SEVERNSIDE DISTRIBUTION LAND LIMITED
C/O UPTON MCGOUGAN LIMITED

REPORT

on

GROUND INVESTIGATION

at

AREA H & I

PHASE 4

AVONMOUTH

MARCH 2013

REPORT NO: 727748

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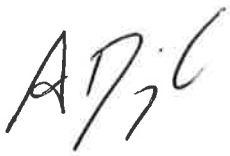
Prepared by:		B Saimen / A Dingle
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Date:		March 2013

REVISION RECORD

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Table of Contents

1 INTRODUCTION

This investigation was carried out on the instructions of Upton McGougan Limited (the Engineer) on behalf of Severnside Distribution Land Limited (the Client). The purpose of the work was to assess the nature of the imported fill on the site with a view to assessing both the risks posed by the fill to human health on a theoretical commercial development and to provide comment on the potential classification of the fill from an earthworks perspective.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and laboratory testing results.

The ground investigation has been carried out using machine dug trial pitting techniques in general accordance with the recommendations of BS5930: 1999 *Code of Practice for Site Investigations.* Whilst every attempt is made to record full details of the strata encountered in the exploratory holes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks. The investigation has also been carried out in accordance with BS10175 *Investigation of Potentially Contaminated Sites: Code of Practice* (2011).

A comprehensive desk study, other than an inspection of geological maps, has not been requested or undertaken as part of this investigation. No testing has been undertaken to detect the presence of gas in the ground.

All information, comments and opinions given in this report are based on the ground conditions encountered during the site work, and on the results of laboratory tests performed during the investigation. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those measured during the investigation.

This report was prepared by Structural Soils Ltd for the sole and exclusive use of Severnside Distribution Land Limited in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SITE DESCRIPTION

2.1 Location and Topography

The site is split into two parts, both of which are located to the north east of Severn Road, approximately 4km north-east of the centre of Avonmouth, Bristol (see Site Location Plan in Appendix A). The British National Grid Reference of the main site is ST 541 816.

The main site investigated is triangular in shape, approximately 3.13 hectares in size and measures a maximum of 180m north to south and 450m east to west. The second area investigated was an irregular plot roughly 100m by 50m in size, located approximately 350m to the south of the main site (See Exploratory Hole Location Plan in Appendix A).

The site was formerly pasture with associated field boundary drainage rhines (ditches) forming part of the former Minor's Farm, the buildings for which are close to the northern extremity of the site.

Ground levels over much of the site have been raised by approximately 1.50m to 2.00m through the emplacement of imported soils by Churngold. This process is complete and although the finished levels on the site are generally uniform, there was also a stockpile of surplus material present during our investigations.

Services that cross the area investigated are understood to be limited to a pair of overhead high voltage electricity transmission lines, which cross the north-eastern edge of the site. The land around the base of the transmission pylons, which falls within the site limits, has not been raised.

A GPSS (Government Pipeline and Storage System) pipeline bounds the southern edge of the main site. Their local representative was met on site prior to the commencement of the works and a 30m easement from the line of the pipeline for our investigation work was agreed.

The filling on the main site appears to be been completed to within a few metres of the line of the GPSS pipeline, and to the south of this the site is bordered by further raised land belonging to the Client. Ground levels in the second site had also been raised; the area investigated had been filled, the fill excavated (or 'borrowed'), and then later replaced.

To the south east the site is bounded by Severn Road, beyond which is further farm land. In the south the site is bounded both by farmland and the Hallen Industrial Estate, whilst to the east is a further farmland, and a gas storage facility.

2.2 Geology

The British Geological Survey map (sheet 264, scale 1:50,000, published 2004) shows the site to be underlain by Quaternary Alluvium, comprising sand silt and clay, over the Triassic undivided Mercia Mudstone Group at depth.

Experience of drilling in the area shows that the Alluvium is typically a desiccated stiff clay in the near surface, becoming softer with depth. In this locality is it common to encounter several metres of fairly clean silty sandy above the base of the Alluvium which can be expected around 17m to 18m below the original ground levels on the site.

The Mercia Mudstone Group will typically comprise increasingly stiff reddish brown clays, tending to mudstone with depth.

2.3 Hydrogeology

The Environment Agency website identified that the Alluvium is classed as 'Unproductive Strata'. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or for providing river base flow.

The underlying Mercia Mudstone Group has been classed as 'Secondary B' aquifer. These aquifers are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers. In the case of the Mercia Mudstone Group this probably relates to the sandstone bands that can be encountered within the group, rather than the mudstones.

The site is not located within a Source Protection Zone (SPZ).

3 FIELDWORK

3.1 Scope of Works

7 no. machine dug trial pits (TP1 to TP7) were completed between 11 and 12 February 2013 2011 at the locations shown on the Exploratory Hole Location Plan in Appendix A.

The scope of investigation was decided by Upton McGougan Limited with the choice of investigative technique being made by Structural Soils Limited. Sampling details were specified by Structural Soils Limited. The positions were selected by and set out by Structural Soils Limited and were placed to provide general site coverage, there being no known specific area of potential contamination.

Access to parts of the site was not possible due to the agreed wayleave in relation to the GPSS pipeline, and appropriate safe working distances for plant in relation to the over head electricity lines.

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS5930: 1999. Detailed descriptions, together with relevant comments, are given in the logs included in Appendix B.

3.2 Trial Pits

The trial pits were excavated using a mechanical excavator and were approximately 0.75m x 2.20m in plan area and up to 2.70m deep. Hand vane and/or hand penetrometer tests were carried out in the cohesive strata in the trial pits. Small disturbed and bulk soil samples were taken from the trial pits at regular intervals.

3.3 Chemical Contamination Sampling

Samples for contamination testing were taken from the exploratory holes. Samples for contamination testing were placed in appropriate contamination sample containers that were supplied by the laboratory. All samples were then kept in cool boxes with ice packs and were transported to the laboratories under Chain of Custody documentation, as promptly as possible to maintain sample integrity.

3.4 Backfill

On completion the trial pits were backfilled with arisings, compacted in layers by the excavator bucket.

4 LABORATORY TESTING

Samples for potential geotechnical testing were returned to the company's laboratory in Bristol and those for potential contamination testing were sent to an accredited chemical testing laboratory. Geotechnical and contamination tests were scheduled by Structural Soils Limited.

Geotechnical laboratory testing was generally carried out in accordance with BS1377: 1990, *Methods of Test for Soils for Civil Engineering Purposes*, Parts 1 to 8, unless indicated otherwise. Where non-standard procedures have been undertaken, this is recorded on the report sheet. The results are reported in tabular and/or graphical form and included as Appendix C of this report.

Contamination testing was carried out in accordance with MCERTs/UKAS standards. The results are reported in Appendix D of this report, along with the accreditation certificate for the laboratory.

4.1 Moisture Content

5 no. moisture content tests were undertaken using the oven-drying method in accordance with BS1377: Part 2: 1990. The results are tabulated in the Summary of Soil Classification Tests and below the Plasticity Chart (see Section 4.2, below).

4.2 Liquid Limit, Plastic Limit and Plasticity Index

5 no. liquid and plastic limit tests were performed in accordance with BS1377: Part 2: 1990. The results are plotted on the Plasticity Chart (in accordance with BS5930: 1999) and tabulated below the chart, and in the Summary of Soil Classification Tests.

4.3 Particle Size Distribution

5 no. particle size distribution tests were undertaken by sieving. All tests were in accordance with BS1377: Part 2: 1990. The results are represented graphically as particle size distribution curves and in tabular format.

4.4 Dry Density/Moisture Content Relationship

5 no. dry density/moisture content relationship tests were undertaken in accordance with BS1377: Part 4: 1990 to determine the maximum dry density and optimum moisture content. Tests were carried out in a California Bearing Ratio (CBR) mould, using a 2.5kg rammer. The results are presented graphically as dry density/moisture content curves together with values of maximum dry density and optimum moisture content identified from the plot.

4.5 Contamination

No potential asbestos fibres, nor man-made materials that could potentially contain asbestos fibres, were observed during site works hence no testing for asbestos was therefore undertaken on any soil samples.

7 no. soil samples were analysed for arsenic, cadmium, chromium (total), lead, mercury, selenium, copper, nickel, zinc, speciated polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (banded TPH), organic matter, soluble sulphate and pH (SSL Soil 1 suite).

In addition the 7 no. soil samples were also analysed for the hexavalent chromium (Cr_{VI}).

5 GROUND CONDITIONS

5.1 General

The exploratory holes were logged by an engineer and the ground conditions encountered are detailed on the logs contained in Appendix B and are summarised below.

5.2 Made Ground

The made ground generally comprised firm reddish brown and grey slightly sandy gravelly clay with the gravel fraction comprising fine to coarse limestone, siltstone, concrete, brick, ceramic, clinker and asphalt.

TP1 recorded a layer of grey very clayey very sandy gravel from 1.20m to 1.90m depth, with the gravel constituent comprising brick, concrete, asphalt, limestone and siltstone.

5.3 Alluvium

Soil representing the desiccated crust of the Alluvium was encountered at the base of the made ground in all of the exploratory holes except TP6 and TP7. It was a stiff grey mottled brown locally sandy clay with occasional black mottling.

5.4 Water

No groundwater was encountered in any of the trial pits during the course of the investigation.

6 DISCUSSION

6.1 Suitability for Use as Fill

The suitability of soil for use as fill is often based upon the classification given in the Specification for Highway Works, Section 600. This document defines acceptable and unacceptable materials, the latter containing peat, wood and perishable materials.

The made ground comprising the fill is predominantly firm slightly sandy gravelly clay, locally with a low cobble content. All of the soils tested were found to contain greater than 15% fines and thus in accordance with the Specification for Highways Works, Section 600, they are classed as cohesive fills. Based upon the Atterberg limits and on the gradings the made ground has been classified as follows.

Location	Class(es) from Table 6/1 and Table 6/2	Comment
TP1	2C	-
TP3	2C	-
TP5	2C	-
TP6	2C	-
TP7	2B	-

All of the imported fill would therefore be class 2C *Stony cohesive material*, barring TP7 which is class 2B *Dry Cohesive Material*. Rare gravel size pieces of decayed wood were observed in TP1 and TP7, but these are not considered significant.

5 no. dry density – moisture content relationship tests were carried out using a 2.5kg rammer on samples of the imported fill. These gave optimum moisture contents of between 14% and 21%, and natural moisture contents of between 20% and 39%.

For all of the soils the Initial Moisture Content is wet of the Optimum Moisture Content indicating that if the sampled moisture content reflects the moisture content when laid, then 95% compaction is unlikely to have been achieved. No testing has been undertaken as part of this investigation to determine the actual densities to which the imported fill has been compacted.

6.2 Contamination

6.2.1 Risk to Human Health

General

To determine whether contaminants are present at levels that may be deemed to pose a significant hazard to human health, measured contamination levels in soil at the site are

compared against derived guideline values ('Tier 2' soil screening), either directly or following statistical analysis. Where contaminants are present above the screening values it is probable that site-specific information will be required to further examine the potential risk of harm arising from such contamination.

The background to the assessment is contained in Appendix D and the findings are summarised in the following pages.

The proposed used of the site is commercial and thus the commercial scenario guidelines have been used to assess the results. We have compared the results directly to the GACs without the use of the statistics.

Results

Contaminants assessed against the GAC's are: arsenic, cadmium, chromium, chromium VI, copper, lead, mercury, nickel, selenium, zinc, Polycyclic Aromatic Hydrocarbons (PAH) & Total Petroleum Hydrocarbons (TPH).

All of the individual results for the remaining contaminants were all below the GAC/CLEA SGV's for a commercial end-use.

Conclusions

The investigation has shown contaminant levels in the soil to be below the assessment criteria, which indicates that no risks to human health have been identified.

6.2.2 Initial Waste Characterisation

Envirolab have produced an assessment tool that characterises contaminated waste soil by following the guidance within WM2. The 'total solid testing' results from this investigation have been run through this assessment tool to aid potential future off-site disposal of materials. This assessment produces an 'initial' characterisation of the waste which determines if it is hazardous or not (if it is 'not' hazardous, then it may be either inert (insoluble and inorganic) or non-hazardous. However, due to complications with the terminology of 'inert waste' it is best not to refer to it as such until after Waste Acceptance Criteria testing).

Any samples that are classed as hazardous will have light cells with bold text, in the respective sample columns (assuming results are in black & white, otherwise yellow cells on a colour copy). The results are summarised as follows:

All of the samples tested are classed as not being hazardous, barring the sample from TP1 which is shown to fail the Ecotoxic H14 threshold and thus is deemed to be hazardous. This results from the elevated zinc concentration in this sample.

As noted in Section 6.2.1, this poses no risk to human health for the proposed end use; the result might be significant if material excavated from this location were to be disposed of in the future. There is no obvious source of the elevated zinc shown on the trial pit log for TP1, although the metal nails noted in TP2 could be a possible source. Such a source would not be deemed significant.

It is important to note that whilst we believe our in-house assessment tool to be an accurate interpretation of the requirements of WM2, thereby producing initial classifications in accordance with it, landfill operators often have their own assessment tools and can often come to a different conclusion. As a result, some landfill operators could even refuse to take apparently suitable waste.

7 SUMMARY

7.1 The investigation was carried out on the instructions of Upton McGougan on behalf of Severnside Distribution Land Limited. The scope of the works was to assess the nature of the recently imported fill to determine any risk posed to human health on an unspecified future commercial development, to determine the waste classification of the imported fill and to provide comment on the potential classification of the fill from an earthworks perspective.

7.2 The site is divided into two parts, both located to the north east of Severn Road, approximately 4km north-east of the centre of Avonmouth, Bristol. The main site investigated is triangular in shape, approximately 3.13 hectares in size and measures a maximum of 180m north to south and 450m east to west. The additional area investigated was an irregular plot roughly 100m by 50m in size, located approximately 350m to the south of the main site.

7.3 The site is underlain by Alluvium over the Triassic Mercia Mudstone Group at depth.

7.4 The thickness of the fill was found to range from 1.70m to 2.10m. The nature of the imported fill was generally fine grained, with a varying but usually significant quantity of coarse grained material up to cobble sized. Anthropogenic components included limestone, siltstone, concrete, brick, ceramic, clinker and asphalt.

7.5 No groundwater was encountered in any of the trial pits during the course of the investigation.

7.6 The testing undertaken has identified that all of the imported fill would be considered 'cohesive' as the fines content has exceeded 15% in all samples tested. The likely classifications for the fill is generally 2C, although the soils from TP7 are classed as 2B.

7.7 Moisture content relationship tests were carried out using a 2.5kg rammer on samples of the imported fill. The Initial Moisture Content is wet of the Optimum Moisture Content indicating that if the sampled moisture content reflects the moisture content when laid, then 95% compaction is unlikely to have been achieved.

7.8 All of the soils could be compacted at their natural moisture content to achieve 95% of the maximum dry density from the 2.5kg rammer method. However no testing has been undertaken to determine the actual densities to which the imported fill has been compacted.

7.9 The contamination analysis undertaken has not identified any significant risk to human health for a theoretical commercial development.

7.10 The initial waste characterisation shows that the samples are classed as non-hazardous, barring the sample from TP1 which is shown to fail the Ecotoxic H14 threshold due to the elevated zinc content and thus is deemed to be hazardous. This poses no risk to human health for the proposed end use; the result might be significant if material excavated from this location were to be disposed of in the future.

STRUCTURAL SOILS LIMITED

A Dingle BSc (Hons) FGS

A Cattell BSc PhD CGeol FGS

8 REFERENCES

8.1 BS 5930:1999 *Code of Practice for Site Investigations: amendment 1 (2011)*

8.2 BS 10175: 2001 *Investigation of potentially contaminated sites: Code of practice*

8.3 Geological Survey of Great Britain sheet 256 scale 1:50000, published 2004

8.4 NRA Groundwater Vulnerability Map sheet 37 scale 1:100,000

8.5 BS 1377:1990 *Methods of Test for Soils for Civil Engineering Purposes*

8.6 Department for Transport, *Manual of Contract Documents for Highway Works (MCHW), Volume One: Specification for Highway Works, Section 600 Earthworks*, November 2009

8.7 Environment Agency Policy. Part IIA – *Detailed Quantitative Assessment of Chronic Risks to Human Health from Contaminated Soils. Policy Number 199_04*, dated 9 March 2004.

8.8 Environment Agency Science Report SR2: *Human health toxicological assessment of contaminants in soil (Final SC050021/SR2)*

8.9 Environment Agency Science Report SR3: *Updated technical background to the CLEA model (Final SC050021/SR3).*

8.10 R & D Publication CLR 11 (September 2004). *Model Procedures for the Management of Contaminated Land. Contaminated Land. Environment Agency.*

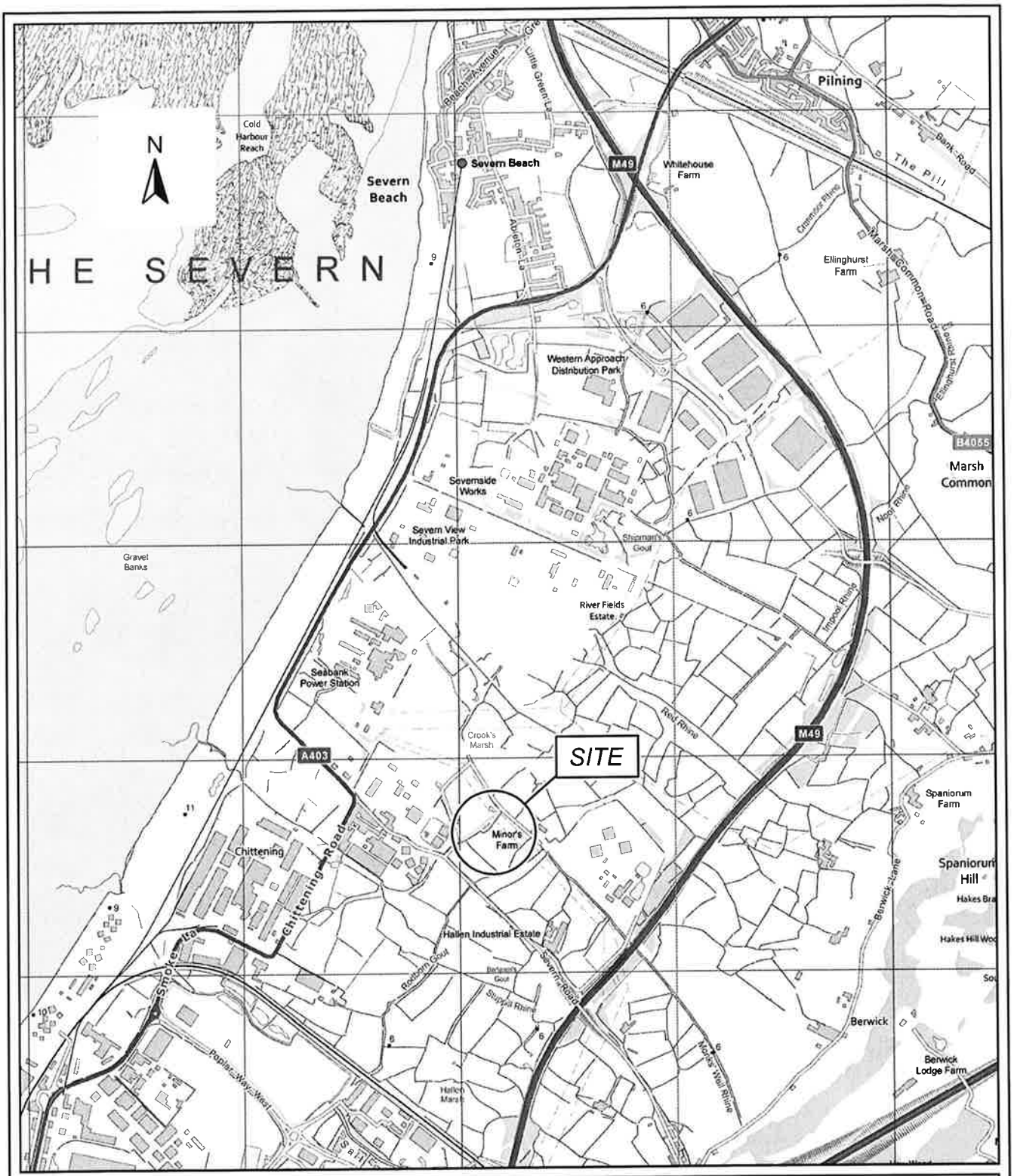
8.11 Landfill (England & Wales) Regulations 2002.

8.12 Hazardous Waste: *Interpretation of the Definition and Classification of Hazardous Waste*, Environment Agency, WM2 Version 1.0, June 2003.

APPENDIX A

(i) Site Location Plan

(ii) Exploratory Hole Location Plan



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REV.	DATE	DESCRIPTION	BY	CHD.	APR.
00	22.03.2013	-	JAH	AD	-

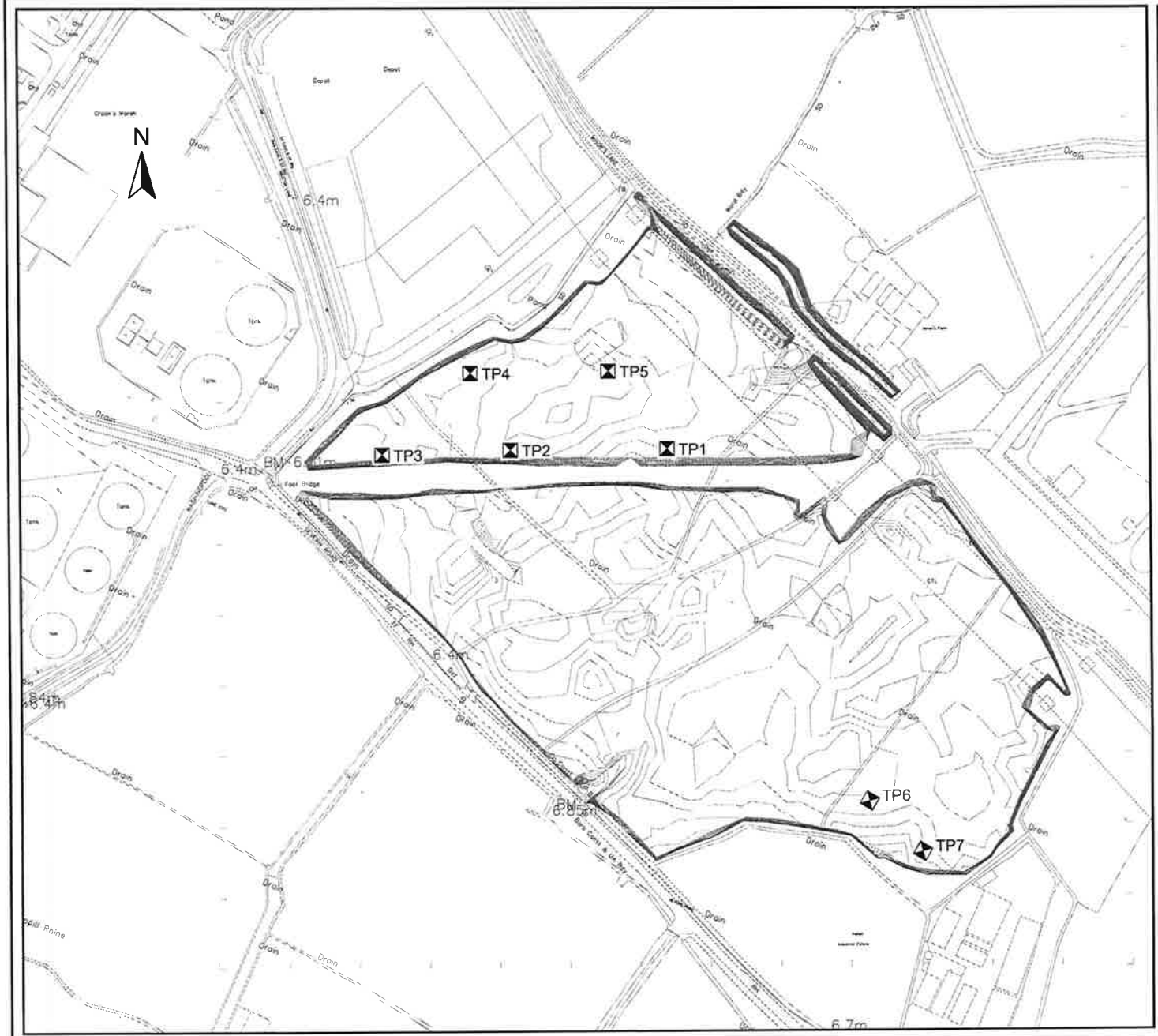
DIMENSION	SCALE	DRAWING STATUS
m	1:25,000	-

CLIENT: AREA H and I Phase 4

PROJECT: SEVERNSIDE DISTRIBUTION LAND LIMITED

TITLE: SITE LOCATION MAP

CONTRACT No	GRID REFERENCE	SCALE BAR	ORIGIN SIZE	FIGURE No
727748	ST 541 816	0 250 500 750 1000m	A4	1



LEGEND

Trial Pit Location

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
00	22.03.2013	-	JAH	AD	-

DIMENSION	SCALE	ORIGIN SIZE
m	1:4000	A4

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CLIENT

AREA H and I Phase 4

PROJECT

SEVERNSIDE DISTRIBUTION LAND LIMITED

TITLE

EXPLORATORY HOLE LOCATION PLAN

JOB NO	FIGURE
727748	2

DRAWING STATUS	REV.
-	00

0 40 80 120 160 200m

APPENDIX B

(i) Key to Exploratory Hole Logs

(ii) Trial Pit Logs

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF ABBREVIATIONS

SAMPLING

Sample type codes

B	=	Bulk disturbed sample.
LB	=	Large Bulk disturbed sample (for earthworks testing).

IN-SITU TESTING

HP	=	Hand Penetrometer Test. Value given as shear strength, c_u in kPa.
V	=	Field Vane Test. Peak value (c_u) & Residual value (c_r), given as shear strength in kPa.

ADDITIONAL NOTES

1. All soil and rock descriptions and legends in general accordance with BS EN ISO 14688-1, 14688-2, 14689-1, and BS5930:1999 including Amendment 2 (2010).
2. Material types divided by a broken line (- - -) indicates an unclear boundary.
3. The data on any sheet within the report showing the AGS icon is available in the AGS format.

GINT LIBRARY V8_04.GLB\GrfcText G - LEGEND - 1 OF 2 | 727748_AREA_H_&_I_PHASE_4.GPJ - v8_04 | 22/3/13 - 16:37 | AD.
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KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF GRAPHIC SYMBOLS

MATERIAL GRAPHIC LEGENDS

MADE GROUND

Sandy CLAY

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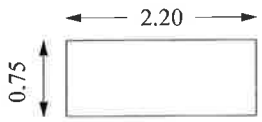
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP1**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13** End: **12.2.13**	**---**	**E:354238.0 N:181588.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.00-1.20	1A	B				MADE GROUND: Firm to stiff reddish brown and grey slightly sandy gravelly CLAY and rare medium gravel sized pieces of partly decayed wood. Gravel is fine to coarse limestone, concrete, siltstone and brick.	(1.20)	
0.00-1.20	1B	B						
0.00-1.20	1C	B						
0.00-1.20	1D	B						
0.00-1.20	1E	B						
1.00		HP	c_u=86				1.20	
1.20-1.90	2A	B				MADE GROUND: Grey very clayey very sandy GRAVEL with a high cobble content. Gravel is fine to coarse brick, concrete, asphalt, limestone and siltstone.	(0.70)	
1.20-1.90	2B	B						
1.20-1.90	2C	B						
1.20-1.90	2D	B						
1.20-1.90	2E	B					1.90	
1.90		V	c_u=104/120/116			Stiff brown mottled grey slightly sandy CLAY with rare black mottling.	(0.80)	
2.20	3	B					2.70	
						Trial pit terminated at 2.70m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:39**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**Tracked excavator**	**BSaimen**	AD

STRUCTURAL SOILS

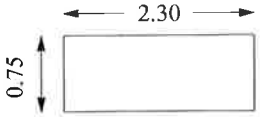
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP2**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13** End: **12.2.13**	**---**	**E:354146.0 N:181588.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.00-1.90	1A	B				MADE GROUND: Firm reddish brown and greyish brown gravelly sandy CLAY with a medium cobble content. Gravel is fine to coarse brick, asphalt, limestone, concrete, siltstone and rare iron nails.	(1.90)	
0.00-1.90	1B	B						
0.00-1.90	1C	B						
0.00-1.90	1D	B						
0.00-1.90	1E	B						
1.50		HP	c_u=50/60				1.90	
						Stiff brown mottled grey slightly sandy CLAY.	(0.80)	
2.30	2	B						
2.50		V	c_u=124/152/148				2.70	
						Trial pit terminated at 2.70m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:39**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**Tracked excavator**	**BSaimen**	AD

AGS

STRUCTURAL SOILS

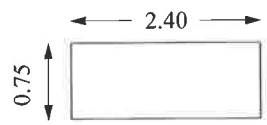
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP3**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13** End: **12.2.13**	**---**	**E:354041.0 N:181581.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.00-1.80	1A	B				MADE GROUND: Firm reddish brown and greyish brown slightly sandy gravelly CLAY. Gravel is fine to coarse angular brick, concrete, ceramic and siltstone and occasional whole bricks and rare plastic.		
0.00-1.80	1B	B						
0.00-1.80	1C	B						
0.00-1.80	1D	B						
						. . . rare plastic at 0.5 and 1.20m		
							(1.80)	
1.00		HP	c_u=60/55/55					
							1.80	
						Stiff brown mottled grey slightly sandy CLAY.		
							(0.60)	
2.10	2	B						
2.10		V	c_u=128/144/136				2.40	
						Trial pit terminated at 2.40m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:39**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**Tracked excavator**	**BSaimen**	AD

AGS

STRUCTURAL SOILS

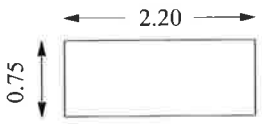
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP4**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13** End: **12.2.13**	**---**	**E:354095.0 N:181624.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.00-1.70	1A	B				MADE GROUND: Greyish brown gravelly slightly sandy CLAY with high cobble and low boulder content. Gravel is fine to coarse brick, concrete, limestone, siltstone and rare clinker and plastic.	(1.70)	
0.00-1.70	1B	B						
0.00-1.70	1C	B						
0.00-1.70	1D	B						
0.00-1.70	1E	B						
1.00		HP	c_u=60/70					
							1.70	
						Stiff brown mottled grey slightly sandy CLAY.	(0.80)	
2.30	2	B					2.50	
2.30		V	c_u=124/124/120			Trial pit terminated at 2.50m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:39**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**Tracked excavator**	**BSaimen**	AD

AGS

GINT_LIBRARY_V8_04.GLB|Log TRIAL PIT LOG - STANDARD | 727748_AREA_H_&_I PHASE 4.GPJ - v8 04 | 22/3/13 - 16:41 | AD
Structural Soils Ltd, Head Office - Bristol: The Old School, Stillhouse Lane, Bedminster, Bristol, BS3 4EB. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email: ask@soils.co.uk.

STRUCTURAL SOILS

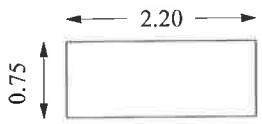
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP5**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13** End: **12.2.13**	**---**	**E:354177.0 N:181669.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.00-2.10	1A	B				MADE GROUND: Stiff greyish brown slightly sandy gravelly CLAY with a low cobble content and low boulder content. Gravel is fine to coarse angular brick, limestone, asphalt, concrete, siltstone and limestone.		
0.00-2.10	1B	B						
0.00-2.10	1C	B						
0.00-2.10	1D	B						
0.00-2.10	1E	B						
0.50		HP	c_u=86			. . . rare plastic,clinker,steel and wood between 0.00m and 2.10m		
1.00		HP	c_u=86				(2.10)	
						. . . at 1.80m partly decayed wood.	2.10	
						Stiff brown mottled grey slightly sandy CLAY.	(0.60)	
2.50	2	B					2.70	
2.50		V	c_u=124/124/120			Trial pit terminated at 2.70m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:39**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**Tracked excavator**	**BSaimen**	

STRUCTURAL SOILS

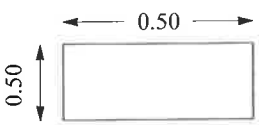
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP6**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13**	**---**	**E:354349.0 N:181325.0**	**1** of **1**
	End: **12.2.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND: Soft greyish brown slightly sandy gravelly CLAY. Gravel is fine to coarse sandstone and limestone.	(1.00)	
0.60	1A	B						
0.60	1B	B						
0.60	1C	B						
0.60	1D	B						
0.60	1E	B						
0.60		V	c_u=32/32/40				1.00	
						Trial pit terminated at 1.00m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:28**

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	**Hand tools**	**BSaimen**	AD

AGS

STRUCTURAL SOILS

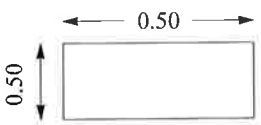
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Area H & I Phase 4	**Severnside Distribution Land Limited**	**TP7**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
727748	**11.2.13** End: **12.2.13**	**---**	**E:354408.0 N:181284.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND: Stiff yellowish brown slightly sandy slightly gravelly CLAY with rare medium gravel sized partly decayed wood and low cobble content. Gravel is fine to coarse angular limestone, red sandstone and brick.	(1.00)	
0.60		V	c_u=104/104/112					
0.70	1A	B						
0.70	1B	B						
0.70	1C	B						
0.70	1D	B						
0.70	1E	B						
							1.00	
						Trial pit terminated at 1.00m depth.		

Plan (Not to Scale)



General Remarks

1. Backfilled on completion with arisings
2. Trial pit stable.
3. No groundwater encountered.

All dimensions in metres | Scale: **1:28**

Method Used:	Plant Used:	Logged By:	Checked By:
Hand dug	**Hand tools**	**BSaimen**	AD

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APPENDIX C

(i) Geotechnical Laboratory Test Results

TESTING VERIFICATION CERTIFICATE

UKAS TESTING

1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with Structural Soils Ltd Laboratory Quality Assurance Manual, Issue 6, January 2010 all results sheets and summaries of results issued by the laboratory are checked by an approved signatory. This check will also involve checking of at least 10% of calculations for each test type to ensure that data has been correctly entered into the computer and calculated. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Assurance Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **19/03/2013 10:26:39**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory
David Trowbridge (Principal Laboratory Manager)

STRUCTURAL SOILS 1a Princess Street Bedminster Bristol BS3 4AG	Contract: **Area H & I Phase 4**	Job No: **727748**

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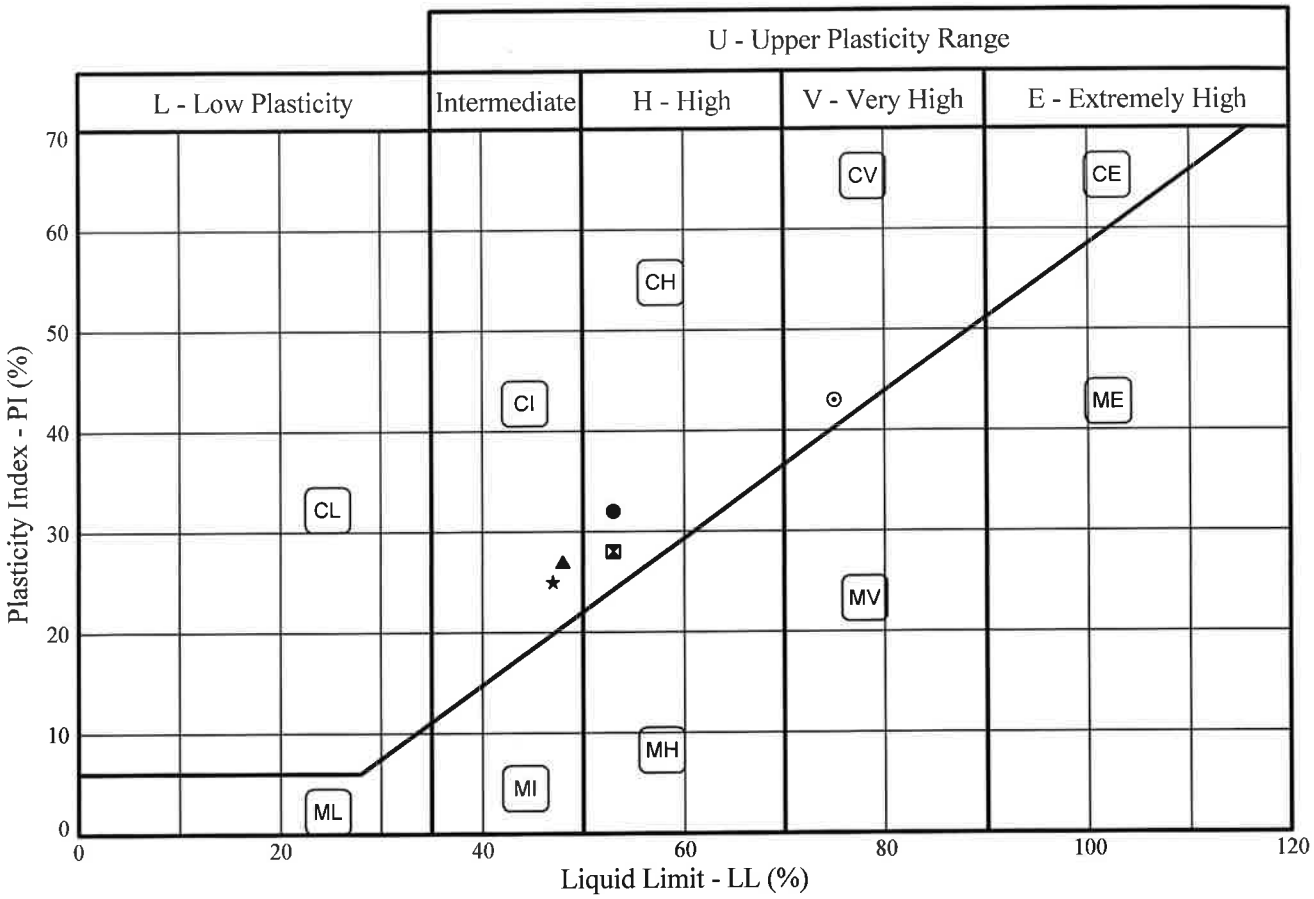
PLASTICITY CHART - PI Vs LL

In accordance with clause 42.3 of BS5930:1999
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC	LL	PL	PI	<425um
	Exploratory Position ID	Sample	Depth (m)			%	%	%	%	%
●	TP1	1LB	0.00	3.2/4.4/5.3/5.4	4.2.4	22	53	21	32	63
⊠	TP3	1LB	0.00	3.2/4.4/5.3/5.4	4.2.4	22	53	25	28	56
▲	TP5	1LB	0.00	3.2/4.4/5.3/5.4	4.2.4	23	48	21	27	60
★	TP6	1LB	0.60	3.2/4.4/5.3/5.4	4.2.4	28	47	22	25	61
⊙	TP7	1LB	0.70	3.2/4.4/5.3/5.4	4.2.4	20	75	32	43	84

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non standard test, NP = Non plastic. Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
A.D. Frost	ALAN FROST	17/03/13

Contract	Contract Ref:
Area H & I Phase 4	727748

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SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
TP1	1	LB	0.00	22	53	21	32	63	Reddish brown slightly sandy gravelly CLAY
TP3	1	LB	0.00	22	53	25	28	56	Reddish brown slightly sandy gravelly CLAY
TP5	1	LB	0.00	23	48	21	27	60	Greyish brown slightly sandy gravelly CLAY with low cobble content
TP6	1	LB	0.60	28	47	22	25	61	Greyish brown slightly sandy gravelly CLAY
TP7	1	LB	0.70	20	75	32	43	84	Yellowish brown slightly sandy slightly gravelly CLAY

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Contract: **Area H & I Phase 4**

Contract Ref: **727748**

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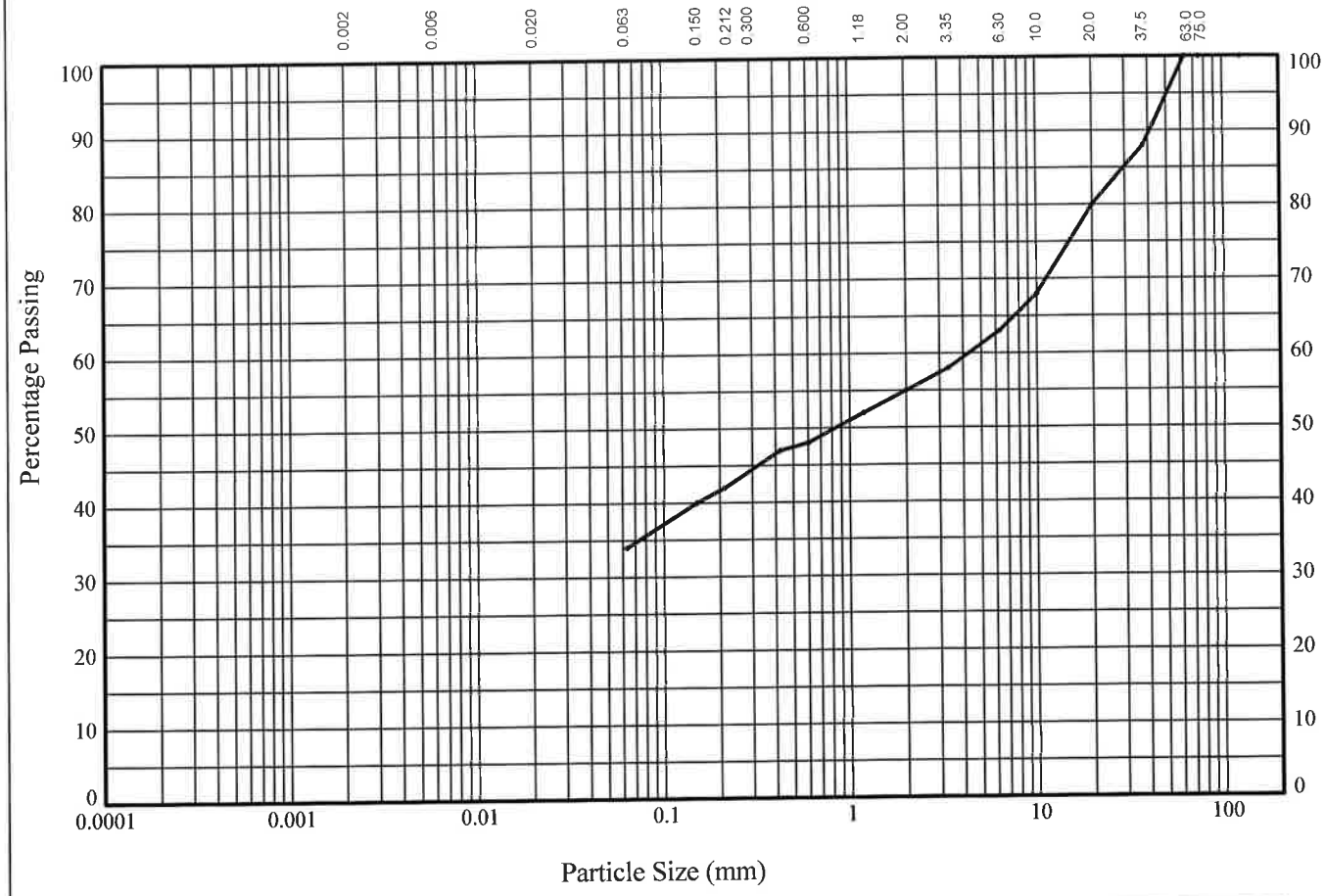
PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Trial Pit : **TP1** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	88
20.0	80
10.0	68
6.30	63
3.35	58
2.00	55
1.18	52
0.600	48
0.425	47
0.212	42
0.150	40
0.063	34

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**45**
SAND	**21**
SILT/CLAY	**34**

Soil Description:
Reddish brown slightly sandy gravelly CLAY

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
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Compiled By		Date
A.S. Frost	**ALAN FROST**	**17/03/13**

Contract	Contract Ref:
Area H & I Phase 4	**727748**

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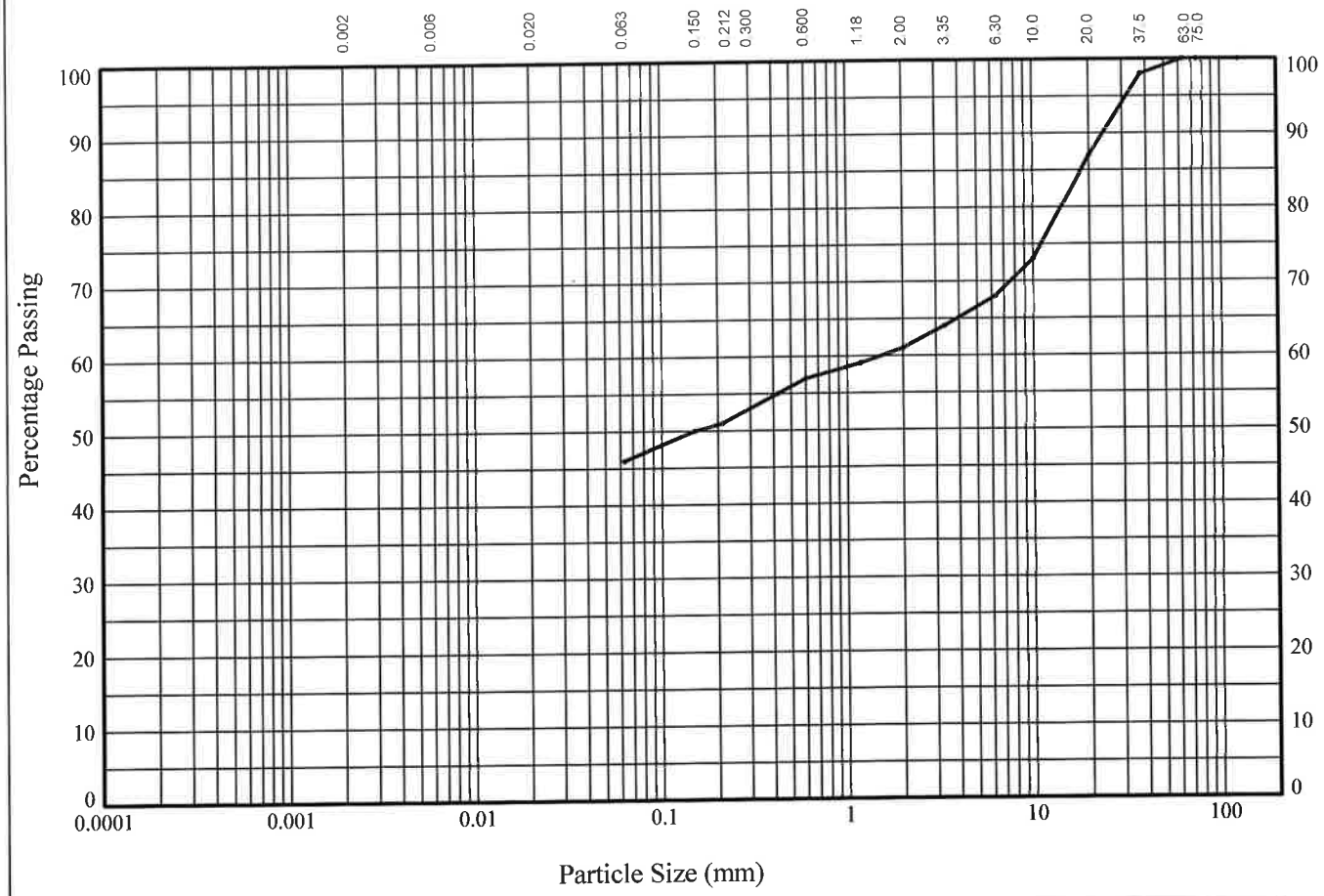
PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Trial Pit : **TP3** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	98
20.0	87
10.0	73
6.30	68
3.35	64
2.00	61
1.18	59
0.600	57
0.425	55
0.212	51
0.150	50
0.063	46

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**39**
SAND	**15**
SILT/CLAY	**46**

Soil Description:
Reddish brown slightly sandy gravelly CLAY

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
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Contract	Contract Ref:
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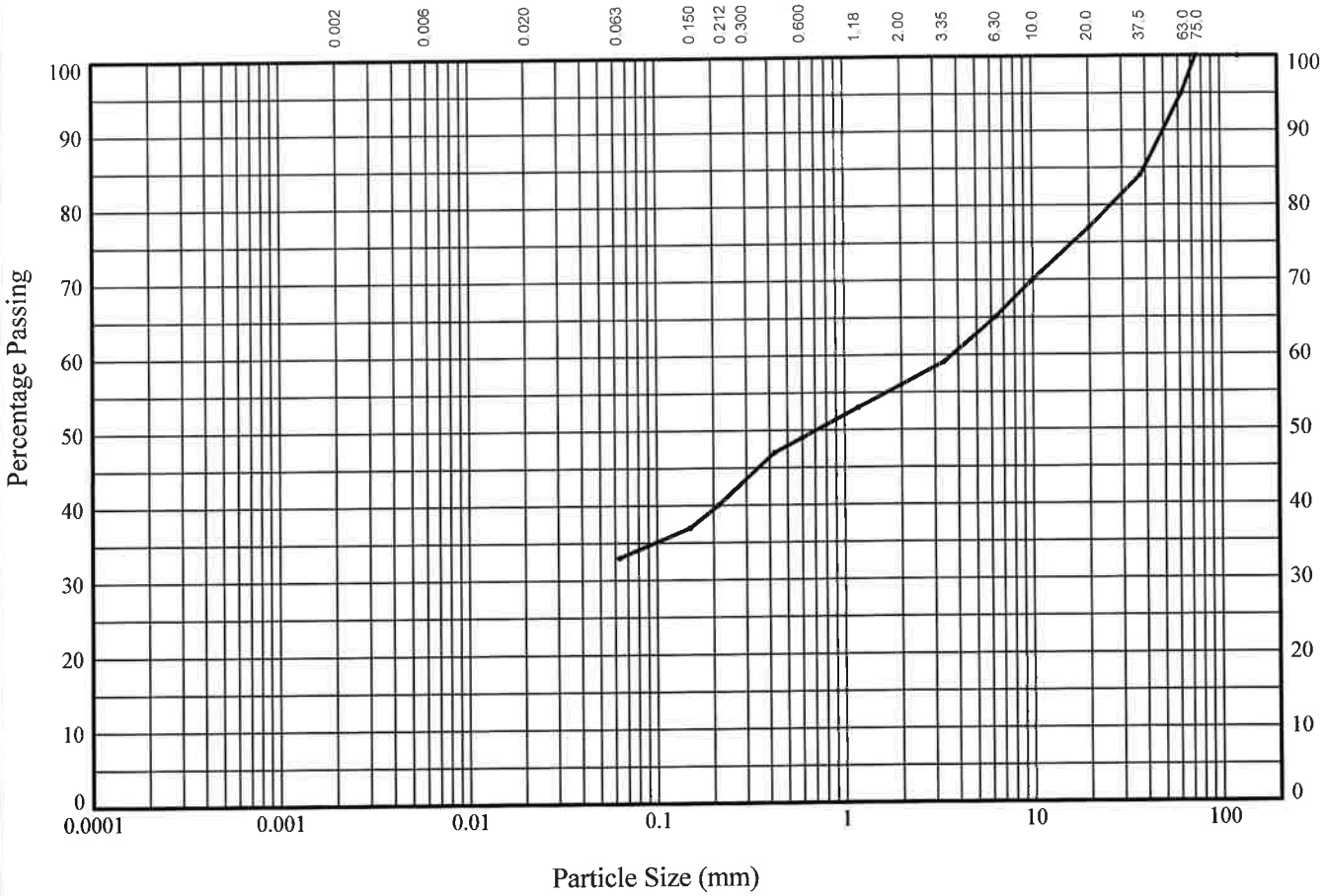
PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

NON STANDARD TEST

Trial Pit : **TP5** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	95
37.5	84
20.0	77
10.0	70
6.30	65
3.35	59
2.00	56
1.18	53
0.600	49
0.425	47
0.212	40
0.150	37
0.063	33

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
COBBLES	**5**
GRAVEL	**39**
SAND	**23**
SILT/CLAY	**33**

Soil Description:
Greyish brown slightly sandy gravelly CLAY with low cobble content

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
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A.J. Frost	**ALAN FROST**	**17/03/13**

Contract	Contract Ref:
Area H & I Phase 4	**727748**

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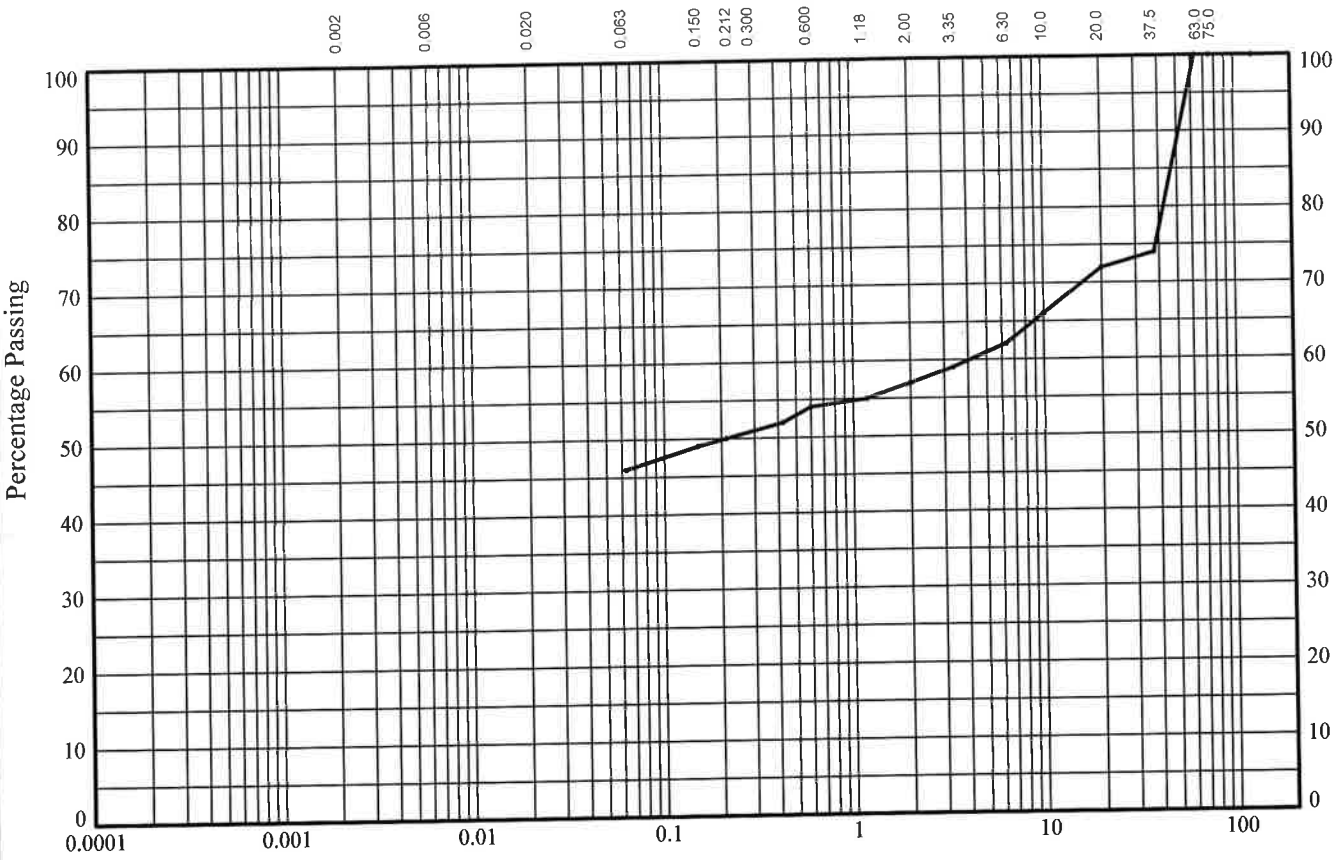
PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

NON STANDARD TEST

Trial Pit : **TP6** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.60**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	74
20.0	72
10.0	66
6.30	62
3.35	59
2.00	57
1.18	55
0.600	54
0.425	52
0.212	50
0.150	49
0.063	46

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**43**
SAND	**11**
SILT/CLAY	**46**

Soil Description:

Greyish brown slightly sandy gravelly CLAY

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
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Compiled By		Date
A.D. Frost	ALAN FROST	17/03/13

Contract	Contract Ref:
Area H & I Phase 4	**727748**

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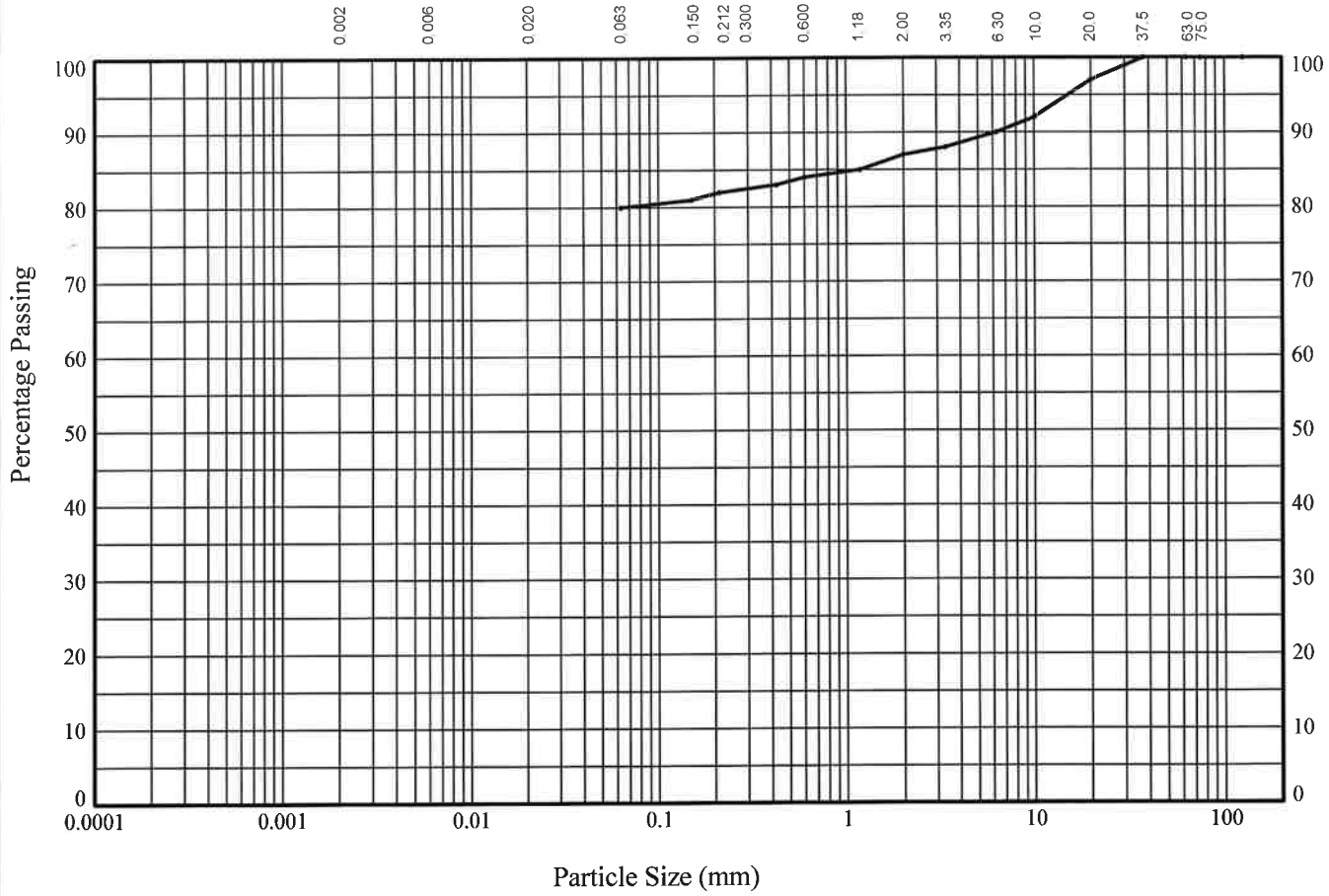
PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Trial Pit : **TP7** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.70**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	100
20.0	97
10.0	92
6.30	90
3.35	88
2.00	87
1.18	85
0.600	84
0.425	83
0.212	82
0.150	81
0.063	80

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**13**
SAND	**7**
SILT/CLAY	**80**

Soil Description:
Yellowish brown slightly sandy slightly gravelly CLAY

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
1a Princess Street
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Compiled By	Date
A.D. Frost — **ALAN FROST**	**17/03/13**

Contract	Contract Ref:
Area H & I Phase 4	**727748**

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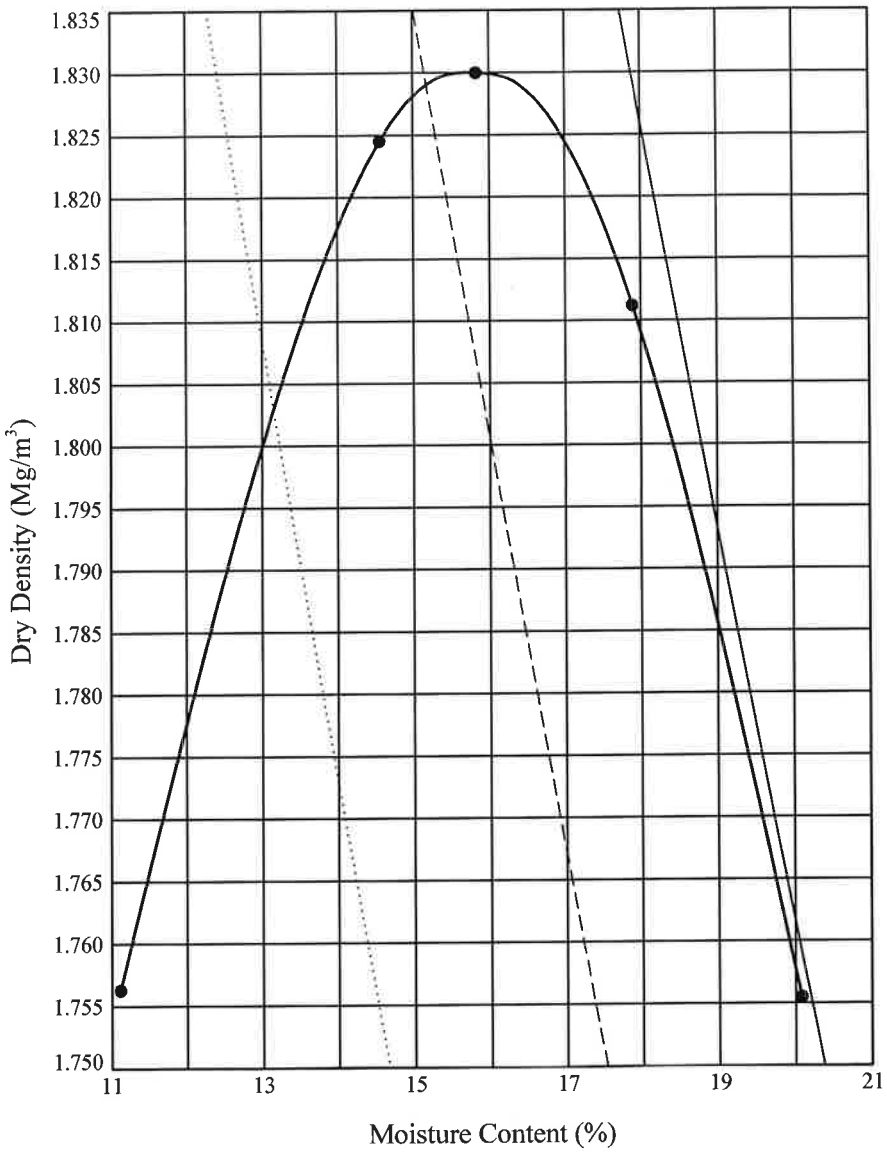
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990
NON-STANDARD TEST

Trial Pit : **TP1** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.00**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **20**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	: **1.83**
% Retained on 37.5mm BS Sieve	: **11**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	: **16**
% Retained on 20.0mm BS Sieve	: **4**	Type of Mould	: **CBR**	Method Used: **Clause 3.4**	
Particle Density - assumed (Mg/m³)	: **2.72**			Remarks:	
Size of Soil Pieces	: **<20mm**	Separate samples were used.			

Sample Description	Key to Air Voids Lines		
Reddish brown slightly sandy gravelly CLAY	—— 0%	- - - - 5%	..... 10%

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
1a Princess Street
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Bristol
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Compiled By		Date
A.D. Frost	**ALAN FROST**	**17/03/13**

Contract	Contract Ref:
Area H & I Phase 4	**727748**

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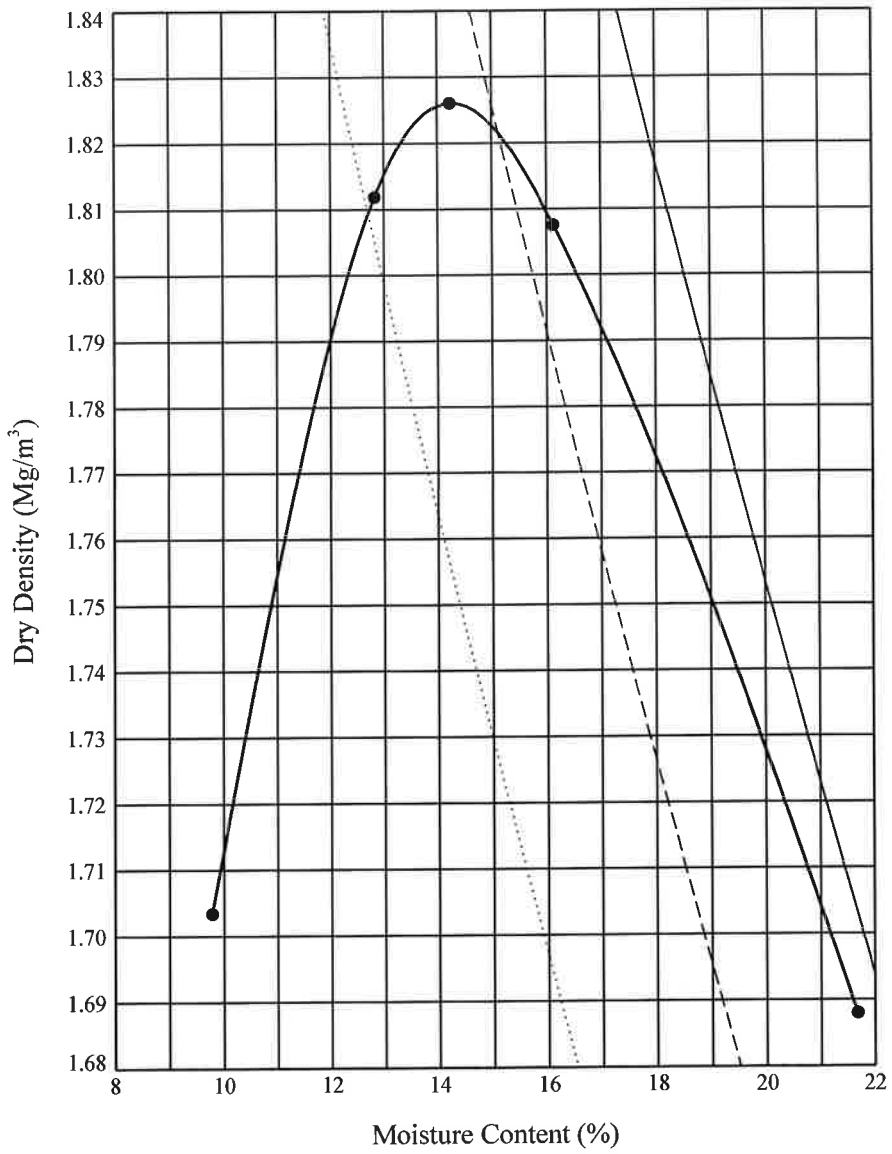
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Trial Pit : **TP3** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.00**



Initial Sample Conditions			Test Details			Test Results		
Initial Moisture Content (%)	:	**22**	Compaction Type	:	**Light**	Maximum Dry Density (Mg/m³)	:	**1.83**
% Retained on 37.5mm BS Sieve	:	**6**	Mass of Rammer (kg):		**2.5**	Optimum Moisture Content (%)	:	**14**
% Retained on 20.0mm BS Sieve	:	**6**	Type of Mould	:	**CBR**	Method Used: **Clause 3.4**		
Particle Density - assumed (Mg/m³)	:	**2.70**				Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.					

Sample Description	Key to Air Voids Lines		
Reddish brown slightly sandy gravelly CLAY	—— 0%	- - - - 5%	····· 10%

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
A.D. Frost	**ALAN FROST**	**17/03/13**

Contract	Contract Ref:
Area H & I Phase 4	**727748**

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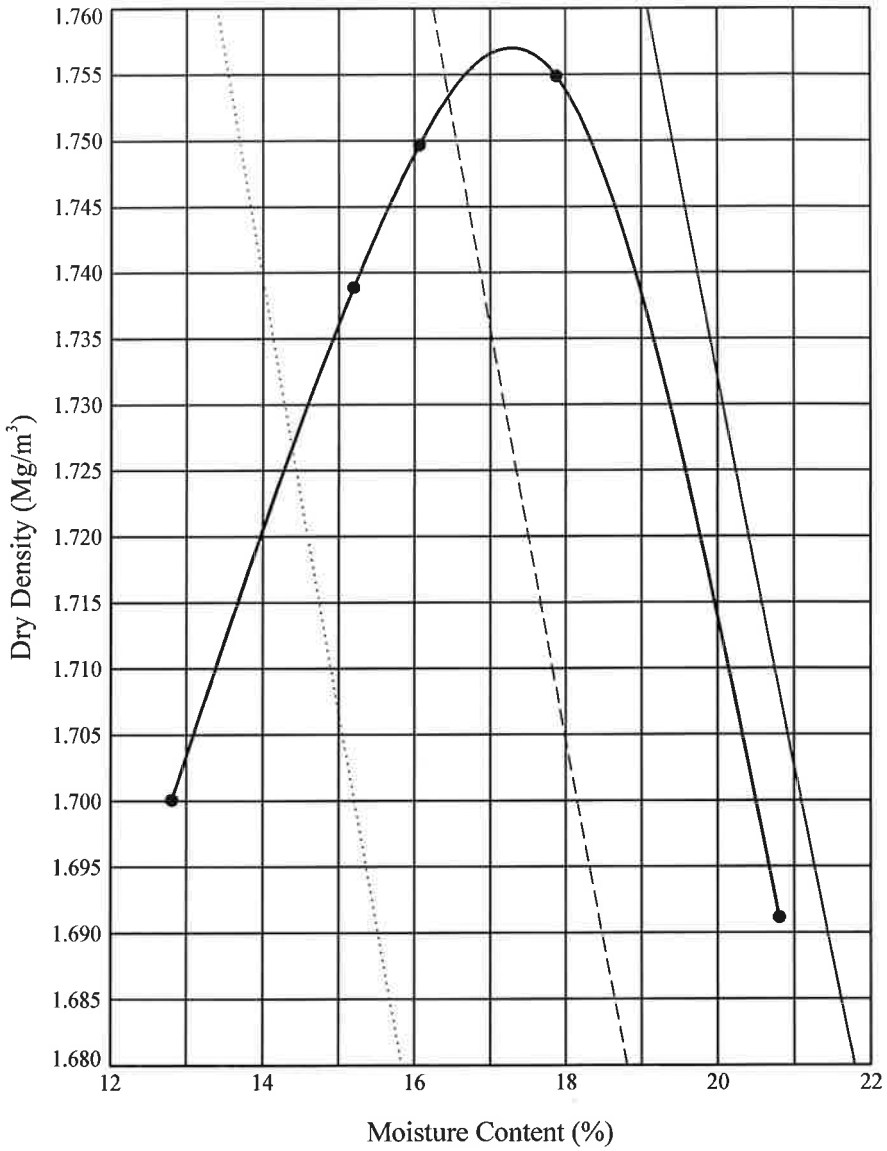
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Trial Pit : **TP5** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.00**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **21**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	: **1.76**
% Retained on 37.5mm BS Sieve	: **3**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	: **17**
% Retained on 20.0mm BS Sieve	: **6**	Type of Mould	: **CBR**	Method Used:	**Clause 3.4**
Particle Density - assumed (Mg/m³)	: **2.65**			Remarks:	
Size of Soil Pieces	: **<20mm**	Separate samples were used.			

Sample Description	Key to Air Voids Lines		
Greyish brown slightly sandy gravelly CLAY with low cobble content	—— 0%	– – – – 5%	····· 10%

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
A.D. Frost	ALAN FROST	17/03/13

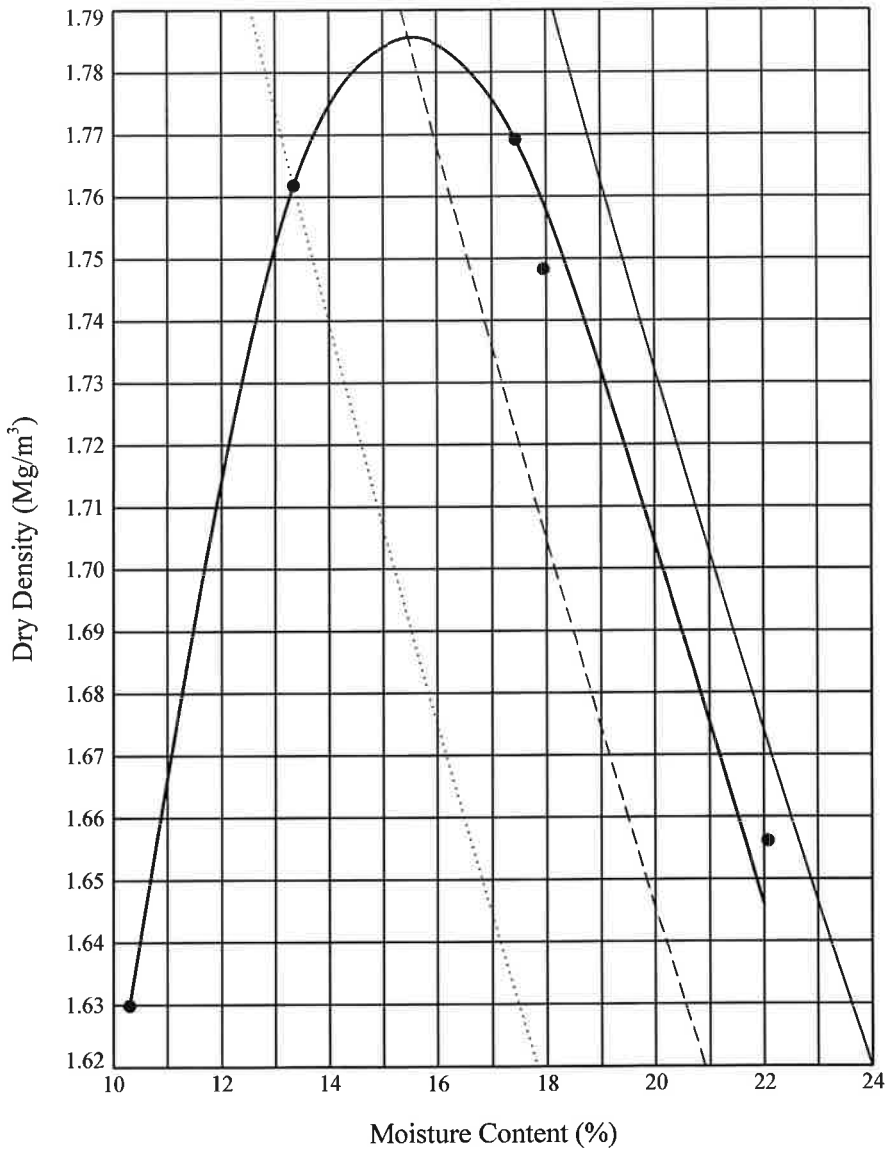
Contract	Contract Ref:
Area H & I Phase 4	**727748**

AGS

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Trial Pit : **TP6** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.60**



Initial Sample Conditions			Test Details			Test Results		
Initial Moisture Content (%)	:	**22**	Compaction Type	:	**Light**	Maximum Dry Density (Mg/m³)	:	**1.79**
% Retained on 37.5mm BS Sieve	:	**3**	Mass of Rammer (kg):		**2.5**	Optimum Moisture Content (%)	:	**16**
% Retained on 20.0mm BS Sieve	:	**10**	Type of Mould	:	**CBR**	Method Used: **Clause 3.4**		
Particle Density - assumed (Mg/m³)	:	**2.65**				Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.					

Sample Description	Key to Air Voids Lines		
Greyish brown slightly sandy gravelly CLAY	——— 0%	– – – – 5%	····· 10%

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

STRUCTURAL SOILS
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Bedminster
Bristol
BS3 4AG

Compiled By		Date
A.D. Frost	**ALAN FROST**	**17/03/13**

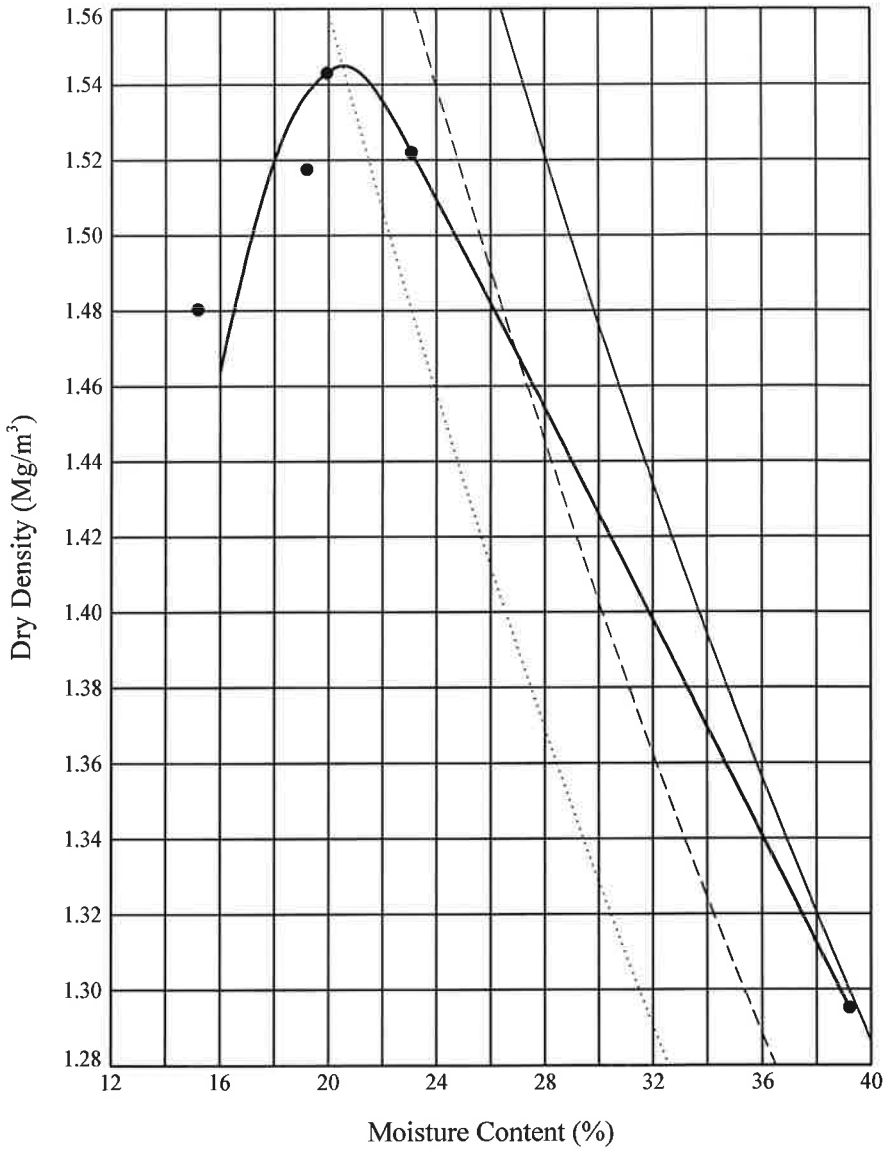
Contract	Contract Ref:
Area H & I Phase 4	**727748**

AGS

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Trial Pit : **TP7** Sample Ref: **1** Sample Type: **LB** Depth (m): **0.70**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **39**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	: **1.55**
% Retained on 37.5mm BS Sieve	: **3**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	: **21**
% Retained on 20.0mm BS Sieve	: **5**	Type of Mould	: **CBR**	Method Used: **Clause 3.4**	
Particle Density - assumed (Mg/m³)	: **2.65**			Remarks:	
Size of Soil Pieces	: **<20mm**	Separate samples were used.			

Sample Description	Key to Air Voids Lines		
Yellowish brown slightly sandy slightly gravelly CLAY	—— 0%	– – – – 5%	····· 10%

Approved Signatories: D. TROWBRIDGE A. FROST M. STOKES S. HANDCOCK

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Bedminster
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Compiled By		Date
A.D. Frost	**ALAN FROST**	**17/03/13**

Contract	Contract Ref:
Area H & I Phase 4	**727748**

AGS

APPENDIX D

(i) Contamination Laboratory Test Results

(ii) Initial Waste Characterisation

(iii) RSK Group Generic Assessment Criteria (GAC)

(iv) Laboratory UKAS Accreditation Certificate

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/00712
Issue Number: 1 **Date:** 27 February, 2013

Client:
Structural Soils Bristol
The Old School House
Stillhouse Lane
Bedminster
Bristol
UK
BS3 4EB

Project Manager: SSL Enviro /Adam Dingle/ Biju Saimen
Project Name: H and I Phase 4
Project Ref: 727748
Order No: Not specified
Date Samples Received: 14/02/13
Date Instructions Received: 14/02/13
Date Analysis Completed: 26/02/13

Prepared by:

MMarshall

Melanie Marshall
Laboratory Coordinator

Approved by:

Carolyn Field
Client Service Manager

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 inert stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.
Notes - General
Subscript "A" indicates analysis performed on the sample as received, "D" indicates analysis performed on the dried sample.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts. Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.
Predominant Matrix Codes - 1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.
Secondary Matrix Codes - A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.
IS indicates Insufficient sample for analysis. NDP indicates No Determination Possible. NAD indicates No Asbestos Detected. S id accredited to ISO 17025. Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
Please contact us if you need any further information.

MCERTS
UKAS TESTING
1247

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Envirolab Job Number: 13/00712

Client Project Name: H and I Phase 4

Client Project Ref: 727748

Lab Sample ID	13/00712/1	13/00712/2	13/00712/3	13/00712/4	13/00712/5	13/00712/6	13/00712/7		Units	Method ref
Client Sample No	1	1	1	1	1	1	1			
Client Sample ID	TP1	TP2	TP3	TP4	TP5	TP6	TP7			
Depth to Top	0.00	0.00	0.00	0.00	0.00	0.60	0.70			
Depth To Bottom	1.20	1.90	1.80	1.70	2.10					
Date Sampled	11-Feb-13	11-Feb-13	11-Feb-13	11-Feb-13	11-Feb-13	12-Feb-13	12-Feb-13			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5	5BE	5AB	5ABE	5ABE	6AE	5B			
pH_D M#	8.90	8.47	8.51	7.87	7.86	7.86	8.00		pH	A-T-031s
Sulphate (water sol 2:1)$_D$ M#	5.71	1.00	0.26	0.73	0.12	0.21	1.39		g/l	A-T-026s
Total Organic Carbon$_D$ M#	2.33	1.10	0.90	1.21	0.72	0.87	1.22		% w/w	A-T-032s
Arsenic$_D$ M#	32	31	25	16	7	9	11		mg/kg	A-T-024
Cadmium$_D$ M#	3.1	2.7	0.9	1.5	0.8	1.2	1.8		mg/kg	A-T-024
Copper$_D$ M#	18	27	38	31	9	24	25		mg/kg	A-T-024
Chromium$_D$ #	49	31	19	26	9	33	57		mg/kg	A-T-024
Chromium (hexavalent)$_D$	<1	<1	<1	<1	<1	<1	<1		mg/kg	A-T-040s
Lead$_D$ M#	66	93	118	102	39	35	42		mg/kg	A-T-024
Mercury$_D$	0.60	0.90	0.61	0.65	0.31	0.78	0.46		mg/kg	A-T-024
Nickel$_D$ M#	21	22	16	24	8	27	38		mg/kg	A-T-024
Selenium$_D$ M#	<1	<1	<1	<1	<1	<1	<1		mg/kg	A-T-024
Zinc$_D$ M#	2380	233	207	190	70	112	131		mg/kg	A-T-024

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Envirolab Job Number: 13/00712

Client Project Name: H and I Phase 4

Client Project Ref: 727748

Lab Sample ID	13/00712/1	13/00712/2	13/00712/3	13/00712/4	13/00712/5	13/00712/6	13/00712/7		Units	Method ref
Client Sample No	1	1	1	1	1	1	1			
Client Sample ID	TP1	TP2	TP3	TP4	TP5	TP6	TP7			
Depth to Top	0.00	0.00	0.00	0.00	0.00	0.60	0.70			
Depth To Bottom	1.20	1.90	1.80	1.70	2.10					
Date Sampled	11-Feb-13	11-Feb-13	11-Feb-13	11-Feb-13	11-Feb-13	12-Feb-13	12-Feb-13			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5	5BE	5AB	5ABE	5ABE	6AE	5B			
PAH-16MS inc b(j)f TIC										
Acenaphthene$_A^{M\#}$	<0.01	0.14	0.21	0.12	0.02	<0.01	0.03		mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	0.01	0.04	<0.01	<0.01	<0.01	<0.01		mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	0.45	0.88	0.40	0.04	<0.02	0.09		mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	1.42	3.56	0.77	0.09	<0.04	0.14		mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	1.13	3.04	0.52	0.09	<0.04	0.09		mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	1.52	3.89	0.64	0.11	<0.05	0.10		mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	0.54	1.30	0.25	0.06	<0.05	<0.05		mg/kg	A-T-019s
Benzo(b)(j)(k)fluoranthene$_A$	<0.07	2.14	5.25	0.95	0.17	<0.07	0.10		mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	0.62	1.38	0.31	<0.07	<0.07	<0.07		mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	1.38	3.40	0.79	0.11	<0.06	0.17		mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	0.12	0.31	0.05	<0.04	<0.04	<0.04		mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	3.21	6.78	2.00	0.20	<0.08	0.36		mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	0.12	0.25	0.11	0.02	<0.01	0.03		mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	0.54	1.36	0.26	0.06	<0.03	0.04		mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03	0.08	<0.03	<0.03	<0.03	<0.03	<0.03		mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.05	1.47	3.53	1.30	0.12	<0.03	0.28		mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	2.76	5.98	1.70	0.17	<0.07	0.30		mg/kg	A-T-019s
Total PAH$_A^{M\#}$	<0.08	15.5	35.9	9.23	1.12	<0.08	1.62		mg/kg	A-T-019s
TPH Banded 1										
>C6-C8$_A^{\#}$	<10	<10	<10	<10	<10	<10	<10		mg/kg	A-T-007s
>C8-C10$_A^{\#}$	<10	<10	<10	<10	<10	<10	<10		mg/kg	A-T-007s
>C10-C12$_A^{\#}$	<10	<10	<10	<10	<10	<10	<10		mg/kg	A-T-007s
>C12-C16$_A^{\#}$	<10	<10	<10	<10	<10	<10	<10		mg/kg	A-T-007s
>C16-C21$_A^{\#}$	<10	17	73	15	<10	<10	<10		mg/kg	A-T-007s
>C21-C40$_A$	<10	40	278	35	24	<10	<10		mg/kg	A-T-007s

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Structural Soils Bristol, The Old School House, Stillhouse Lane, Bedminster, Bristol, UK, BS3 4EB

Project No: 13/00712
Date Received: 14/02/2013 (am)

Project: H and I Phase 4
Clients Project No: 727748

NO DEVIATIONS IDENTIFIED

As cmpds (AsS), Cd (CdO), CrVI cmpds ($FeCrO_4$), Cu (Cu_2O), Inorg Hg cmpds (HgO), Pb cmpds ($PbSO_4$), Ni ($NiCO_3$), Se cmpds (SeS) and Zn as ZnO. Also Ba ($BaCO_3$), Be cmpds ($BeSO_4$), Co (CoO), Mn (MnO_2) and Mo (MoO_3).

HASWASTE v4b. Envirolab's Contaminated Land Soil Hazardous Waste Assessment Tool.

Envirolab, Sandpits Business Park, Mottram Road, Hyde, Cheshire SK14 3AR

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Site Code and Name	727748 Hand I Phase 4

TP/WS/BH	TP1	TP2	TP3	TP4	TP5	TP6	TP7											
Depth (m)	0.00-1.20	0.00-1.90	0.00-1.30	0.00-1.70	0.00-2.10	0.60	0.70											
Envirolab reference																		
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic	32	31	25	16	7	9	11											
CrVI or Chromium	1	1	1	1	1	1	1											
Copper	18	27	36	31	9	24	25											
Lead	66	90	118	102	39	35	42											
Nickel	21	22	16	24	8	27	38											
Zinc	2,360	230	207	190	70	112	131											
Cadmium	3.1	2.7	0.9	1.5	0.8	1.2	1.8											
Mercury	0.66	0.90	0.61	0.65	0.31	0.78	0.46											
Selenium																		
Barium																		
Beryllium																		
Cobalt																		
Manganese																		
Molybdenum																		
Total USEPA 16 PAHs																		
Acenaphthene	0.01	0.14	0.21	0.12	0.02	0.01	0.03											
Acenaphthylene	0.01	0.01	0.04	0.01	0.01	0.01	0.01											
Anthracene	0.02	0.45	0.88	0.40	0.04	0.02	0.09											
Benzo(a)anthracene	0.04	1.42	3.56	0.77	0.09	0.04	0.14											
Benzo(a)pyrene	0.04	1.13	3.04	0.52	0.09	0.04	0.09											
Benzo(b)fluoranthene	0.05	1.52	3.89	0.64	0.11	0.05	0.10											
Benzo(ghi)perylene	0.05	0.54	1.30	0.25	0.06	0.05	0.05											
Benzo(k)fluoranthene	0.07	0.62	1.38	0.95	0.07	0.07	0.07											
Chrysene	0.06	1.38	3.40	0.79	0.11	0.06	0.17											
Dibenzo(ah)anthracene	0.04	0.12	0.31	0.05	0.04	0.04	0.04											
Fluoranthene	0.08	3.21	6.78	2.00	0.20	0.08	0.36											
Fluorene	0.01	0.12	0.25	0.11	0.02	0.01	0.03											
Indeno(123cd)pyrene	0.03	0.54	1.36	0.26	0.06	0.03	0.04											
Naphthalene	0.03	0.08	0.03	0.01	0.03	0.03	0.03											
Phenanthrene	0.05	1.47	3.53	1.30	0.12	0.03	0.28											
Pyrene	0.07	2.76	5.98	1.70	0.17	0.07	0.30											
Benzo(j)fluoranthene																		
Benzene																		
Toluene																		
Ethylbenzene																		
Xylenes																		
Trimethylbenzenes																		
Chlorobenzene																		
1,2-Dichlorobenzene																		
1,3-Dichlorobenzene																		
1,4-Dichlorobenzene																		
1,2,4-Trichlorobenzene																		
2-Chlorotoluene																		
4-Chlorotoluene																		
Trichloroethene (TCE)																		
Oil in Waste Carcinogenic H7																		
Total TPH																		
Petrol or (C6-C10)	10.00	10.00	10.00	10.00	10.00	10.00	10.00											
Diesel or (C10-C25) or (conservative C10-C35)	10.0	17.0	73.0	15.0	10.0	10.0	10.0											
Lube Oil or (C25+) or (conservative C21+)	10.0	40.0	278.0	35.0	24.0	10.0	10.0											
8 IARC H7 Carcinogenic PAHs marker test (applicable to LRO only)	3.30	16.83	6.09	11.37	2.38	3.30	6.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Kerosene																		
Kerosene																		
Creosote																		
Creosote																		
pH Corrosive H8 (Irritant H4)																		
pH (soil)	8.9	8.5	8.5	7.9	7.9	7.9	8.0											
pH (leachate)																		
Alkali Reserve (gNaOH/100g)																		
H4 Alkali Reserve test	8.9	8.5	8.5	7.9	7.9	7.9	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H8 Alkali Reserve test	8.9	8.5	8.5	7.9	7.9	7.9	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Produces Toxic Gases H12																		
Total Sulphide																		
Free Cyanide																		
Thiocyanate																		
Elemental/Free Sulphur																		
PCBs Total																		
Phenols Total by HPLC																		
Phenol																		
Cresols																		
Xylenols																		
1-Naphthol																		
Resourcinol																		
2,3,5,6-Tetrachlorophenol																		
2,4,5-Trichlorophenol																		
2,4,6-Trichlorophenol																		
2,4-Dichlorophenol																		
4-Chloro-3-methylphenol																		
Pentachlorophenol																		
Bis(2-ethylhexyl)phthalate																		
Butylbenzylphthalate																		
Di-n-butylphthalate																		
Visual Fibre Screen or Asbestos ID (enter Y or N)																		

Hazard Codes	Thresholds	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Irritant H4	≥10%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Irritant H4	≥20%	0.004	0.004	0.003	0.005	0.002	0.005	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Harmful H5	≥25%	0.018	0.024	0.033	0.026	0.010	0.015	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic H6 (Harmful H5)	≥0.1%H5<1%; H6≥1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic H6 (Harmful H5)	≥3%H5<25%; H6≥25%	0.009	0.009	0.007	0.007	0.003	0.007	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carcinogenic H7	≥0.1%	0.004	0.004	0.003	0.005	0.002	0.005	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carcinogenic H7	≥1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corrosive H8 (Irritant H4)	≥5%H4<10%; H8≥10%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic for Reproduction H10	≥0.5%	0.010	0.014	0.017	0.015	0.006	0.005	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic for Reproduction H10	≥5%	0.010	0.014	0.017	0.015	0.006	0.005	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mutagenic H11	≥0.1%	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mutagenic H11	≥1%	0.004	0.004	0.003	0.005	0.002	0.003	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
New H13 Sensitising	≥1%	0.0043	0.0044	0.0032	0.0048	0.0016	0.0055	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ecotoxic H14	≥1.0	1.258	0.202	0.202	0.180	0.067	0.109	0.132	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
New Ecotoxic H14 individual substance specific thresholds	≥0.0025%	0.00000	0.00014	0.00036	0.00008	0.00001	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
New Ecotoxic H14 individual substance specific thresholds	≥0.025%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Consider other individual contaminants on a case by case basis.

Table 3.2 of Annex VI of the CLP Regulation including 3rd ATP where applicable (sometimes called ATSP3).

Generic assessment criteria for human health: commercial scenario

The human health generic assessment criteria (GAC) have been developed during a period of regulatory review and updating of the Contaminated Land Exposure Assessment (CLEA) project. Therefore, the Environment Agency (EA) is in the process of publishing updated reports relating to the CLEA project and the GAC presented in this document may change to reflect these updates. This issue was prepared following the publication of soil guideline value (SGV) reports and associated publications[1] for mercury, selenium, benzene, toluene, ethylbenzene and xylene in March 2009, arsenic and nickel in May 2009, cadmium and phenol in June 2009, dioxins, furans and dioxin-like polychlorinated biphenyls (PCBs) in September 2009. It was also produced following publication of GAC by LQM[6]. Where available, the published soil guideline values (SGV)[1] were used as the GAC. The GAC for lead is discussed separately below owing to it not being derived using the same approach as other compounds.

Lead GAC derivation

The Environment Agency SGV and Tox reports for lead were withdrawn in 2009. In addition, the provisional tolerable weekly intake data published in the Netherlands was also withdrawn in 2010 owing to concerns that it was not suitably protective of human health. The withdrawn SGV was based on a target blood lead concentration 10 µg/dl. In the absence of current guidelines, many consultants have continued to use the withdrawn SGV. However, as this is not considered sufficiently protective of human health RSK has revised its GAC for lead and is currently undertaking a review of recent toxicological developments that will be used to refine this GAC further in the coming months.

Variable	Description of variable	Units	Value in SGV10	Revised value for RSK GAC
T	Health criteria value – reduced owing to concern that 10ug/dl may not be suitably protective of human health	ug/dl	10	5
G	Geometric standard deviation for B typically in range of 1.8 to 2.1	-	2.0	1.8
B	Geometric mean of blood lead concentration in adult women. The value used in SGV10 was based on UK data from 1995 from women in an urban area aged 16–44. Data in the US has shown decreases from between 1.7 and 2.2 to 1ug/dl between the late 1980s/early 1990s and late 1990s/early 2000s for adult females between 17 and 45 years old. Lead concentrations in blood are likely to be decreasing in the UK owing to a ban on lead in internal paint, a ban on lead in fuel and replacement of lead pipes for water supply	ug/dl	2.3	1.0
n	Selected on the basis of the degree of protection needed for a population at risk at the target concentration (T); the default value is 95%	-	1.645	1.645
$AT_{S,D}$	Averaging time assuming exposure over working lifetime. The value has been revised to reflect 49 years in accordance with CLEA commercial scenario outlined in SR3	days	15695	17885
BKSF	Biokinetic slope factor	ug/dl per ug/day	0.4	0.4
IR_S	Soil ingestion rate (including soil-derived indoor dust). This value has been revised to reflect the CLEA commercial scenario outlined in SR3	g/day	0.040	0.050
$AF_{S,D}$	Absorption fraction (same for soil and dust)	-	0.12	0.12
$EF_{S,D}$	Exposure frequency – based on CLEA commercial conceptual model	days/yr	230	230
ED	Exposure duration. This value has been revised to reflect CLEA commercial conceptual model outlined in SR3	years	43	49

The methodology utilised for the adult receptor is the Adult Lead Methodology used in the USA, which is a similar equation to that used in production of the UK SGV outlined in R&D publication SGV10. Parameters within the equation are presented below and have been updated to reflect:

- a revised and more health protective target blood level
- more recent US data pertaining to the geometric blood lead concentration, which indicates decreasing concentrations from 1988 to 2004
- more recent US data regarding the geometric standard deviation (the measure of inter-individual variability in blood lead concentrations within the adult population).

Although the update is based on US data, RSK considers that background blood levels in the UK will also be decreasing owing to lead pipes being replaced, lead no longer being used in fuel and lead paints being banned from internal use. Furthermore, RSK has run the equation with varying inputs to ascertain its sensitivity to certain parameters. Using the parameters outlined above RSK obtains a GAC of **600mg/kg** for an adult in a commercial setting. A similar value is obtained if all input parameters remain equal to those used in production of the former SGV but the soil ingestion rate is increased to reflect 50mg/day reported for the commercial scenario in SR3.

GAC derivation for other metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated for compounds where SGV have not been published using CLEA v1.06 and the supporting UK guidance[1–6]. Groundwater assessment criteria (GrAC) protective of human health via the inhalation pathway were derived using the RBCA 1.3b model. RSK has updated the inputs within RBCA to reflect the UK guidance[2–5]. The SAC and GrAC collectively are termed GAC.

Pathway selection

In accordance with EA Science Report SC050221/SR3[3] the commercial scenario considers risks to a female worker who works from the age of 16 to 65 years. It should be noted that this end use is not suitable for a workplace nursery but also may be appropriate for a sport centre or shopping centre where children are present. In accordance with Box 3.5, SR3[3] the pathways considered for production of the SAC in the commercial scenario are:

- direct soil and dust ingestion
- dermal contact with soil both indoor and outdoors
- indoor air inhalation from soil and vapour and outdoor inhalation of soil and vapour.

Figure 1 is a conceptual model illustrating these linkages.

The pathway considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by workers while indoors. Figure 2 illustrates this linkage. Although the outdoor air inhalation pathway is also valid, this contributes little to the overall risks owing to the dilution in outdoor air.

Within RBCA, the solubility limit of the determinant restricts the extent of volatilisation, which in turn drives the indoor air inhalation pathway. While the same restriction is not built into the CLEA model, the model output cells are flagged red where the soil saturation limit has been exceeded.

An assumption used in the CLEA model is that of simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[4]. The upper boundaries of this partitioning are represented by the aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous-based or the vapour-based saturation limits. Where model output cells are flagged red the soil or vapour saturation limit has been exceeded and further consideration of the SAC to be used within the assessment is required. One approach that could be adopted is to use the 'modelled' solubility saturation limit or vapour saturation limit of the compound as the SAC. However, as stated within the CLEA handbook[4] this is likely to be impractical in many cases because of the very low solubility/vapour saturation limits and, in any case, is highly conservative. Unless free-phase product is present, concentrations of the chemical are unlikely to be present at sufficient concentration to result in an exceedance of the health criteria value (HCV).

RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH[6] whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limits given in brackets. Therefore, when using the SAC to screen laboratory analysis the assessor should take note if a given SAC has a corresponding solubility saturation or vapour saturation limit (in brackets), and subsequently incorporate this information within the screening analytical discussion. If further assessment is required following this process then an additional approach can be utilised as detailed within Section 4.12 of the CLEA model handbook[4] which explains how to calculate an effective assessment criterion manually.

Input selection

Chemical data was obtained from EA Report SC050021/SR7[5] and the health criteria values (HCV) from the UK TOX[1] reports where available. For SAC for total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), toxicological and specific chemical parameters were obtained from the LQM/CIEH report[6]. Similarly, toxicological and specific chemical parameters for the volatile organic compound 1,2,4-trimethylbenzene were obtained from EIC/AGS/CL:AIRE[7].

For TPH, aromatic hydrocarbons C_5–C_8 were not modelled since benzene and toluene are being modelled separately. The aromatic C_8-C_9 hydrocarbon fraction comprises ethylbenzene, xylene and styrene. As ethylbenzene and xylene are being modelled separately, the physical, chemical and toxicological data for this band have been taken from styrene.

Owing to the lack of UK-specific data, default information in the RBCA model was used to evaluate methyl tertiary butyl ether (MTBE). No published UK data was available for 1,3,5-trimethylbenzene, so information was obtained from the US EPA as in the RBCA model. RBCA

uses toxicity data for the inhalation pathway in different units to the CLEA model and cannot consider separately the mean daily intake (MDI), occupancy periods or breathing rates. Therefore, the HCV in RBCA was amended to take account of:

- an adult weighing 70kg and breathing 14.8m^3 air per day in accordance with the UK TOX reports[2] and SR3[3]
- the 50% rule (for petroleum hydrocarbons, trimethylbenzenes and MTBE)[2] where MDI data is not currently available but background exposure is considered important in the overall exposure.

Physical parameters

For the commercial end use, the CLEA default pre-1970s three-storey office building was used. SR3 notes this commercial building type to be the most conservative in terms of protection from vapour intrusion. The building parameters are outlined in Table 3.

The parameters for a sandy loam soil type were used in line with SR3[3]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this parameter, RSK has produced an additional set of SAC for an SOM of 1% and 2.5%.

For the GrAC, the depth to groundwater was taken as 2.5m based on RSK's experience of assessing the volatilisation pathway from groundwater.

GAC

The SAC were produced using the input parameters in Tables 1, 2 and 3 and the GrAC using the input parameters in Table 4. The final selected GAC are presented by pathway in Table 5 with the combined GAC in Table 6.

Figure 1: Conceptual model for CLEA commercial scenario

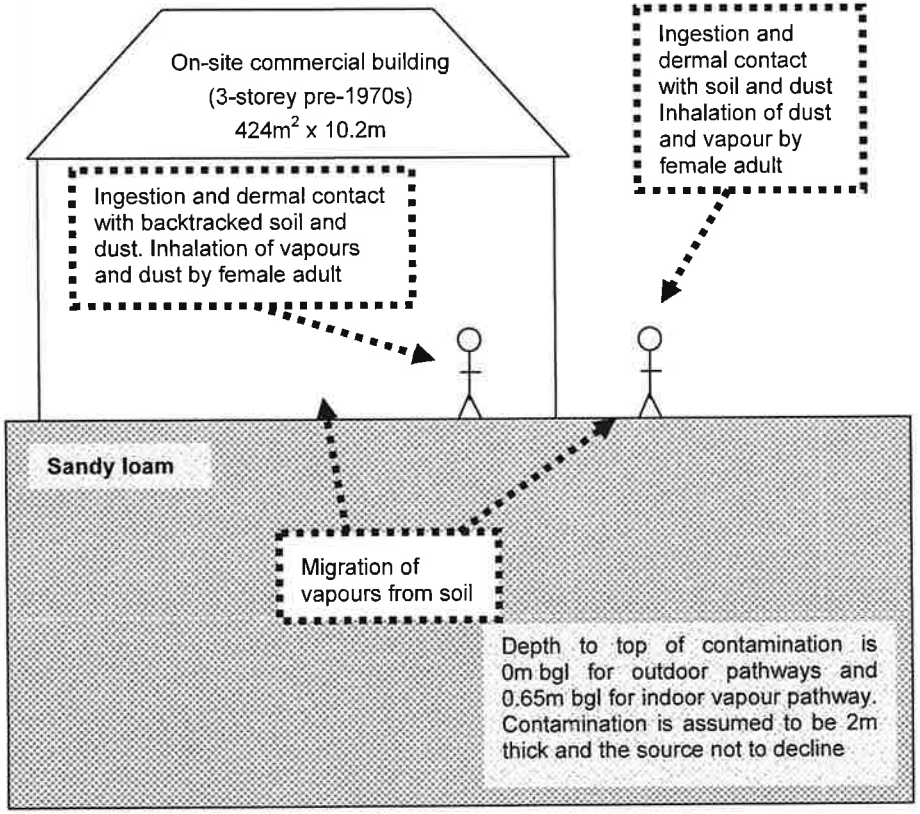

Table 1: Exposure assessment parameters for commercial scenario – inputs for CLEA model

Parameter	Value	Justification
Land use	Commercial	Chosen land use
Receptor	Female worker	Taken as female adult exposed over 49 years from age 16 to 65 years, Box 3.5, SR3[3]
Building	Office (pre-1970)	Key generic assumption given in Box 3.5, SR3[3]. Pre-1970s three-storey office building chosen as it is the most conservative in terms of protection from vapour intrusion (Section 3.4.6, SR3[3])
Soil type	Sandy loam	Most common UK soil type (Section 4.3.1, Table 4.4, SR3[3]). Table 4 presents soil-specific inputs
Start age class (AC)	17	AC corresponding to key generic assumption that the critical receptor is a working female adult exposed over a 49-year period from age 16 to 65 years. Assumption given in Box 3.5, SR3[3]. Data specific to AC exposure is presented in Table 2 and receptor specific in Table 3
End AC	17	
SOM (%)	6	Representative of sandy loam according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[8]
	1	To provide SAC for sites where SOM < 6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Commercial – receptor inputs for CLEA model

Parameter	Unit	Value	Justification
Exposure frequency (EF) (soil and dust ingestion)	day yr^{-1}	230	From Table 3.9, SR3[3]. The working week is assumed 45 hours including a 1-hour lunch break each day. Indoor and outdoor exposure are weighted by the frequency of time spent indoors and outdoors (8.3 hours a day and 0.7 hours a day respectively)
EF (dermal contact with dust. indoor)	day yr^{-1}	230	
EF (dermal contact with soil, outdoor)	day yr^{-1}	170	
EF (inhalation of dust and vapour, indoor)	day yr^{-1}	230	
EF (inhalation of dust and vapour, outdoor)	day yr^{-1}	170	
Occupancy period (indoor)	hr day^{-1}	8.3	Box 3.6, SR3[3]. Weighted average based on a nine-hour day including one-hour lunch being spent outside 75% of the year
Occupancy period (outdoor)	hr day^{-1}	0.7	
Soil to skin adherence factor (indoor and outdoor)	mg cm^{-2} day^{-1}	0.14	Table 8.1, SR3[3] for age class 17
Soil and dust ingestion rate	g day^{-1}	0.05	Table 6.2, SR3[3] for age class 17
Body weight	kg	70	Table 4.6, SR3[3] for female AC 17
Body height	m	1.6	Table 4.6, SR3[3] for female AC 17
Inhalation rate	m^3 day^{-1}	14.8	Table 4.14, SR3[3] for female AC 17
Max. exposed skin fraction (indoor and outdoors)	m^2 m^{-2}	0.08	Based on adult female assuming face and hands are exposed. Table 4.7, SR3[3]

Table 3: Commercial – soil, air and building inputs for CLEA model

Parameter	Unit	Value	Justification
Soil properties for sandy loam			
Porosity, total	$cm^3\ cm^{-3}$	0.53	Default soil type is sandy loam, Section 4.3.1, SR3[3]. Parameters for sandy loam from Table 4.4, SR3[3]
Porosity, air filled	$cm^3\ cm^{-3}$	0.20	
Porosity, water filled	$cm^3\ cm^{-3}$	0.33	
Residual soil water content	$cm^3\ cm^{-3}$	0.12	
Saturated hydraulic conductivity	$cm\ s^{-1}$	0.00356	
van Genuchten shape parameter (*m*)	-	0.3201	
Bulk density	$g\ cm^{-3}$	1.21	
Threshold value of wind speed at 10m	$m\ s^{-1}$	7.20	Default value taken from Section 9.2.2, SR3[3]
Empirical function (F_x) for dust model	-	1.22	Value taken from Section 9.2.2, SR3[3]
Ambient soil temperature	K	283	Annual average soil temperature of UK surface soils. Section 4.3.1, SR3[3]
Air dispersion model			
Mean annual wind speed (10m)	$m\ s^{-1}$	5.0	Default value taken from Section 9.2.2, SR3[3]
Air dispersion factor at height of 1.6m	$g\ m^{-2}\ s^{-1}$ per $kg\ m^{-3}$	120	From Table 9.1, SR3. Values for a 2ha site, appropriate to a commercial land use in Newcastle (most representative city for UK, section 9.2.1,SR3[3])
Fraction of site with hard or vegetative cover	$m^2\ m^{-2}$	0.8	Section 3.4.6 and 9.2.2, SR3[3] for average office such as that used in the commercial scenario
Building properties for office (pre-1970) with ground-bearing floor slab			
Building footprint	m^2	424	From Table 3.10, SR3[3]
Living space air exchange rate	hr^{-1}	1.0	
Living space height (above ground)	m	9.6	
Living space height (below ground)	m	0.0	Assumed no basement.
Pressure difference (soil to enclosed space)	Pa	4.4	From Table 3.10, SR3[3]
Foundation thickness	m	0.15	

Parameter	Unit	Value	Justification
Floor crack area	m^2	0.165	
Dust loading factor	$\mu g\ m^{-3}$	100	Default value for a commercial site taken from Section 9.3, SR3[3]
Vapour model			
Default soil gas ingress rate	$cm^3\ s^{-1}$	150	Section 10.3, report SC050021/SR3[3]
Depth to top of source (beneath building for indoor exposure)	cm	50	Section 3.4.6, SR3[3] states source is 50cm below building or 65cm below ground surface
Depth to top of source (outdoors)	cm	0	Section 10.2, SR3[3] assumes impact from 0-1m for outdoor inhalation pathway
Thickness of contaminant layer	cm	200	Model default for indoor air, Section 4.9, SR4[4]
Time average period for surface emissions	years	49	Working lifetime from 16–65 years. Key generic assumption given in Box 3.5, SR3[3]
User-defined effective air permeability	cm^2	3.05E-08	Calculated for sandy loam using equations in Appendix 1, SR3[3]

Figure 2: GrAC conceptual model for RBCA commercial scenario

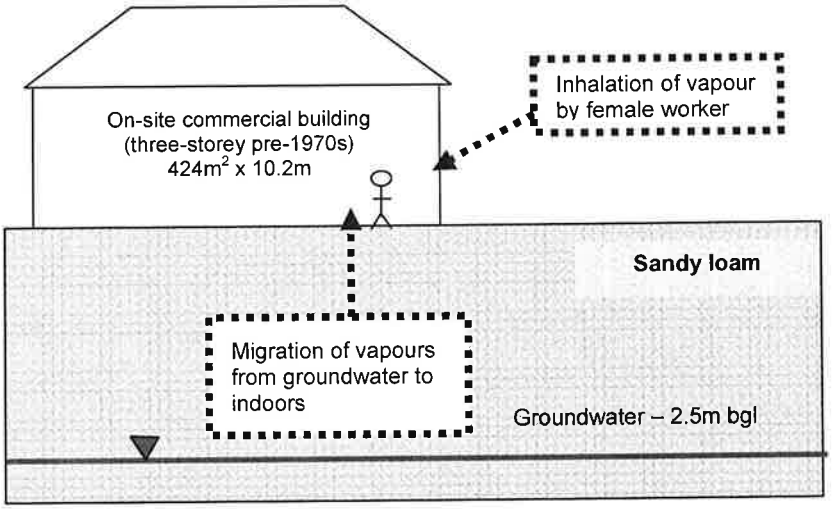

Table 4: Commercial – RBCA inputs

Parameter	Unit	Value	Justification
Receptor			
Averaging time	Years	49	From Box 3.5, SR3[3]
Receptor weight	kg	70	Female adult, Table 4.6, SR3[3]
Exposure duration	Years	49	From Box 3.5, SR3[3]
Exposure frequency	Days/yr	86.25	Weighted using occupancy period of 9 hours per day for 230 days of the year ((9hours x 230 days)/24 hours)
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3[3]
Volumetric water content	-	0.33	
Volumetric air content	-	0.20	
Dry bulk density	g cm^{-3}	1.21	
Vertical hydraulic conductivity	cm s^{-1}	3.56E-3	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3[3]
Vapour permeability	m^2	3.05E-12	Calculated for sandy loam using equations in Appendix 1, SR3[3]
Capillary zone	m	0.1	Professional judgement

Parameter	Unit	Value	Justification
thickness			
Building			
Building volume/area ratio	m	9.6	Table 3.10, SR3[3]
Foundation area	m^2	424	Table 3.10, SR3[3]
Foundation perimeter	m	82.40	Based on square root of building area being 20.59m
Building air exchange rate	d^{-1}	24	Table 3.10, SR3[3]
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	Table 3.10, SR3[3]
Foundation crack fraction	-	3.89E-04	Calculated from floor crack area of $0.165m^2$ and building footprint of $424m^2$ in Table 4.21, SR3[3]
Volumetric water content of cracks	-	0.33	Assumed equal to underlying soil type in assumption that cracks become filled with soil over time. Parameters for sandy loam from Table 4.4, SR3[3]
Volumetric air content of cracks	-	0.2	
Indoor/outdoor differential pressure	Pa	4.4	From Table 3.10, SR3[3]

References

1. Environment Agency (2009), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

2. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

3. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

4. Environment Agency (2009), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

5. Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

6. Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

7. CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

8. Changes made to the CLEA framework documents after the three-month evaluation period in 2008, released January 2009 by the Environment Agency.

Table 5

Human health generic assessment criteria by pathway for commercial scenario

Compound	Notes	GrAC (mg/l)	SAC appropriate to pathway SOM 1% (mg/kg)			Soil saturation limit (mg/kg)	SAC appropriate to pathway SOM 2.5% (mg/kg)			Soil saturation limit (mg/kg)	SAC appropriate to pathway SOM 6% (mg/kg)			Soil saturation limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Metals														
Arsenic	(b)(c)	-	6.35E+02	6.95E+02	-	NR	6.35E+02	6.95E+02	-	NR	6.35E+02	6.95E+02	-	NR
Cadmium	(b)	-	3.99E+02	3.87E+02	2.30E+02	NR	3.99E+02	3.87E+02	2.30E+02	NR	3.99E+02	3.87E+02	2.30E+02	NR
Chromium (III) - oxide		-	3.31E+05	3.34E+04	3.04E+04	NR	3.31E+05	3.34E+04	3.04E+04	NR	3.31E+05	3.34E+04	3.04E+04	NR
Chromium (VI) - hexavalent		-	2.01E+03	3.48E+01	3.42E+01	NR	2.01E+03	3.48E+01	3.42E+01	NR	2.01E+03	3.48E+01	3.42E+01	NR
Copper		-	1.78E+05	9.60E+04	7.17E+04	NR	1.78E+05	9.60E+04	7.17E+04	NR	1.78E+05	9.60E+04	7.17E+04	NR
Lead	(a)	-	6.00E+02	-	-	NR	6.00E+02	-	-		6.00E+02	-	-	NR
Elemental mercury (Hg^0)	(b)(d)	5.50E-02	-	1.84E+01	-	4.31E+00	-	4.57E+01	-	1.07E+01	-	1.09E+02	-	2.58E+01
Inorganic mercury (Hg^{2+})	(b)	-	4.41E+03	2.09E+04	3.64E+03	NR	4.41E+03	2.09E+04	3.64E+03		4.41E+03	2.09E+04	3.64E+03	NR
Methyl mercury (Hg^{2+})	(b)	1.00E+02	4.25E+02	2.73E+03	3.68E+02	7.33E+01	4.25E+02	4.97E+03	3.91E+02	1.42E+02	4.25E+02	9.41E+03	4.07E+02	3.04E+02
Nickel	(b)	-	2.22E+04	1.79E+03	-	NR	2.22E+04	1.79E+03	-	NR	2.22E+04	1.79E+03	-	NR
Selenium	(b)(c)	-	1.30E+04	-	-	NR	1.30E+04	-	-	NR	1.30E+04	-	-	NR
Zinc	(c)	-	6.67E+05	2.09E+08	-	NR	6.67E+05	2.09E+08	-	NR	6.67E+05	2.09E+08	-	NR
Cyanide		-	1.69E+04	1.95E+03	1.81E+03	NR	1.69E+04	1.95E+03	1.81E+03	NR	1.69E+04	1.95E+03	1.81E+03	NR
Volatile organic compounds														
Benzene	(b)	1.40E+02	5.53E+02	2.96E+01	2.81E+01	1.22E+03	5.53E+02	5.51E+01	5.01E+01	2.26E+03	5.53E+02	1.14E+02	9.47E+01	4.71E+03
Toluene	(b)	5.90E+02	4.25E+05	6.65E+04	5.90E+04	8.69E+02	4.25E+05	1.51E+05	1.11E+05	1.92E+03	4.25E+05	3.42E+05	1.89E+05	4.36E+03
Ethylbenzene	(b)	1.80E+02	1.91E+05	1.84E+04	1.68E+04	5.18E+02	1.91E+05	4.31E+04	3.51E+04	1.22E+03	1.91E+05	1.00E+05	6.57E+04	2.84E+03
Xylene - m	(b)	2.00E+02	3.43E+05	6.59E+03	6.46E+03	6.25E+02	3.43E+05	1.55E+04	1.48E+04	1.47E+03	3.43E+05	3.61E+04	3.27E+04	3.46E+03
Xylene - o		1.70E+02	3.43E+05	7.08E+03	6.94E+03	4.78E+02	3.43E+05	1.65E+04	1.58E+04	1.12E+03	3.43E+05	3.84E+04	3.46E+04	2.62E+03
Xylene - p		2.00E+02	3.43E+05	6.34E+03	6.22E+03	5.76E+02	3.43E+05	1.48E+04	1.42E+04	1.35E+03	3.43E+05	3.45E+04	3.14E+04	3.17E+03
Total xylene		2.00E+02	3.43E+05	6.59E+03	6.46E+03	6.25E+02	3.43E+05	1.55E+04	1.48E+04	1.47E+03	3.43E+05	3.61E+04	3.27E+04	3.46E+03
Methyl tertiary butyl ether (MTBE)		4.80E+04	9.53E+03	2.09E+04	8.21E+03	1.66E+04	9.53E+03	2.72E+04	8.55E+03	2.16E+04	9.53E+03	4.18E+04	8.93E+03	3.34E+04
Trichloroethene		3.60E+01	9.92E+03	1.19E+01	1.19E+01	1.54E+03	9.92E+03	2.49E+01	2.49E+01	3.22E+03	9.92E+03	5.54E+01	5.50E+01	7.14E+03
Tetrachloroethene		2.30E+02	2.65E+04	1.31E+02	1.31E+02	4.24E+02	2.65E+04	2.94E+02	2.91E+02	9.51E+02	2.65E+04	6.75E+02	6.58E+02	2.18E+03
1,1,1-Trichloroethane		1.30E+03	1.14E+06	7.01E+02	7.00E+02	1.43E+03	1.14E+06	1.43E+03	1.43E+03	2.92E+03	1.14E+06	3.14E+03	3.13E+03	6.39E+03
1,1,1,2 Tetrachloroethane		1.10E+03	1.10E+04	1.16E+02	1.15E+02	2.60E+03	1.10E+04	2.68E+02	2.62E+02	6.02E+03	1.10E+04	6.24E+02	5.91E+02	1.40E+04
1,1,2,2 Tetrachloroethane		1.10E+03	1.10E+04	2.98E+02	2.90E+02	2.67E+03	1.10E+04	6.10E+02	5.78E+02	5.46E+03	1.10E+04	1.34E+03	1.19E+03	1.20E+04
Carbon Tetrachloride (tetrachloromethane)		5.70E+00	2.70E+03	3.04E+00	3.04E+00	1.52E+03	2.70E+03	6.67E+00	6.65E+00	3.32E+03	2.70E+03	1.51E+01	1.50E+01	7.54E+03
1,2-Dichloroethane		6.10E+00	2.29E+02	7.14E-01	7.12E-01	3.41E+03	2.29E+02	1.03E+00	1.03E+00	4.91E+03	2.29E+02	1.77E+00	1.75E+00	8.43E+03
Vinyl Chloride (chloroethene)		4.10E-01	2.67E+01	8.31E-02	6.30E-02	1.36E+03	2.67E+01	8.16E-02	8.14E-02	1.76E+03	2.67E+01	1.25E-01	1.24E-01	2.69E+03
1,2,4-Trimethylbenzene		5.70E+01	-	4.17E+01	-	5.57E+02	-	9.89E+01	-	1.36E+03	-	2.19E+02	-	3.25E+03
1,3,5-Trimethylbenzene		3.80E+01	2.19E+04	4.71E+01	4.71E+01	9.47E+01	2.19E+04	1.12E+02	1.12E+02	2.26E+02	2.19E+04	2.63E+02	2.63E+02	5.33E+02
Semi-volatile organic compounds														
Acenaphthene		3.20E+00	1.10E+05	3.75E+05	8.49E+04	5.70E+01	1.10E+05	8.95E+05	9.77E+04	1.41E+02	1.10E+05	2.00E+06	1.04E+05	3.36E+02
Acenaphthylene		1.61E+01	1.10E+05	3.84E+05	8.43E+04	8.61E+01	1.10E+05	8.68E+05	9.74E+04	2.12E+02	1.10E+05	1.94E+06	1.04E+05	5.06E+02
Anthracene		2.10E-02	5.49E+05	1.19E+07	5.25E+05	1.17E+00	5.49E+05	2.49E+07	5.37E+05	2.91E+00	5.49E+05	4.38E+07	5.42E+05	6.96E+00
Benzo(a)anthracene		3.80E-03	2.52E+02	1.39E+02	8.95E+01	1.71E+00	2.52E+02	1.52E+02	9.48E+01	4.28E+00	2.52E+02	1.59E+02	9.74E+01	1.03E+01
Benzo(b)fluoranthene		2.00E-03	2.60E+02	1.63E+02	1.00E+02	1.22E+00	2.60E+02	1.67E+02	1.02E+02	3.04E+00	2.60E+02	1.69E+02	1.03E+02	7.29E+00
Benzo(g,h,i)perylene		2.60E-04	1.66E+03	1.08E+03	6.54E+02	1.54E-02	1.66E+03	1.09E+03	6.59E+02	3.85E-02	1.66E+03	1.10E+03	6.61E+02	9.23E-02
Benzo(k)fluoranthene		8.00E-04	3.66E+02	2.31E+02	1.41E+02	6.87E-01	3.66E+02	2.35E+02	1.43E+02	1.72E+00	3.66E+02	2.38E+02	1.44E+02	4.12E+00
Chrysene		2.00E-03	3.66E+02	2.20E+02	1.37E+02	4.40E-01	3.66E+02	2.29E+02	1.41E+02	1.10E+00	3.66E+02	2.34E+02	1.43E+02	2.64E+00
Dibenzo(a,h)anthracene		6.00E-04	3.29E+01	2.80E+01	1.27E+01	3.93E-03	3.29E+01	2.12E+01	1.29E+01	9.82E-03	3.29E+01	2.15E+01	1.30E+01	2.36E-02
Fluoranthene		2.30E-01	2.29E+04	2.01E+06	2.26E+04	1.89E+01	2.29E+04	2.89E+06	2.27E+04	4.73E+01	2.29E+04	3.52E+06	2.27E+04	1.13E+02
Fluorene		1.90E+00	7.31E+04	4.82E+05	6.35E+04	3.09E+01	7.31E+04	1.12E+06	6.87E+04	7.65E+01	7.31E+04	2.38E+06	7.10E+04	1.83E+02
Indeno(1,2,3-cd)pyrene		2.00E-04	1.57E+02	9.71E+01	6.00E+01	6.13E-02	1.57E+02	9.98E+01	6.11E+01	1.53E-01	1.57E+02	1.01E+02	6.17E+01	3.68E-01
Phenanthrene		5.30E-01	2.28E+04	5.67E+05	2.19E+04	3.60E+01	2.28E+04	1.16E+06	2.24E+04	8.96E+01	2.28E+04	1.98E+06	2.26E+04	2.14E+02
Pyrene		1.30E-01	5.49E+04	4.74E+06	5.42E+04	2.20E+00	5.49E+04	6.86E+06	5.44E+04	5.49E+00	5.49E+04	8.39E+06	5.45E+04	1.32E+01
Benzo(a)pyrene		3.80E-03	3.66E+01	2.30E+01	1.41E+01	9.11E-01	3.66E+01	2.35E+01	1.43E+01	2.28E+00	3.66E+01	2.38E+01	1.44E+01	5.46E+00
Naphthalene		1.90E+01	3.64E+04	2.05E+02	2.04E+02	7.64E+01	3.64E+04	4.90E+02	4.83E+02	1.83E+02	3.64E+04	1.15E+03	1.12E+03	4.32E+02
Phenol	(b)(e)	-	1.54E+06	3.16E+04	3.10E+04	4.16E+04	1.00E+06	3.57E+04	3.49E+04	8.15E+04	1.54E+06	3.85E+04	3.76E+04	1.74E+05
Total petroleum hydrocarbons														
Aliphatic hydrocarbons EC_5–EC_6		3.60E+01	4.77E+06	3.38E+03	3.39E+03	3.04E+02	4.77E+06	6.21E+03	6.21E+03	5.58E+02	4.77E+06	1.28E+04	1.28E+04	1.15E+03
Aliphatic hydrocarbons >EC_6–EC_8		5.40E+00	4.77E+06	8.26E+03	8.25E+03	1.44E+02	4.77E+06	1.84E+04	1.84E+04	3.22E+02	4.77E+06	4.21E+04	4.20E+04	7.36E+02
Aliphatic hydrocarbons >EC_8–EC_{10}		4.30E-01	9.53E+04	2.14E+03	2.13E+03	7.77E+01	9.53E+04	5.21E+03	5.14E+03	1.90E+02	9.53E+04	1.24E+04	1.19E+04	4.51E+02
Aliphatic hydrocarbons >EC_{10}–EC_{12}		3.40E-02	9.53E+04	1.06E+04	1.03E+04	4.75E+01	9.53E+04	2.62E+04	2.42E+04	1.18E+02	9.53E+04	6.25E+04	4.93E+04	2.83E+02

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - COMMERCIAL

Table 5

Human health generic assessment criteria by pathway for commercial scenario

Compound	Notes	GrAC (mg/l)	SAC appropriate to pathway SOM 1% (mg/kg)			Soil saturation limit (mg/kg)	SAC appropriate to pathway SOM 2.5% (mg/kg)			Soil saturation limit (mg/kg)	SAC appropriate to pathway SOM 6% (mg/kg)			Soil saturation limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Aliphatic hydrocarbons >EC_{12}–EC_{16}		7.60E-04	9.53E+04	8.75E+04	6.08E+04	2.37E+01	9.53E+04	2.16E+05	8.26E+04	5.91E+01	9.53E+04	5.10E+05	9.50E+04	1.42E+02
Aliphatic hydrocarbons >EC_{16}–EC_{35}	(c)	-	1.59E+06	-	-	8.48E+00	1.76E+06	-	-	2.12E+01	1.83E+06	-	-	5.09E+01
Aliphatic hydrocarbons >EC_{35}–EC_{44}	(c)	-	1.59E+06	-	-	8.48E+00	1.76E+06	-	-	2.12E+01	1.83E+06	-	-	5.09E+01
Aromatic hydrocarbons >EC_8–EC_8 (styrene)		6.50E+01	1.14E+05	3.00E+04	2.77E+04	6.20E+02	1.14E+05	7.38E+04	5.81E+04	1.52E+03	1.14E+05	1.73E+05	9.00E+04	3.61E+03
Aromatic hydrocarbons >EC_8–EC_{10}		6.50E+01	3.81E+04	3.76E+03	3.67E+03	6.13E+02	3.81E+04	9.18E+03	8.56E+03	1.50E+03	3.81E+04	2.17E+04	1.78E+04	3.58E+03
Aromatic hydrocarbons >EC_{10}–EC_{12}		2.50E+01	3.81E+04	2.03E+04	1.69E+04	3.64E+02	3.81E+04	4.97E+04	2.85E+04	8.99E+02	3.81E+04	1.17E+05	3.45E+04	2.15E+03
Aromatic hydrocarbons >EC_{12}–EC_{16}	(c)	5.80E+00	3.81E+04	2.15E+05	3.63E+04	1.69E+02	3.81E+04	5.05E+05	3.74E+04	4.19E+02	3.81E+04	1.09E+06	3.78E+04	1.00E+03
Aromatic hydrocarbons >EC_{16}–EC_{21}	(c)	-	2.82E+04	-	-	5.37E+01	2.83E+04	-	-	1.34E+02	2.84E+04	-	-	3.21E+02
Aromatic hydrocarbons >EC_{21}–EC_{35}	(c)	-	2.84E+04	-	-	4.83E+00	2.84E+04	-	-	1.21E+01	2.84E+04	-	-	2.90E+01
Aromatic hydrocarbons >EC_{35}–EC_{44}	(c)	-	2.84E+04	-	-	4.83E+00	2.84E+04	-	-	1.21E+01	2.84E+04	-	-	2.90E+01

Notes:

"-" Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway or an absence of toxicological data.

NR - the compound is not volatile and therefore a soil saturation limit not calculated within CLEA

EC - equivalent carbon, GrAC - groundwater screening value. SAC - soil screening value.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

Calculated SAC exceeds soil saturation limit and may significantly affect the interpretation of any exceedances as the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RBCA output where the theoretical solubility limit has been exceeded. The SAC has been set as the model calculated SAC with the saturation limits shown in brackets.

Calculated SAC exceeds soil saturation limit but the exceedance will not affect the SAC significantly as the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.

Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RBCA has been exceeded in production of the GrAC, these cells have also been hatched red and the GrAC set at the solubility limit.

The SAC for organic compounds are dependent upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58; 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3

(a) RSK Lead GAC obtained following sensitivity analysis of blood lead concentrations.

(b) GAC taken from the Environment Agency SGV reports published 2009.

(c) SAC for selenium, aliphatic and aromatic hydrocarbons >EC16 does not include inhalation pathway owing to absence of toxicity data. SAC for arsenic is only based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The same approach has been adopted for zinc.

(d) SAC for elemental mercury, chromium VI and nickel is based on the inhalation pathway only owing to an absence of toxicity for elemental mercury, in accordance with the SGV report for nickel and LQM report for chromium VI.

(e) The GAC for phenol is based on a threshold which is protective of acute direct skin contact with phenol (the figure in brackets is based on health effects following long-term exposure and is provided for illustration only).

Table 6
Selected human health generic assessment criteria for commercial scenario

Compound	GrAC for groundwater (mg/l)	SAC for soil SOM 1% (mg/kg)	SAC for soil SOM 2.5% (mg/kg)	SAC for soil SOM 6% (mg/kg)
Metals				
Arsenic	-	640	640	640
Cadmium	-	230	230	230
Chromium (III) - oxide	-	30,000	30,000	30,000
Chromium (VI) - hexavalent	-	35	35	35
Copper	-	72,000	72,000	72,000
Lead	-	600	600	600
Elemental mercury (Hg^0)	0.056	18 (4.3)	46 (11)	110 (26)
Inorganic mercury (Hg^{2+})	-	3,600	3,600	3,600
Methyl mercury (Hg^{4+})	100	370 (73)	391	410
Nickel	-	1,800	1,800	1,800
Selenium	-	13,000	13,000	13,000
Zinc	-	670,000	670,000	670,000
Cyanide	-	1,800	1,800	1,800
Volatile organic compounds				
Benzene	140	28	50	95
Toluene	590	59,000 (870)	110,000 (1,900)	189,000 (4,400)
Ethylbenzene	180	17,000 (520)	35,000 (1,200)	65,700 (2,800)
Xylene - m	200	6,500 (620)	15,000 (1,500)	32,700 (3,500)
Xylene - o	170	6,900 (480)	16,000 (1,100)	34,600 (2,600)
Xylene - p	200	6,200 (580)	14,000 (1,400)	31,400 (3,200)
Total xylene	200	6,500 (630)	15,000 (1,500)	32,700 (3,500)
Methyl tertiary butyl ether (MTBE)	48,000	8,200	8,600	8,900
Trichloroethene	36	12	25	55
Tetrachloroethene	230	130	1,400	660
1,1,1-Trichloroethane	1,300	700	1,400	3,100
1,1,1,2 Tetrachloroethane	1,100	120	260	590
1,1,2,2 Tetrachloroethane	1,100	290	580	1,200
Carbon tetrachloride (tetrachloromethane)	5.7	3.0	6.7	15
1,2-Dichloroethane	6.1	0.71	1.0	1.8
Vinyl chloride (chloroethene)	0.41	0.063	0.08	0.12
1,2,4-Trimethylbenzene	57	42	99	220
1,3,5-Trimethylbenzene	38	47	110	260
Semi-volatile organic compounds				
Acenaphthene	3.2	85,000 (57)	98,000 (141)	100,000
Acenaphthylene	16	84,000 (86)	97,000 (212)	100,000
Anthracene	0.021	530,000	540,000	540,000
Benzo(a)anthracene	0.0038	90	95	97
Benzo(b)fluoranthene	0.0020	100	100	100
Benzo(g,h,i)perylene	0.00026	650	660	660
Benzo(k)fluoranthene	0.00080	140	140	140
Chrysene	0.0020	140	140	140
Dibenzo(a,h)anthracene	0.00060	13	13	13
Fluoranthene	0.23	23,000	23,000	23,000
Fluorene	1.9	64,000 (31)	69,000	71,000
Indeno(1,2,3-cd)pyrene	0.00020	60	61	62
Phenanthrene	0.53	22,000	22,000	23,000
Pyrene	0.13	54,000	54,000	55,000
Benzo(a)pyrene	0.0038	14	14	14
Naphthalene	19	200 (76)	480 (183)	1100 (432)
Phenol	-	3,200 * (31,000)	3,200* (35,000)	3,200 * (38,000)
Total petroleum hydrocarbons				
Aliphatic hydrocarbons EC_5–EC_6	36	3,400 (304)	6,200 (558)	13,000 (1,150)
Aliphatic hydrocarbons >EC_6–EC_8	5.4	8,300 (144)	18,000 (322)	42,000 (736)
Aliphatic hydrocarbons >EC_8–EC_{10}	0.43	2,100 (78)	5,100 (190)	12,000 (451)
Aliphatic hydrocarbons >EC_{10}–EC_{12}	0.034	10,000 (48)	24,000 (118)	49,000 (283)
Aliphatic hydrocarbons >EC_{12}–EC_{16}	0.00076	61,000 (24)	83,000 (59)	91,000 (142)
Aliphatic hydrocarbons >EC_{16}–EC_{35}	-	1,000,000**	1,000,000**	1,000,000**
Aliphatic hydrocarbons >EC_{35}–EC_{44}	-	1,000,000**	1,000,000**	1,000,000**
Aromatic hydrocarbons >EC_8–EC_9 (styrene)	65	28,000 (620)	58,000 (1,500)	90,000 (3,600)
Aromatic hydrocarbons >EC_9–EC_{10}	65	3,700 (610)	8,600 (1,500)	18,000 (3,600)
Aromatic hydrocarbons >EC_{10}–EC_{12}	25	17,000 (364)	29,000 (899)	35,000 (2,150)
Aromatic hydrocarbons >EC_{12}–EC_{16}	5.8	36,000 (169)	37,000	38,000
Aromatic hydrocarbons >EC_{16}–EC_{21}	-	28,000	28,000	28,000
Aromatic hydrocarbons >EC_{21}–EC_{35}	-	28,000	28,000	28,000
Aromatic hydrocarbons >EC_{35}–EC_{44}	-	28,000	28,000	28,000

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway or an absence of toxicological data.

** Denotes SAC calculated exceeds 100% contaminant. Hence 100% taken as SAC.

EC - equivalent carbon; GrAC - groundwater assessment criteria; SAC - soil assessment criteria.

* The GAC for phenol is based on a threshold which is protective of direct skin contact with phenol (the figure in brackets is based on health effects following long-term exposure and is provided for illustration only).

The SAC for organic compounds are dependent on soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58; 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

The SAC has been set as the model calculated SAC with the saturation limit shown in brackets. For consistency where the GrAC exceeds the solubility limit, GrAC has been set at the solubility limit. The GrAC are highly conservative as concentrations of the chemical are very unlikely to be at sufficient concentration to result in an exceedance of the health criteria value at the point of exposure (i.e. indoor air) provided free-phase product is absent.

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ACCREDITATION CERTIFICATE

TESTING LABORATORY
No. 1247

Envirolab

is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005
General Requirements for the competence of testing and calibration laboratories.

This accreditation demonstrates technical competence for a defined scope as detailed in and at the locations specified in the schedule to this certificate, and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated 18 June 2005).

The schedule to this certificate is an essential accreditation document and from time to time may be revised and reissued by the United Kingdom Accreditation Service. The most recent issue of the schedule of accreditation, which bears the same accreditation number as this certificate, is available from the UKAS website www.ukas.org.

This accreditation is subject to continuing conformity
with United Kingdom Accreditation Service requirements. The absence of a schedule on the UKAS website indicates that the accreditation is no longer in force.

R Bellamy

Accreditation Manager, United Kingdom Accreditation Service

Initial Accreditation date
02 December 1992

This certificate issued on
11 August 2006

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