33	MADE GROUND: Blackish brown gravelly silty SAND with frequent brick fragments, concrete, painted tarmac, occasional ash, clinker, pottery fragments, glass fragments. Sand is fine to coarse. Gravel is fine to coarse, angular to subangular comprising coal, sandstone.		
					0.58	Refusal on sandstone slab.		
						Complete at 0.58m		


Remarks

Elevation estimated from <https://www.freemaptools.com/elevation-finder.htm>.
National Grid Reference estimated from <https://gridreferencefinder.com/> accurate to 3.0-5.0m.
Hand dug dry and stable.

Scale (approx)

1:20

Logged By

NJ

Figure No.

LKC 20 1205.HD102

Appendix C

Certificates of Analysis – Soil



2183



Final Report

Report No.: 20-01512-1

Initial Date of Issue: 23-Jan-2020

Client LK Consult

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

Contact(s): Colin Crompton
Contaminated Land

Project LKC 20 1205 Holy Trinity CE,
Manchester

Quotation No.:		Date Received:	17-Jan-2020
Order No.:	737524	Date Instructed:	17-Jan-2020
No. of Samples:	4		
Turnaround (Wkdays):	5	Results Due:	23-Jan-2020
Date Approved:	23-Jan-2020		

Approved By:**Details:** Ken Scally, Technical Director

Results - Soil

Client: LK Consult	Chemtest Job No.:				20-01512	20-01512	20-01512	20-01512
Quotation No.:	Chemtest Sample ID.:				955272	955273	955274	955276
	Client Sample ID.:				HD101 D	HD101 D	HD102	HD104
	Sample Type:				SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.0	0.3	0.2	0.2
	Bottom Depth (m):				0.30	0.70	0.60	0.58
	Date Sampled:				16-Jan-2020	16-Jan-2020	16-Jan-2020	16-Jan-2020
	Asbestos Lab:				COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD				
ACM Type	U	2192		N/A	-	-	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-	-	-
Moisture	N	2030	%	0.020	21	15	5.7	12
Soil Colour	N	2040		N/A	Brown,	Brown,	Brown,	Brown,
Other Material	N	2040		N/A	Stones,	Stones,	Stones,	Stones,
Soil Texture	N	2040		N/A	Sand,	Sand,	Sand,	Sand,
Chromatogram (TPH)	N			N/A	See Attached		See Attached	
pH	M	2010		4.0	7.4	8.1	8.7	8.6
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.52		< 0.40	
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.046	< 0.010	0.021	0.021
Cyanide (Free)	M	2300	mg/kg	0.50	< 0.50		< 0.50	
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50		< 0.50	
Arsenic	M	2450	mg/kg	1.0	11	32	9.1	12
Cadmium	M	2450	mg/kg	0.10	0.17	0.24	0.23	0.41
Chromium	M	2450	mg/kg	1.0	13	29	45	28
Copper	U	2450	mg/kg	0.50	30	67	21	25
Mercury	M	2450	mg/kg	0.10	0.29	0.63	0.12	0.18
Nickel	M	2450	mg/kg	0.50	16	37	28	17
Lead	M	2450	mg/kg	0.50	99	250	170	650
Selenium	M	2450	mg/kg	0.20	0.48	0.61	< 0.20	< 0.20
Vanadium	U	2450	mg/kg	5.0	14	38	38	19
Zinc	U	2450	mg/kg	0.50	43	110	39	79
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.40	5.7	16	8.8	3.1
Fuel Type	N	2670		N/A	PAH		H. Oil	
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	39		< 1.0	
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	39		< 5.0	
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0		< 1.0	

Results - Soil

Client: LK Consult	Chemtest Job No.:				20-01512	20-01512	20-01512	20-01512
Quotation No.:	Chemtest Sample ID.:				955272	955273	955274	955276
	Client Sample ID.:				HD101 D	HD101 D	HD102	HD104
	Sample Type:				SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.0	0.3	0.2	0.2
	Bottom Depth (m):				0.30	0.70	0.60	0.58
	Date Sampled:				16-Jan-2020	16-Jan-2020	16-Jan-2020	16-Jan-2020
	Asbestos Lab:				COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD				
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0		< 1.0	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	2.9		< 1.0	
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	4.9		1800	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0		< 1.0	
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	7.8		1800	
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	47		1800	
Benzene	M	2760	µg/kg	1.0	< 1.0		< 1.0	
Toluene	M	2760	µg/kg	1.0	< 1.0		< 1.0	
Ethylbenzene	M	2760	µg/kg	1.0	< 1.0		< 1.0	
m & p-Xylene	M	2760	µg/kg	1.0	< 1.0		< 1.0	
o-Xylene	M	2760	µg/kg	1.0	< 1.0		< 1.0	
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0	< 1.0		< 1.0	
Naphthalene	M	2800	mg/kg	0.10	< 0.10	1.5	< 0.10	0.16
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	0.72	< 0.10	0.16
Acenaphthene	M	2800	mg/kg	0.10	0.16	0.62	< 0.10	4.1
Fluorene	M	2800	mg/kg	0.10	< 0.10	0.95	< 0.10	2.3
Phenanthrene	M	2800	mg/kg	0.10	1.7	6.9	0.47	18
Anthracene	M	2800	mg/kg	0.10	0.34	1.4	0.13	3.1
Fluoranthene	M	2800	mg/kg	0.10	2.7	7.0	0.75	16
Pyrene	M	2800	mg/kg	0.10	2.5	7.0	0.75	16
Benzo[a]anthracene	M	2800	mg/kg	0.10	0.79	2.8	0.38	5.5
Chrysene	M	2800	mg/kg	0.10	1.0	3.4	0.35	5.6
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	1.1	3.3	0.45	6.3
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	0.30	1.1	0.13	2.3
Benzo[a]pyrene	M	2800	mg/kg	0.10	0.68	3.1	0.46	5.7
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	0.24	1.6	0.35	3.7
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	0.32	< 0.10	0.17
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	0.47	1.8	0.54	4.1
Total Of 16 PAH's	N	2800	mg/kg	2.0	12	44	4.8	93
Total Phenols	M	2920	mg/kg	0.30	< 0.30		< 0.30	

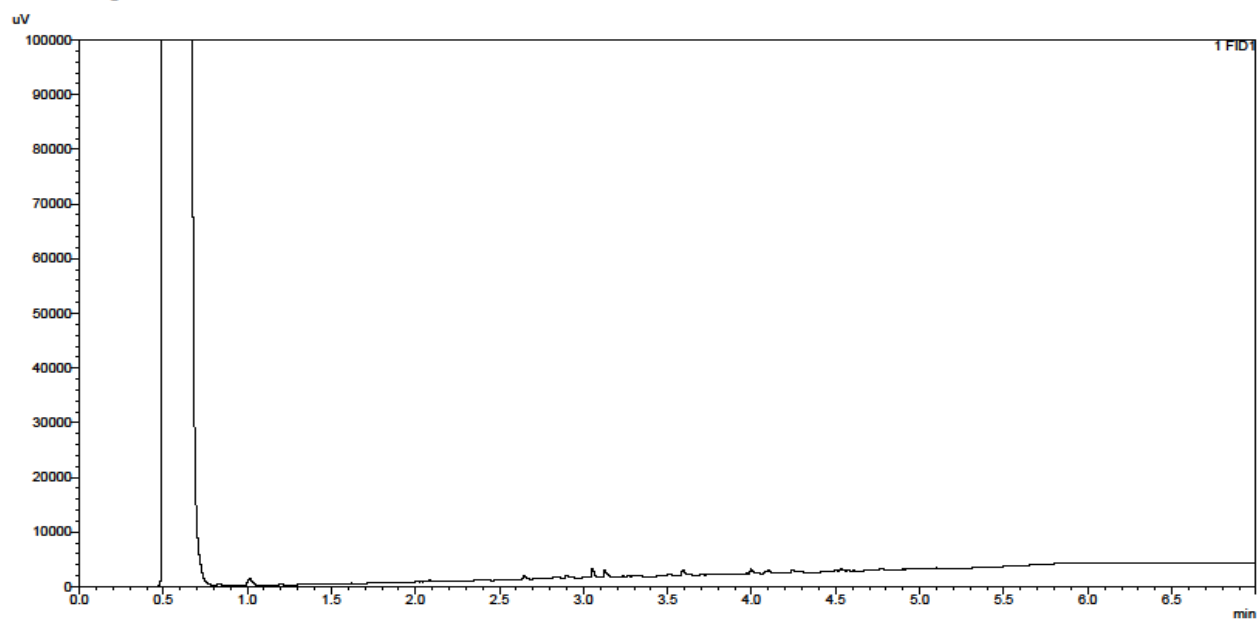
TPH Chromatogram on Soil Sample: 955272

<Sample Information>

Sample Name : 955272 20-01512
Data Filename : 21Jan2020_21012020_955272 20-01512_117.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 59
Date Acquired : 22/01/2020 04:30:29
Date Processed : 23/01/2020



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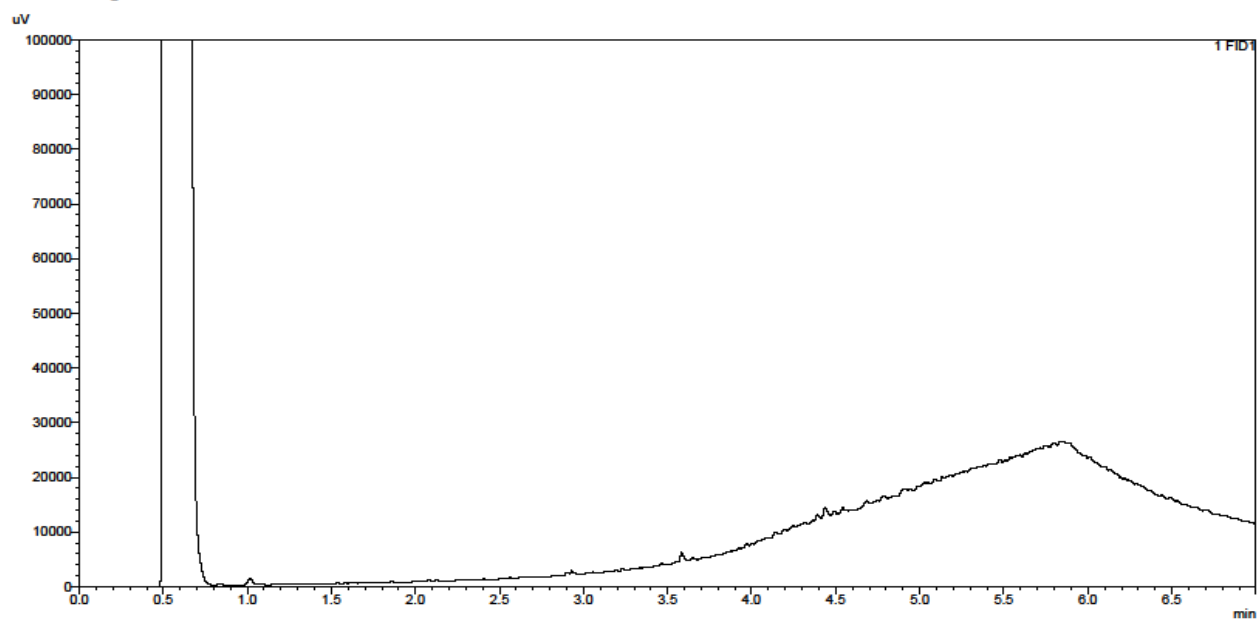
TPH Chromatogram on Soil Sample: 955274

<Sample Information>

Sample Name : 955274 20-01512
Data Filename : 21Jan2020_21012020_955274 20-01512_119.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 60
Date Acquired : 22/01/2020 04:43:03
Date Processed : 23/01/2020



<Chromatogram>



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

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

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

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

All Asbestos testing is performed at the indicated laboratory

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

Sample Deviation Codes

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

Sample Retention and Disposal

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

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

Charges may apply to extended sample storage

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

customerservices@chemtest.com

Appendix D

Generic Assessment Criteria Values

Summary of Category 4 Screening Levels: 2015

Substance	Residential (with home- grown produce)	Residential (without home- grown produce)	Allotments	Commercial	Public Open Space 1	Public Open Space 2
Arsenic	37 mg/kg	40 mg/kg	49 mg/kg	640 mg/kg	79 mg/kg	170 mg/kg
Benzene	0.87 mg/kg	3.3 mg/kg	0.18 mg/kg	98 mg/kg	140 mg/kg	230 mg/kg
Benzo(a)pyrene	5.0 mg/kg	5.3 mg/kg	5.7 mg/kg	77 mg/kg	10 mg/kg	21 mg/kg
Cadmium	22 mg/kg	150 mg/kg	3.9 mg/kg	410 mg/kg	220 mg/kg	880 mg/kg
Chromium VI	21 mg/kg	21 mg/kg	170 mg/kg	49 mg/kg	21 mg/kg	250 mg/kg
Lead	200 mg/kg	310 mg/kg	80 mg/kg	2300 mg/kg	630 mg/kg	1300 mg/kg

Summary Table for the Generic Assessment Criteria for Human Health Risk Assessment Land Quality Management (LQM) S4ULs.

All GAC are based on sandy loam soils with a pH 7.

All GAC are based on sandy loam soils with a pH 7.			LQM Generic Assessment Criteria (mg/kg) Dry weight soil					
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Metals	Inorganic Arsenic	6%	37	40	43	640	79	170
	Beryllium	6%	1.7	1.7	35	12	2.2	63
	Boron	6%	290	11,000	45	240,000	21,000	46,000
	Cadmium	6%	11	85	1.9	190	120	532
	Chromium (III)	6%	910	910	18,000	8,600	1,500	33,000
	Chromium (VI)	6%	6.0	6.0	1.8	33	7.7	220
	Copper	6%	2,400	7,100	520	68,000	12,000	44,000
	Elemental Mercury	6%	1.2	1.2	21	58 (25.8) ^{vap}	16	30 (25.8) ^{vap}
	Inorganic Mercury	6%	40	56	19	1,100	120	240
	Methylmercury	6%	11	15	6.0	320	40	68
	Nickel	6%	180	180	230	980	230	3,400
	Selenium	6%	250	430	88	12,000	1,100	1,800
	Vanadium	6%	410	1,200	91	9,000	2,000	5,000
Zinc	6%	3,700	40,000	620	730,000	81,000	170,000	
BTEX Compounds	Benzene	1%	0.087	0.38	0.017	27	72	90
		2.5%	0.17	0.70	0.034	47	72	100
		6%	0.37	1.4	0.075	90	73	110
	Toluene	1%	130	880 (869) ^{vap}	22	56,000 (869) ^{vap}	56,000	87,000 (869) ^{vap}
		2.5%	290	1,900	51	110,000 (1,920) ^{vap}	56,000	95,000 (1,920) ^{vap}
		6%	660	3,900	120	180,000 (4,360) ^{vap}	56,000	100,000 (4,360) ^{vap}
	Ethylbenzene	1%	47	83	16	5,700 (518) ^{vap}	24,000	17,000 (518) ^{vap}
		2.5%	110	190	39	13,000 (1,220) ^{vap}	24,000	22,000 (1,220) ^{vap}
		6%	260	440	91	27,000 (2,840) ^{vap}	25,000	27,000 (2,840) ^{vap}
	o-xylene	1%	60	88	28	6,600 (478) ^{sol}	41,000	17,000 (478) ^{sol}
		2.5%	140	210	67	15,000 (1,120) ^{sol}	42,000	24,000 (1,120) ^{sol}
		6%	330	480	160	33,000 (2,620) ^{sol}	43,000	33,000 (2,620) ^{sol}
	m-xylene	1%	59	82	31	6,200 (625) ^{vap}	41,000	17,000 (625) ^{vap}
		2.5%	140	190	74	14,000 (1,470) ^{vap}	42,000	24,000 (1,470) ^{vap}
		6%	320	450	170	31,000 (3,460) ^{vap}	43,000	32,000 (3,460) ^{vap}
	p-xylene	1%	56	79	29	5,900 (576) ^{sol}	41,000	17,000 (576) ^{sol}
		2.5%	130	180	69	14,000 (1,350) ^{sol}	42,000	23,000 (1,350) ^{sol}
		6%	310	430	160	30,000 (3,170) ^{sol}	43,000	31,000 (3,170) ^{sol}

NOTES

^{sol/vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

f = oral, dermal and inhalation exposures compared to oral HCV.

All GAC are based on sandy loam soils with a pH 7.

All GAC are based on sandy loam soils with a pH 7.			LQM Generic Assessment Criteria (mg/kg) Dry weight soil					
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene	1%	210	3,000 (57.1) ^{sol}	34	84,000 (57.0) ^{sol}	15,000	29,000
		2.5%	510	4,700 (141) ^{sol}	85	97,000 (141) ^{sol}	15,000	30,000
		6%	1,100	6,000 (336) ^{sol}	200	100,000	15,000	30,000
	Acenaphthylene	1%	170	2,900 (86.1) ^{sol}	28	83,000 (86.1) ^{sol}	15,000	29,000
		2.5%	420	4,600 (212) ^{sol}	69	97,000 (212) ^{sol}	15,000	30,000
		6%	920	6,000 (506) ^{sol}	160	100,000	15,000	30,000
	Anthracene	1%	2,400	31,000 (1.17) ^{vap}	380	520,000	74,000	150,000
		2.5%	5,400	35,000	950	540,000	74,000	150,000
		6%	11,000	37,000	2,200	540,000	74,000	150,000
	Benz(a)anthracene	1%	7.2	11	2.9	170	29	49
		2.5%	11	14	6.5	170	29	56
		6%	13	15	13	180	29	62
	Benzo(a)pyrene (only)	1%	2.2	3.2	0.97	35	5.7	11
		2.5%	2.7	3.2	2.0	35	5.7	12
		6%	3.0	3.2	3.5	36	5.7	13
	Benzo(b)fluoranthene	1%	2.6	3.9	0.99	44	7.1	13
		2.5%	3.3	4.0	2.1	44	7.2	15
		6%	3.7	4.0	3.9	45	7.2	16
	Benzo(ghi)perylene	1%	320	360	290	3,900	640	1,400
		2.5%	340	360	470	4,000	640	1,500
		6%	350	360	640	4,000	640	1,600
	Benzo(k)fluoranthene	1%	77	110	37	1,200	190	370
		2.5%	93	110	75	1,200	190	410
		6%	100	110	130	1,200	190	440
	Chrysene	1%	15	30	4.1	350	57	93
		2.5%	22	31	9.4	350	57	110
		6%	27	32	19	350	57	120
	Dibenzo(ah)anthracene	1%	0.24	0.31	0.14	3.5	0.57	1.1
		2.5%	0.28	0.32	0.27	3.6	0.58	1.3
		6%	0.3	0.32	0.43	3.6	0.58	1.4
	Fluoranthene	1%	280	1,500	52	23,000	3,100	6,300
		2.5%	560	1,600	130	23,000	3,100	6,300
		6%	890	1,600	290	23,000	3,100	6,400
	Fluorene	1%	170	2,800 (36.0) ^{sol}	27	63,000 (30.9) ^{sol}	9,900	20,000
		2.5%	400	3,800 (76.5) ^{sol}	67	68,000	9,900	20,000
		6%	860	4,500 (183) ^{sol}	160	71,000	9,900	20,000
	Indeno(123-cd)pyrene	1%	27	45	9.5	500	82	150
		2.5%	36	46	21	510	82	170
		6%	41	46	39	510	82	180
	Naphthalene	1%	2.3 ^f	2.3 ^f	4.1 ^f	190 ^f (76.4) ^{sol}	4,900 ^f	1,200 ^f (76.4) ^{sol}
		2.5%	5.6 ^f	5.6 ^f	10 ^f	460 ^f (183) ^{sol}	4,900 ^f	1,900 ^f (183) ^{sol}
		6%	13 ^f	13 ^f	24 ^f	1,100 ^f (432) ^{sol}	4,900 ^f	3,000
Phenanthrene	1%	95	1,300 (36.0) ^{sol}	15	22,000	3,100	6,200	
	2.5%	220	1,500	38	22,000	3,100	6,200	
	6%	440	1,500	90	22,000	3,100	6,300	
Pyrene	1%	620	3,700	110	54,000	7,400	15,000	
	2.5%	1,200	3,800	270	54,000	7,400	15,000	
	6%	2,000	3,800	620	54,000	7,400	15,000	
Coal Tar (B(a)P as surrogate marker)	1%	0.79	1.2	0.32	15	2.2	4.4	
	2.5%	0.98	1.2	0.67	15	2.2	4.7	
	6%	1.1	1.2	1.2	15	2.2	4.8	

NOTES

^{sol} / ^{vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

^f = naphthalene is based on comparison of inhalation exposure with TDI_{inhal} for localised effect.

All GAC are based on sandy loam soils with a pH 7.

LQM Generic Assessment Criteria (mg/kg) Dry weight soil

Contaminant	SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Aliphatic							
EC 5-6	1%	42	42	730	3,200 (304) ^{sol}	570,000(304) ^{sol}	95,000 (304) ^{sol}
EC>6-8	1%	100	100	2,300	7,800 (144) ^{sol}	600,000	150,000 (144) ^{sol}
EC>8-10	1%	27	27	320	2,000 (78) ^{sol}	13,000	14,000 (78) ^{vap}
EC>10-12	1%	130 (48) ^{vap}	130 (48) ^{vap}	2,200	9,700 (48) ^{sol}	13,000	21,000 (48) ^{vap}
EC>12-16	1%	1,100 (24) ^{sol}	1,100 (24) ^{sol}	11,000	59,000 (24) ^{sol}	13,000	25,000 (24) ^{sol}
EC>16-35	1%	65,000 (8.48) ^{f, sol}	65,000 (8.48) ^{f, sol}	260,000 ^f	160,000 ^f	250,000 ^f	450,000 ^f
EC>35-44	1%	65,000 (8.48) ^{f, sol}	65,000 (8.48) ^{f, sol}	260,000 ^f	160,000 ^f	250,000 ^f	450,000 ^f
Aliphatic							
EC 5-6	2.5%	78	78	1,700	5,900 (558) ^{sol}	590,000	130,000 (558) ^{sol}
EC>6-8	2.5%	230	230	5,600	17,000 (322) ^{sol}	610,000	220,000 (322) ^{sol}
EC>8-10	2.5%	65	65	770	4,800 (190) ^{vap}	13,000	18,000 (190) ^{vap}
EC>10-12	2.5%	330 (118) ^{vap}	330 (118) ^{vap}	4,400	23,000 (118) ^{vap}	13,000	23,000 (118) ^{vap}
EC>12-16	2.5%	2,400 (59) ^{sol}	2,400 (59) ^{sol}	13,000	82,000 (59) ^{sol}	13,000	25,000 (59) ^{sol}
EC>16-35	2.5%	92,000 (21) ^{f, sol}	92,000 (21) ^{f, sol}	270,000 ^f	1,700,000 ^f	250,000 ^f	480,000 ^f
EC>35-44	2.5%	92,000 (21) ^{f, sol}	92,000 (21) ^{f, sol}	270,000 ^f	1,700,000 ^f	250,000 ^f	480,000 ^f
Aliphatic							
EC 5-6	6%	160	160	3,900	12,000 (1,150) ^{sol}	600,000	180,000 (1,150) ^{sol}
EC>6-8	6%	530	530	13,000	40,000 (736) ^{sol}	620,000	320,000 (736) ^{sol}
EC>8-10	6%	150	150	1,700	11,000 (451) ^{vap}	13,000	21,000 (451) ^{vap}
EC>10-12	6%	760 (283) ^{vap}	760 (283) ^{vap}	7,300	47,000 (283) ^{vap}	13,000	24,000 (283) ^{vap}
EC>12-16	6%	4,300 (142) ^{sol}	4,400 (142) ^{sol}	13,000	90,000 (142) ^{sol}	13,000	26,000 (142) ^{sol}
EC>16-35	6%	110,000 ^f	110,000 ^f	270,000 ^f	1,800,000 ^f	250,000 ^f	490,000 ^f
EC>35-44	6%	110,000 ^f	110,000 ^f	270,000 ^f	1,800,000 ^f	250,000 ^f	490,000 ^f
Aromatic							
EC5-7(benzene as non-threshold)	1%	70	370	13	26,000 (1,220) ^{sol}	56,000	76,000 (1,220) ^{sol}
EC>7-8(toluene)	1%	130	860	22	56,000 (869) ^{vap}	56,000	87,000 (869) ^{vap}
EC>8-10	1%	34	47	8.6	3,500 (613) ^{vap}	5,000	7,200 (613) ^{vap}
EC>10-12	1%	74	250	13	16,000 (364) ^{sol}	5,000	9,200 (364) ^{sol}
EC>12-16	1%	140	1,800	23	36,000 (169) ^{sol}	5,100	10,000
EC>16-21	1%	260 ^f	1,900 ^f	46 ^f	28,000 ^f	3,800 ^f	7,600 ^f
EC>21-35	1%	1,100 ^f	1,900 ^f	370 ^f	28,000 ^f	3,800 ^f	7,800 ^f
EC>35-44	1%	1,100 ^f	1,900 ^f	370 ^f	28,000 ^f	3,800 ^f	7,800 ^f
Aromatic							
EC5-7(benzene as non-threshold)	2.5%	140	690	27	46,000 (2,260) ^{sol}	56,000	84,000 (2,260) ^{sol}
EC>7-8(toluene)	2.5%	290	1,800	51	110,000 (1,920) ^{sol}	56,000	95,000 (1,920) ^{sol}
EC>8-10	2.5%	83	110	21	8,100 (1,500) ^{vap}	5,000	8,500 (1,500) ^{vap}
EC>10-12	2.5%	180	590	31	28,000 (899) ^{sol}	5,000	9,700 (899) ^{sol}
EC>12-16	2.5%	330	2,300 (419) ^{sol}	57	37,000	5,100	10,000
EC>16-21	2.5%	540 ^f	1,900 ^f	110 ^f	28,000 ^f	3,800 ^f	7,700 ^f
EC>21-35	2.5%	1,500 ^f	1,900 ^f	820 ^f	28,000 ^f	3,800 ^f	7,800 ^f
EC>35-44	2.5%	1,500 ^f	1,900 ^f	820 ^f	28,000 ^f	3,800 ^f	7,800 ^f
Aromatic							
EC5-7(benzene as non-threshold)	6%	300	1,400	57	86,000 (4,710) ^{sol}	56,000	92,000 (4,710) ^{sol}
EC>7-8(toluene)	6%	660	3,900	120	180,000 (4,360) ^{vap}	56,000	100,000 (4,360) ^{vap}
EC>8-10	6%	190	270	51	17,000 (3,580) ^{vap}	5,000	9,300 (3,580) ^{vap}
EC>10-12	6%	380	1,200	74	34,000(2,150) ^{sol}	5,000	10,000
EC>12-16	6%	660	2,500	130	38,000	5,100	10,000
EC>16-21	6%	930 ^f	1,900 ^f	260 ^f	28,000 ^f	3,800 ^f	7,800 ^f
EC>21-35	6%	1,700 ^f	1,900 ^f	1,600 ^f	28,000 ^f	3,800 ^f	7,900 ^f
EC>35-44	6%	1,700 ^f	1,900 ^f	1,600 ^f	28,000 ^f	3,800 ^f	7,900 ^f
Aliphatic	1%	1,600 ^f	1,900 ^f	1,200 ^f	28,000 ^f	3,800 ^f	7,800 ^f
+Aromatic	2.5%	1,800 ^f	1,900 ^f	2,100 ^f	28,000 ^f	3,800 ^f	7,800 ^f
>EC44	6%	1,900 ^f	1,900 ^f	3,000 ^f	28,000 ^f	3,800 ^f	7,900 ^f

NOTES

^{sol}/^{vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

^f = oral, dermal and inhalation exposures compared to oral HCV.

All GAC are based on sandy loam soils with a pH 7.

		LQM Generic Assessment Criteria (mg/kg) Dry weight soil						
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Chloalkanes and Alkenes & Explosives	1,2 Dichloroethane (DCA)	1%	7.1E-03	9.2E-03	4.6E-03	0.67	29	21
		2.5%	1.1E-02	1.3E-02	8.3E-03	0.97	29	24
		6%	1.9E-02	2.3E-02	1.6E-02	1.7	29	28
	1,1,1 Trichloroethane (TCA)	1%	8.8	9.0	48	660	140,000	57,000 (1,425) ^{vap}
		2.5%	18	18	110	1,300	140,000	76,000 (2,915) ^{vap}
		6%	39	40	240	3,000	140,000	100,000 (6,392) ^{vap}
	1,1,2,2-Tetrachloroethanes (PCA)	1%	1.6	3.9	0.41	270	1,400	1,800
		2.5%	3.4	8.0	0.89	550	1,400	2,100
		6%	7.5	17	2.0	1,100	1,400	2,300
	1,1,1,2-Tetrachloroethanes (PCA)	1%	1.2	1.5	0.79	110	1,400	1,500
		2.5%	2.8	3.5	1.9	250	1,400	1,800
		6%	6.4	8.2	4.4	560	1,400	2,100
	Tetrachloroethene (PCE)	1%	0.18	0.18	0.65	19	1,400	810 (424) ^{sol}
		2.5%	0.39	0.40	1.5	42	1,400	1,100 (951) ^{sol}
		6%	0.90	0.92	3.6	95	1,400	1,500
	Tetrachloromethane (carbon tetrachloride)	1%	2.6E-02	2.6E-02	0.45	2.9	890	190
		2.5%	5.6E-02	5.6E-02	1.0	6.3	920	270
		6%	0.13	0.13	2.4	14	950	400
	Trichloroethene (TCE)	1%	1.6E-02	1.7E-02	4.1E-02	1.2	120	70
		2.5%	3.4E-02	3.6E-02	9.1E-02	2.6	120	91
		6%	7.5E-02	8.0E-02	0.21	5.7	120	120
	Trichloromethane (chloroform)	1%	0.91	1.2	0.42	99	2,500	2,600
		2.5%	1.7	2.1	0.83	170	2,500	2,800
		6%	3.4	4.2	1.7	350	2,500	3,100
	Chloroethene (vinyl chloride)	1%	6.4E-04	7.7E-04	5.5E-04	5.9E-02	3.5	4.8
		2.5%	8.7E-04	1.0E-03	1.0E-03	7.7E-02	3.5	5.0
		6%	1.4E-03	1.5E-03	1.8E-03	0.12	3.5	5.4
	2,4,6-Trinitrotoluene (TNT)	1%	1.6	65	0.24	1,000	130	260
		2.5%	3.7	66	0.58	1,000	130	270
		6%	8.1	66	1.4	1,000	130	270
	RDX	1%	120	13,000	17	210,000	26,000	49,000 (18.7) ^{sol}
		2.5%	250	13,000	38	210,000	26,000	51,000
		6%	540	13,000	85	210,000	27,000	53,000
	HMX	1%	5.7	6,700	0.86	110,000	13,000	23,000 (0.35) ^{vap}
		2.5%	13	6,700	1.9	110,000	13,000	23,000 (0.39) ^{vap}
		6%	26	6,700	3.9	110,000	13,000	24,000 (0.48) ^{vap}
Pesticides	Aldrin	1%	5.7	7.3	3.2	170	18	30
		2.5%	6.6	7.4	6.1	170	18	31
		6%	7.1	7.5	9.8	170	18	31
	Dieldrin	1%	0.97	7.0	0.17	170	18	30
		2.5%	2.0	7.3	0.41	170	18	30
		6%	3.5	7.4	0.96	170	18	31
	Atrazine	1%	3.3	610	0.5	9,300	1,200	2,300
		2.5%	7.8	620	1.2	9,400	1,200	2,400
		6%	17.4	620	2.7	9,400	1,200	2,400
	Dichlorvos	1%	3.2E-02	6.4	4.9E-03	140	16	26
		2.5%	6.6E-02	6.5	1.0E-02	140	16	26
		6%	0.14	6.6	2.2E-02	140	16	27
	Endosulfans (2 isomers)	1%	7.4	160 (3.0E-03) ^{vap}	1.2	5,600 (3.0E-03) ^{vap}	1,200	2,300
		2.5%	18	280 (7.0E-03) ^{vap}	2.9	7,400 (7.0E-03) ^{vap}	1,200	2,400
		6%	41	410 (1.6E-02) ^{vap}	6.8	8,400 (1.6E-02) ^{vap}	1,200	2,500
	Hexachlorocyclohexane (3 isomers), inc Lindane	1%	8.5E-02	3.7	1.3E-02	65	8.1	15
		2.5%	0.2	3.8	3.2E-02	65	8.1	15
		6%	0.46	3.8	7.7E-02	65	8.1	16

NOTES

^{sol} / ^{vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

All GAC are based on
sandy loam soils with a pH
7.

All GAC are based on sandy loam soils with a pH 7.			LQM Generic Assessment Criteria (mg/kg) Dry weight soil					
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Chlorobenzenes	Chlorobenzene	1%	0.46	0.46	5.9	56	11,000	1,300 (675) ^{sol}
		2.5%	1.0	1.0	14	130	13,000	2,000 (1,520) ^{sol}
		6%	2.4	2.4	32	290	14,000	2,900
	Dichlorobenzenes (3 isomers)	1%	23	24	94	2,000 (571) ^{sol}	90,000	24,000 (571) ^{sol}
		2.5%	55	57	230	4,800 (1,370) ^{sol}	95,000	36,000 (1,370) ^{sol}
		6%	130	130	540	11,000 (3,240) ^{sol}	98,000	51,000 (3,270) ^{sol}
	Trichlorobenzenes (3 isomers)	1%	2.6	2.6	55	220	15,000	1,700 (318) ^{vap}
		2.5%	6.4	6.4	140	530	17,000	2,600 (786) ^{vap}
		6%	15	15	320	1,300	19,000	4,000 (1,880) ^{vap}
	Tetrachlorobenzenes (3 isomers)	1%	0.66	0.75	0.38	49 (39.4) ^{vap}	78	110 (39) ^{vap}
		2.5%	1.6	1.9	0.90	120 (98.1) ^{vap}	79	120
		6%	3.7	4.3	2.2	240 (235) ^{vap}	79	130
	Pentachlorobenzene	1%	5.8	19	1.2	640 (43.0) ^{sol}	100	190
		2.5%	12	30	3.1	770 (107) ^{sol}	100	190
		6%	22	38	7.0	830	100	190
	Hexachlorobenzene	1%	1.8 (0.20) ^{vap}	4.1 (0.20) ^{vap}	0.47	110 (0.20) ^{vap}	16	30
		2.5%	3.3 (0.50) ^{vap}	5.7 (0.50) ^{vap}	1.1	120	16	30
		6%	4.9	6.7 (1.2) ^{vap}	2.5	120	16	30
Chlorophenol	Chlorophenols (4 congeners)	1%	0.87 ^g	94	0.13 ^g	3,500	620	1,100
		2.5%	2.0	150	0.30	4,000	620	1,100
		6%	4.5	210	0.70	4,300	620	1,100
	Pentachlorophenol	1%	0.22	27 (16.4) ^{vap}	3.0E-02	400	60	110
		2.5%	0.52	29	8.0E-02	400	60	120
		6%	1.2	31	0.19	400	60	120
Others	Carbon Disulphide	1%	0.14	0.14	4.8	11	11,000	1,300
		2.5%	0.29	0.29	10	22	11,000	1,900
		6%	0.62	0.62	23	47	11,000	2,700
	Hexachlorobutadiene	1%	0.29	0.32	0.25	31	25	48
		2.5%	0.7	0.78	0.61	66	25	50
		6%	1.6	1.8	1.4	120	25	51
	Phenol	1%	280	750	66	760 ^{dir} (31,000)	760 ^{dir} (11,000)	760 ^{dir} (8,600)
		2.5%	550	1,300	140	1,500 ^{dir} (35,000)	1,500 ^{dir} (11,000)	1,500 ^{dir} (9,700)
		6%	1,100	2,300	280	3,200 ^{dir} (37,000)	3,200 ^{dir} (11,000)	3,200 ^{dir} (11,000)

NOTES

^{sol / vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

^{dir} = S4uls based on threshold protective of direct skin contact with phenol (brackets long term exposure for illustration purposes).

^g = derived based on 2,3,4,6-tetrachlorophenol.

Appendix E

Examples of Surfacing

BODPAVE 85 Porous Pavers



www.terram.com

 **TERRAM**
Geosynthetics you can trust

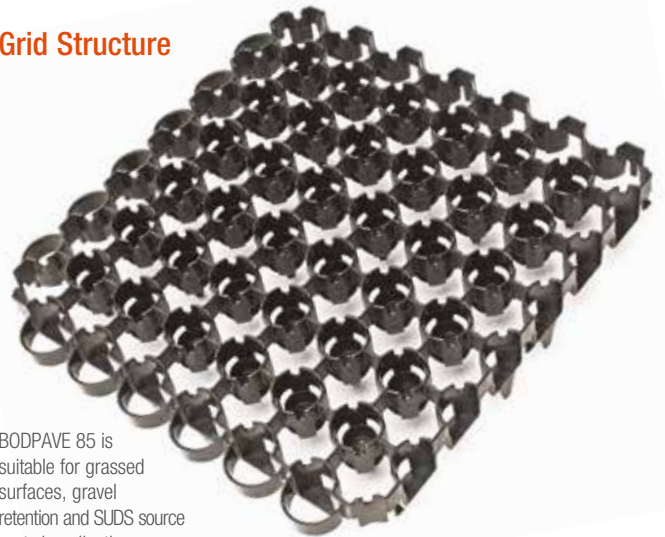
Bodpave™ 85



Permanent grassed or gravel car and coach parking bays, fire access routes, helipads, taxiways, cycle paths, driveways, access roads and other trafficked areas where a structurally-sound, well drained base is present or will be installed.

TERRAM BODPAVE 85 is an interlocking cellular porous plastic paving grid system for ground reinforcement which can be installed with either a grass or gravel filled surface. BODPAVE 85 units are manufactured in the UK from UV stabilised 100% recycled waste plastic and are strong, chemically inert & non-toxic. The unique design of the BODPAVE 85 units resist lateral movement, improves traction and allows expansion & contraction whilst promoting optimum grass growth, root protection and surface stabilisation. BODPAVE 85 porous paving provides a durable, safe and environmentally friendly surface for trafficked areas with a very low carbon footprint compared to traditional paving solutions.

Grid Structure



BODPAVE 85 is suitable for grassed surfaces, gravel retention and SUDS source control applications.

Applications (Grass or Gravel)

- Car Parking / Coach Parking bays
- Overspill / overflow grass car parks
- Emergency Service (Fire access routes)
- Grass aircraft taxiways & helipads
- Walkways and disabled access routes
- Golf buggy paths
- Driveways and residential lawn parking
- SUDS source control



BODPAVE 85 installation for a gravel car park.



Bodpave™ 85



Features and Benefits:

- Load bearing capacity up to 400t/m² - will cope with static axle loads up to 60kN
- Supplied as 4 pre-connected pavers (1m x 1m) - allows rapid installation
- 24 interlocking connections per paver – excellent lateral transfer of traffic loads
- 18 ground spikes per paver – excellent shear connection with the ground allows slopes up to 1:8 / 12% / 7° and generally no pinning required
- Expansion/contraction tolerant – suitable for hot and cold climates
- Manufactured from 100% recycled and recyclable polymers – highly sustainable, non-toxic and chemically inert to chemicals naturally found in soils
- British manufactured - lower transport carbon footprint for UK deliveries
- 92% open surface structure- SUDS source control compliant
- Grass or gravel finish - free draining and naturally pleasing appearance
- Paving grids can be offset by 1 cell increments – easy to fit around obstacles



Sustainable Drainage System (SUDS) - Source Control

The open cell structure of TERRAM BODPAVE 85 provides high surface water infiltration and is ideally suited to provide source control within a Sustainable Urban Drainage System (SUDS). BODPAVE 85 permeable paving grids should be installed onto a well prepared, free draining, firm and relatively level existing or newly constructed sub-base. By careful specification of suitable materials the sub-base can be designed to hold rain water (source control SUDS) allowing it to slowly drain away into either the underlying ground or surface water drainage system depending upon site conditions. Construction profiles for each application will be determined by specific site conditions & loading criteria. Detailed specification, design and installation guidance literature and technical information are available to download from www.terram.com. Please note that for all BODPAVE 85 grass paver/gravel paver installations, we strongly recommend that all areas should have sufficient drainage prior to the installation. Failure to ensure this may result in the product not performing as intended.

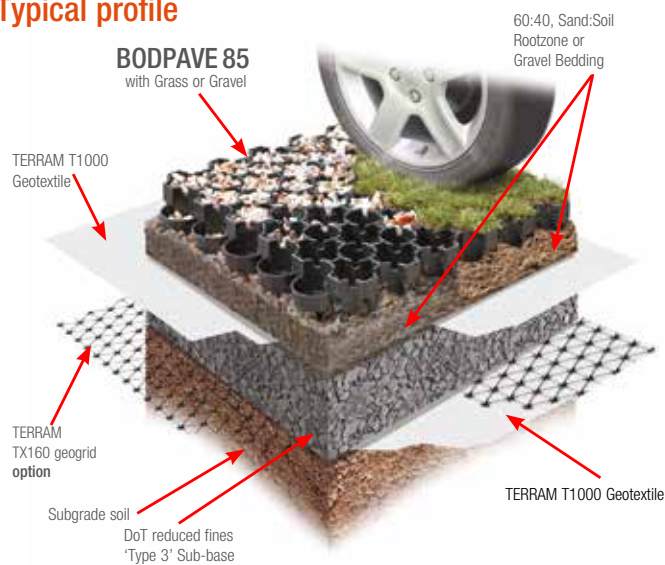
Please note that regular tight turning of vehicles and “dry” steering may cause damage to the units and/or displace gravel infill; vehicle manoeuvring should be carefully considered at specification/design stage. Gravel filled units may require some maintenance when subjected to regular channelised and turning traffic loadings. For confirmation of the correct construction profile required and guidance on suitable loadings please contact our office on 01621 874200 to speak with a member of our technical team.



Bodpave™ 85



Typical profile



Not all layers will apply to every application and drainage may be required. Please refer to design guidance documents.



Car Park Bay Markers

TERRAM also manufacture car park bay markers that have been designed to snap-fit into the square-shaped cells of the BODPAVE 85 units. Each marker is 215mm x 70mm and can be used to create dashed or solid lines and L or T shapes. They can be fixed permanently in place by using a suitable exterior grade high-strength adhesive.



Line marker details

COLOUR	SIZE	MATERIAL
White/Yellow	215 x 70	HDPE

Bodpave 85 product details

PAVER SIZE (mm)	NOMINAL CELL SIZE (mm)	QUANTITY (per m ²)	COLOUR	WEIGHT (Nominal)	LOAD BEARING CAPACITY	MATERIAL
500 x 500 x 50	67 Plaque & 46 Round	4 Grids	Black	6.24kg/m ²	400tonnes/m ²	Recycled Polyethylene
500 x 500 x 50	67 Plaque & 46 Round	4 Grids	Green	6.24kg/m ²	400tonnes/m ²	Recycled Polyethylene
Ground Spikes:	Each paver includes a 35mm integral ground spike					
Assembled Size on Pallet:	1000mm x 1000mm (2 x 2 units)					
Weight:	6.24kg per m ² / 1.56kg per tile					
Pallet Dimensions:	1000mm x 1000mm x 2340mm / Contains 18 units / 45 layers (45m ³) / Total pallet weight 300kg					

TERRAM Data Sheets, Installation & Design Guidances and Case Studies can be downloaded from www.terram.com

Further market specific literature available:

- Railways
- Road and Highways
- Landfill
- Coastal & Waterways
- Pipelines / Utilities
- Forestry & Landscaping
- Fruit & Viticulture

www.tubex.com

Application specific literature, product data sheets, case studies and installation guides are available on request or can be freely downloaded from **www.terram.com**

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TERRAM excels in the innovative application of technology to create versatile, high-performance materials which are unique, cost-efficient and deliver significant added value.

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Grasscrete

Grass reinforcement

Occasionally confused with pre-cast blocks Grasscrete is in fact a cast on site cellular reinforced concrete system with voids created by styrene void formers.

This type of construction offers significant structural advantages over precast concrete and plastic systems:

- load bearing up to 40 tonnes gross vehicle weight
- resists differential settlement
- reduces sub-base depths
- eliminates kerb edges
- no reliance on grass for stability
- optimum drainage capability

The lightweight nature of the Grasscrete former moulds enables us to ship economically throughout the world.



Typical traffic related specifications for Grasscrete can include:

- vehicle parking for daily or overspill use
- emergency access
- maintenance access
- highway verges and pull-ins

In addition to its ability to withstand traffic loads, Grasscrete is also massively used for projects in the water environment. Tested to flow rates in excess of 8 metres per second, this self-venting paving system is ideal for armouring the following:-

- reservoirs
- spillways
- storm/drainage channels
- river and sea defences
- swales

When combined with its ability to withstand traffic, Grasscrete has a unique position in the field of Water Engineering.



Grasscrete - Grassblock - Grassroad - Grasskerb - Grassroof - Betoflor - Betoplus - Betotatlas - Betotitan - Leromur - Binwall

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