Harworth Estates

Rockingham 1, South Yorkshire

Geo-environmental Site Assessment

Report no. 321393-R2 (00)

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RSK GENERAL NOTES

Project No.: 321393-R2 (00)

Title: Geo-Environmental Site Assessment: Rockingham 1

Client: Harworth Estates Limited

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EXECUTIVE SUMMARY

Site description and proposed development	The Rockingham 1 development site forms part of the larger Rockingham former opencast coal mining site, and is anticipated to be the subject of the first phase of development of the larger site area. The proposed development of the Rockingham 1 site comprises commercial properties.
Purpose of assessment	The purpose of this assessment is to investigate ground conditions and ground treatment required to enable the proposed future redevelopment of the land for commercial end use.
PRELIMINARY RISK ASSESSMENT	
Site description	The site is largely level and currently comprises grassland, which is unused except for recreational access for walking, largely by neighbouring residents.
History of site and surrounding area	The main Rockingham colliery was formerly located off-site to the west, with some infrastructure located on the site. More recently the site has been used for the opencast extraction of coal and was restored by 2002.
Geology, hydrogeology and hydrology	As a result of the former opencast extraction of coal a significant thickness of made ground covers the majority of the site. This comprises the excavated overburden material replaced to fill the voids created by coal extraction. The underlying bedrock is recorded as being Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone with coal seams. The bedrock units comprise a Secondary A aquifer. Substantial underground and opencast mining activity has previously occurred on site. Although there are several recorded mine entries nearby, there are none recorded on site.
Potentially contaminative uses on site and in surrounding area	The fill materials used to backfill the opencast voids will largely include materials moved locally to minimise haulage and are generally considered unlikely to have been exposed to significant contamination sources. The fill materials may contain highly calorific materials, as well as naturally occurring concentrations of sulphates and pyrites.
Conceptual model	Potentially complete pollutant linkages identified with a risk estimate of moderate/low or above include direct contact between future site users and impacted soils, chemical attack and permeation of water supply pipes, migration of contaminants to underlying groundwater in Secondary A aquifer and migration of ground gases into buildings.
SITE ASSESSMENT	
Site investigation	To investigate the potentially complete pollutant linkages a site

	investigation was undertaken comprising a series of boreholes and trial pits. Soil samples were recovered from these and scheduled for laboratory analyses. Gas monitoring was subsequently undertaken on installed boreholes, and at the time of writing this report the programme of gas monitoring is still ongoing. Groundwater monitoring and sampling was also undertaken, with groundwater samples subjected to laboratory analyses.
Refined conceptual site model	The laboratory data were compared to generic assessment criteria to evaluate whether the pollutant linkages in the conceptual model require further consideration or mitigation measures. The linkages found to be complete and that may require mitigation measures are permeation of plastic (PE) potable water supply pipes by contaminants in soils and the migration of hazardous ground gases into future buildings at the site.
CONCLUSIONS AND RECOMMENDATIONS	
Environmental assessment	Results of the investigation indicate that in one part of the site contaminants in soils may permeate through plastic (PE) water supply pipes. As such, in this one area, alternative pipe materials (including PVC) are required. As a precaution, across the rest of the site excavations for water supply pipes should be inspected for evidence of contamination as they progress. Basic gas ingress protective measures are required in any new buildings, likely to comprise the installation of a 2000 gauge gas resistant membrane across the floor slab, with all service entries sealed. However, further gas monitoring is still to be undertaken, which may affect the results of the assessment.
Geotechnical assessment	The investigation has confirmed the presence of competent backfill across the area which is consistent with it having been placed as an engineered fill. Across the plot fill thicknesses vary considerably generally from 5m or so in the west to 20m in the east. Groundwater within the backfill is recorded at a range of depths.
Recommendations including issues for further assessment	In order to assess the behaviour of the backfill to loading it will be necessary to carry out loading tests. These should be of a sufficient size (area) and loading to test the full depth of backfill and be representative of the proposed development. It is recommended that surface groundwater infiltration is tested as part of this additional work. Groundwater monitoring needs to continue to confirm that groundwater levels have recovered post opencast coal mining.
The information given in this summary is necessarily incomplete and is provided for initial briefing purposes only. The summary must not be used as a substitute for the full text of the report.	

1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Harworth Estates Limited to carry out a geo-environmental assessment of the land at the Rockingham 1 site in South Yorkshire. This site forms part of the larger Rockingham former opencast coal mining site and is anticipated to be the subject of the first phase of a development that will eventually occupy the entire larger site area.

This report is subject to the RSK service constraints given in Appendix A.

1.1 Objective

The objective of this review is to assess ground conditions and ground treatment required to enable the proposed future redevelopment of the land for commercial end use.

1.2 Scope

The scope of the investigation and layout of this report has been designed with consideration of CLR11 (Environment Agency, 2004a) and BS 10175: 2011 (BSI, 2011) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a). A summary of relevant legislation and policy relating to contaminated land is included in Appendix B.

The scope of works for this report was set out in RSK's proposal reference 321393TL02 dated 2 July 2013. The brief included:

- an intrusive investigation consisting of eight boreholes and 16 trial pits with laboratory analysis plus subsequent groundwater and gas monitoring
- development of a refined conceptual site model followed by generic quantitative risk assessment (GQRA) to assess complete pollutant linkages that may require the implementation of mitigation measures to facilitate redevelopment
- interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundations and infrastructure design
- a factual and interpretative report with recommendations for further works (i.e. undertake a remedial options appraisal to identify appropriate mitigation measures/produce a remedial implementation and verification plan) and/or remediation as necessary.

1.3 Existing reports

A number of existing reports relating to the Rockingham 1 site as part of the larger former opencast site area have been reviewed by RSK. Following that review RSK produced the following report providing comment on ground conditions across the larger site area:

- Appraisal of Ground Conditions and Coal Mining Review: Rockingham, South Yorkshire, RSK, July 2013 (ref. 321393-R01 (01)).

Points from that report relevant to the Rockingham 1 site are summarised in Section 2.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows may vary from those reported due to seasonal, or other, effects.

2 SITE INFORMATION

2.1 Site location

The site that is the subject of this report is referred to as Rockingham 1, and is the area of the wider Rockingham opencast coal mining site that is anticipated to be developed in the first phase of works. Rockingham 1 lies to the western end of the larger site area to the north of the dual-carriageway link road. Figure 1 shows the site location and Figure 2 provides information relating to the site setting. The approximate centre of the site is located at Ordnance Survey National Grid reference SE 35017 00904. The site occupies an area of approximately 12.37 acres and is situated at an elevation of approximately 130m above Ordnance Datum (AOD). The site lies between the residential areas of Birdwell and Hoyland in South Yorkshire.

2.2 Site description

The site is currently mainly grassed land with trees and shrubs around the perimeter. Historically, the site was subject to deep underground mining (Rockingham Colliery from pre-1893 to 1980) and used for opencast coal mining (1991 to 1995), and subsequent backfilling and restoration, which was completed by 2002. A small depression within the eastern part of the site is understood to be in the location of a former balancing pond, and there is a small earth bund or stockpile also in that area.

The site is bounded to the west by residential properties, to the south east by a dual-carriageway, and to the north and north east by woodland and agricultural land. A site boundary plan is included in Figure 2.

2.3 Proposed site use

It is understood that the site is being considered for redevelopment for commercial purposes, and that outline planning permission was gained for this in 2000.

2.4 Previous RSK report

More detailed information for the Rockingham 1 site is provided in the RSK Appraisal of Ground Conditions and Coal Mining Review, which should be read in conjunction with this report. A brief summary of the relevant information is presented below.

2.4.1 Geology and hydrogeology

Published records indicate that no superficial geological units are present across the site. The bedrock is recorded as being Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone with coal seams. The bedrock units comprise a Secondary A aquifer.

BGS borehole records for the site and surrounding area that were drilled before the opencast coaling operations generally indicate bedrock to comprise mudstone and siltstone with bands of coal.

There are no groundwater protection zones on or around the site, and there is no evidence of groundwater abstractions in the vicinity.

Coal Authority information confirms that substantial underground and opencast mining activity has previously occurred on site. This includes 13 underlying worked coal seams, from shallow depth to 430m below ground level, last worked underground in 1977. Although there are several nearby, there are no recorded mine entries on site.

The worked coal seams at the site dipped downwards towards the north-east, with the result that excavations for a coal seam extraction were shallower in the west. The basal seam worked at the site was referred to as the unnamed 3 seam (1AQ).

2.4.2 Environmental database review

There are no landfill sites or waste management facilities within the site boundary, although there are a number of each in the area around the site.

2.4.3 Review of historical maps

The main buildings for Rockingham colliery were located off the site to the west, with coke ovens and railway sidings located on the western site area. Railway lines were located on-site adjacent to the north western boundary, passing across the site, and off-site adjacent to the south eastern boundary. An aerial ropeway passed across the site. By the time of the OS map dated 2002 there is little evidence of the presence of the colliery in the area around the site.

2.4.4 Pertinent information contained within other reports

Following coal extraction operations, Mott MacDonald were tasked with supervising controlled reinstatement of the excavations, including the area of the Rockingham 1 site. These works included supervision to ensure that the compaction specification was achieved in all areas of controlled backfill, that periodic testing was completed to demonstrate compliance and to provide certification on completion of all works. Compaction work was undertaken between 1990 and 1996. On completion of backfill, surface settlement markers (permanent ground markers – PGMs) and borehole piezometers were installed and subsequently monitored.

The report produced by Mott MacDonald concluded that settlement was not proportionate to the consolidation/compaction work undertaken. It was also concluded that compaction was completed to the required standard in the controlled areas.

An Initial Environmental Review produced by consultants BWB identified a number of potential sources of soil and groundwater contamination on the wider site. These were sources largely associated with the former colliery off-site to the west and included; made ground, electricity substations and transformers, above ground tanks, coking ovens, railway lines, in-filled excavations and slurry ponds, with likely contaminants including heavy metals, PAHs, high calorific value soils, PCBs, BTEX compounds and other hydrocarbons, phenols, solvents, spent oxides and pesticides.

2.4.5 Previous RSK report summary and conclusions

Opencast work in the Rockingham 1 site area worked an unnamed coal seam (1AQ) and the overlying Swallow Wood seam. The excavations would have proceeded from west to east, with the downward dip of the seams. Maximum excavation depth is reported to have been around 20m bgl in the northeastern corner of the site.

Compaction of Backfill Certification reports are available for the site which detail the compaction works undertaken. Five surface settlement markers were located within the Rockingham 1 area; which include SM10 to SM14. These markers were located where the thickness of made ground was measured as 6.6m, 9.9m, 10.7m, 16.0m and 16.4m respectively. Relative movement at these markers was measured as a heave of between 2mm and 21mm in four of the five markers, with one location where settlement of 7mm was recorded.

RSK has experience of working on an adjacent site with similar ground conditions where the solution to providing a development platform for buildings was to surcharge the soils over the proposed footprints to induce settlement in advance of construction. Monitoring was undertaken to ensure that acceptable amounts of settlement were achieved by the surcharging so that buildings would not be damaged due to future ground movement.

Information available indicates that the ground surface is stable (no ongoing self-weight settlement) it is therefore only necessary to confirm the loading settlement which would result from future development. This can be assessed by undertaking a loading test with monitoring to confirm performance. If this test records low or negligible settlement it may be possible to build directly on standard shallow foundations. If larger settlements are recorded options such as ground treatment by surcharging or dynamic compaction may be required.

2.5 Initial conceptual model

The available information has been used to compile an initial conceptual model. The identified potential sources of contamination, associated contaminants and receptors have been considered with plausible pathways that may link them. The resulting potential pollutant linkages are considered below and are summarised in Table 1. The

risk classification has been estimated in accordance with methodology presented in Appendix C.

2.5.1 Summary of potential contaminant sources

Potential sources and contaminants of concern identified for the site are:

- fill materials used to backfill former opencast voids, both on and off-site. These may have been impacted by the former contaminative activities elsewhere on the Rockingham colliery site prior to their placement at their current location (Heavy metals, PAH compounds, BTEX and other petroleum hydrocarbons and asbestos)
- highly calorific and/or organic soils within fill materials (hazardous ground gases; carbon dioxide, methane etc.)
- naturally occurring concentrations of sulphates and pyrites within reworked coal measure deposits.

2.5.2 Sensitive receptors

Sensitive receptors identified for this site include:

- future site occupants
- adjacent site users
- vegetation
- potable water supply pipes
- proposed buildings and infrastructure
- groundwater beneath the site.

Please note that construction workers have not been identified in the conceptual model as receptors because risks are considered to be managed through appropriate health and safety procedures including CDM regulations.

2.5.3 Summary of plausible pathways

The plausible pathways are summarised below:

- direct contact (soil, dust and vegetable ingestion, dermal contact, dust and fibre inhalation)
- ground gas and soil gas migration
- vertical and lateral migration including leaching
- root uptake

- chemical attack of infrastructure (including water supply pipes) and buildings.

2.5.4 Potentially complete pollutant linkages

The outline conceptual model and an estimate of the risk associated with each linkage is summarised in Table 1. The risk classification has been undertaken in accordance with CIRIA C552 (Rudland et al., 2001), a summary of which is included in Appendix C.

Table 1: Risk estimation for potentially complete pollutant linkages

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
Fill materials (organic and inorganic contamination)	Future site users	Direct contact	Likely	Medium	**Moderate**: Potential long-term health effect, but exposure not highly likely as commercial development.
	Adjacent site users	Direct contact	Unlikely	Medium	**Low**: Unlikely to be significant dust generation potential once site developed.
	Vegetation	Root uptake	Likely	Minor	**Low**: Low consequence of some vegetation stress at the proposed commercial development.
	Potable water supply pipes	Chemical attack	Low likelihood	Medium	**Moderate/Low**: Long-term health effects for future users possible.
	Groundwater beneath site	Migration	Likely	Mild	**Moderate/Low**: Underlying groundwater receptor not particularly sensitive.
Highly calorific and/or organic soils within fill materials (hazardous ground gas)	Future site users	Ground gas migration	Low likelihood	Severe	**Moderate**: Fill materials controlled and engineered, so gas generation should be minimal.
	Adjacent site users	Ground gas migration	Unlikely	Severe	**Moderate/Low**: Fill materials controlled and engineered, so gas generation should be minimal.
	Proposed buildings	Ground gas migration	Low likelihood	Medium	**Moderate/Low**: Fill materials controlled and engineered, so gas generation should be minimal.
Naturally occurring sulphates and pyrites (chemical attack)	Proposed buildings	Chemical attack	Highly likely	Mild	**Moderate**: High potential for pyritic ground conditions.

The potential pollutant linkages with a risk of moderate/low or above that require further assessment by site investigation works are:

1. direct contact between future site users and impacted soils
2. chemical attack and permeation of water supply pipes
3. migration of contaminants to underlying groundwater in Secondary A aquifer
4. migration of ground gases into future buildings on site and inhalation by occupants
5. migration of ground gases off-site to adjacent properties and occupants
6. migration of ground gases resulting in damage to future buildings on site
7. chemical attack of buried concrete in building foundations.

3 SITE INVESTIGATION METHODOLOGY

RSK carried out intrusive investigation work and subsequent ground gas and groundwater monitoring between July and September 2013 to confirm the thickness and the composition of fill material across the site, to carry out in situ geotechnical testing, to take soil and water samples for laboratory testing and to install monitoring equipment. It should be noted that at the time of the investigation it was not possible to access the former pond feature in the eastern corner of the site due to the surrounding fence. As a result, this area was not investigated.

3.1 Sampling strategy and methodology

The techniques adopted for the investigation have been chosen considering the anticipated ground conditions, existing land use and the proposed development. Investigation locations were chosen to provide the best spread of data across the site.

Trial pits were excavated (using a JCB 3CX) to gain a better understanding of the type of shallow fill material on the site. Trial pits allow the engineer to see a clear profile of the ground to a depth of up to approximately 4m.

Boreholes were drilled using cable percussive methods through fill materials to the underlying bedrock in order to establish the depth of the fill across the site. This drilling technique is able to penetrate through cohesive and most granular soils and into bedrock, and carry out Standard Penetration Tests (SPTs) during the drilling in order to test geotechnical characteristics of the soil. A number of the boreholes were converted to monitoring wells by installation of slotted standpipes.

Return visits to the site were made to collect groundwater samples and to undertake ground gas monitoring.

3.1.1 Health and safety considerations

Plans showing the routes of any underground services were provided by the client in advance of intrusive works, and all investigation locations were scanned by the RSK Engineer using a cable avoidance tool.

3.1.2 Investigation locations

The following site work was carried out between 15 and 24 July:

- 16 trial pits were excavated to depths of up to 3.6m

- two further trial pits were excavated to allow investigation and sampling of the earth bund/stockpile on the eastern part of the site
- eight cable percussive boreholes were drilled to depths of between 4.8m and 17.2m with SPTs at 1.5m intervals
- six groundwater/ground gas monitoring installations were constructed in boreholes
- one set of magnet extensometers were installed in a borehole (BH6).

The investigation and the soil descriptions were carried out in general accordance with 'BS 5930:1999. Code of Practice for Site Investigations' (BSI, 1999). The exploratory hole records are presented in Appendix D.

The locations of the intrusive investigations are shown in Figure 2. The trial pits and boreholes were evenly distributed around the site in order to obtain information about as much of the site as possible.

3.1.3 Soil sampling, in-situ testing and laboratory analysis

Environmental samples were taken at each exploratory location mainly from the top 3m of the soil, as this is the soil that would pose the greatest risk to human health if it was contaminated. Samples were occasionally taken from greater depths in order to provide information on deeper soils. A sample of the soils within the earth bund/stockpile on the western part of the site was also recovered.

Soils collected for laboratory analysis were retained in a variety of containers appropriate to the anticipated testing suite required. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

All samples are recorded together with their depths on the exploratory hole records in Appendix D. The samples were transported to the laboratory in chilled cool boxes. Laboratory chain of custody forms can be provided if required. A selection of representative samples were tested for a standard suite of chemical contaminants and the results are included in Appendix F.

In situ SPTs were carried out in boreholes at 1.5m intervals during the cable percussion drilling in accordance with part 9 of BS 1377:1990 (BSI, 1990). Test results are given on the borehole records presented in Appendix D. Disturbed samples were taken at 1.5m intervals for subsequent geotechnical analysis. Bulk samples for geotechnical analyses were also recovered from trial pits.

The geotechnical laboratory testing included the following:

- two samples for plasticity index analyses and natural moisture content determination
- eight samples for particle size determination (PSD)

- five samples for dry density/moisture content relationship (4.5kg compaction tests).

The results are included in Appendix K.

3.1.4 Groundwater monitoring and levelling

Depths to any groundwater were recorded using an electronic interface probe throughout the drilling process and then after the completion of monitoring wells during a monitoring visit on 24 July 2013. The monitoring results are presented alongside the gas monitoring data in Appendix E.

3.1.5 Groundwater developing, sampling and analysis

Subsequent to the installation of groundwater monitoring wells the installations were developed at least one week before sampling.

Groundwater samples were retrieved using a United States Environment Protection Agency (USEPA) approved low-flow purging and sampling methodology. The low-flow method relies on moving groundwater through the well screen at approximately the same rate as it flows through the geological formation. This results in a significant reduction in the volume of water extracted before sampling and significantly reduces the amount of disturbance of the water in the monitoring well during purging and sampling. Drawdown levels in the monitoring well and water quality indicator parameters (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) are monitored during low-flow purging and sampling, with stabilisation indicating that purging is complete and sampling can begin. As the flow rate used for purging, in most cases, is the same or only slightly higher than the flow rate used for sampling, and because purging and sampling are conducted as one continuous operation in the field, the process is referred to as low-flow purging and sampling.

In-situ water quality measurements undertaken during the low-flow sampling process are provided in Appendix E.

The groundwater samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported to the testing laboratory under chain of custody documentation and tested for a broad suite of chemical contaminants.

3.1.6 Ground gas monitoring

In line with the conceptual model six monitoring rounds are to be undertaken. At the time of writing this report three monitoring rounds have been completed, and the programme is ongoing.

An infrared gas meter was used to measure, concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage by volume, while hydrogen sulphide

(H_2S) and carbon monoxide (CO) were recorded in parts per million. Initial and steady state concentrations were recorded. Gas flow rates have also been recorded.

All monitoring results together with the temporal conditions are contained within Appendix E and discussed in Section 4.

4 GROUND CONDITIONS

The results of the intrusive investigation, subsequent laboratory analysis undertaken and monitoring completed are detailed below. The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in Appendix D.

4.1 Soil

The exploratory holes revealed that the site is underlain by a variable thickness of made ground over Coal Measures bedrock. This confirms the stratigraphical succession described within the Appraisal of Ground Conditions and Coal Mining Review. For the purpose of discussion, the ground conditions are summarised in Table 2 and the strata discussed in subsequent subsections.

Table 2: General succession of strata encountered

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made ground	All boreholes and trial pits	Ground level	1.8 - 16.7
Mudstone	All boreholes, TP1, TP2 and TP16	1.8 - 16.7	Not penetrated

4.1.1 Made ground

The made ground generally comprised very friable clay with a significant proportion of granular material. Gravels, cobbles and boulders encountered were generally angular to subangular grey mudstone, sandstone and siltstone. In two boreholes coal fragments were occasionally encountered. The made ground ranged in thickness from 1.8m at the south western side of the site (south west of the quarry high wall) to 16.7m at the north eastern side of the site, demonstrating an increase in the depth of fill material from south west to north east.

Boulders were encountered in a number of trial pits and boreholes, with those returned to the surface (from the trial pits) measuring up to approximately 0.3m x 0.6m x 0.5m. In a number of trial pits it was recorded that large boulders within the ground were broken up by the excavation, so that only smaller pieces were returned to the surface, and the actual size could not be determined. In one trial pit (TP5) a slight diesel odour was noted between 1.0m and 1.5m bgl.

As well as the in-situ SPT tests undertaken in boreholes, samples of made ground materials were subject to the following geotechnical laboratory analyses:

- particle size determination (dry sieve)
- compaction and moisture content relationship using 2.5kg rammer
- compaction and moisture content relationship using 4.5kg rammer
- plasticity index.

The results of the geotechnical laboratory testing are included in Appendix K.

Representative soil samples have been tested for a broad range of contaminants, including speciated hydrocarbons and the results are included in Appendix F.

4.1.2 Bedrock

Mudstone bedrock was encountered directly underlying the made ground in all of the boreholes and three of the trial pits. This was recovered as clayey angular mudstone gravel and cobbles. In a number of locations the upper surfaces of the mudstone were found to be weathered. Mudstone bedrock was encountered from between 1.8m and 16.7m bgl, to the full depth of investigation.

The depth of bedrock recorded during this investigation has been used to help validate a contour plan of the wider site presented in Figure 3 where approximate fill thicknesses are presented. This plan has been produced from overlaying all available opencast abandonment plans for each worked seam. It should be noted that there are large areas of the wider site where very few records are available, particularly in the vicinity of the Elsecar Fault and to the east of it. The plan should be of assistance in considering the adjacent areas but additional borehole investigation work will be required to confirm the ground conditions.

4.1.3 Groundwater

During drilling groundwater was not encountered in any of the boreholes except for BH4 where it was first struck at 6.8m bgl within made ground, rising to 6.3m after 20 minutes. Groundwater was also encountered in one trial pit (TP14 at 1.6m), where a small perched pocket was noted.

Subsequent monitoring of the installed boreholes (results presented with the gas monitoring data in Appendix E) has recorded the presence of groundwater in four of the six monitoring wells at a range of depths.

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal variations. There had been no rain on site for a number of weeks prior to the site investigation.

The results of the groundwater monitoring undertaken on the first three gas monitoring visits are summarised in Table 3.

Table 3: Groundwater monitoring data

Monitoring well	Top of pipe elevation (mAOD)	Product thickness (m)	Round 1 Water elevation (mAOD)	Round 2 Water elevation (mAOD)	Round 3 Water elevation (mAOD)
BH2	130.946	None	Dry	Dry	Dry
BH3	132.58	None	Dry	Dry	Dry
BH4	130.652	None	123.914	123.857	123.606
BH5	131.801	None	121.943	123.585	123.462
BH7	130.16	None	122.953	122.447	121.892
BH8	129.901	None	115.546	117.86	118.857

The findings indicate depth to groundwater being greatest in the north eastern most borehole, where the depth of fill material is also greatest. As such groundwater flow is likely to be to the north east. Groundwater monitoring will be carried out during future gas monitoring visits and further comments will be provided on completion of all monitoring.

Laboratory chemical analysis of groundwater samples identified concentrations of water-soluble sulphate ranging between 618mg/l (BH7) and 818mg/l (BH4).

Groundwater analytical results are presented within Appendix G.

4.2 Ground gas regime

The results of the ground gas monitoring carried out to date are given in Appendix E. The maximum (for methane, carbon dioxide and flow) and minimum (for oxygen) results and are recorded in Table 4.

Table 4: Summary of ground gas monitoring results

Borehole	strata	Probable source(s) of ground gas	Number of monitoring visits	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)
BH2	MG	Reworked mudstone fill	3	<0.1	10.4	6.4	-0.1
BH3	MG	Reworked mudstone fill	3	0.2	20.3	0.4	0.0
BH4	MG	Reworked mudstone fill	3	<0.1	9.4	9.8	0.0

Borehole	strata	Probable source(s) of ground gas	Number of monitoring visits	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)
BH5	MG	Reworked mudstone fill	3	<0.1	7.5	3.3	2.5
BH7	MG	Reworked mudstone fill	3	0.1	6.6	16.1	0.7
BH8	MG	Reworked mudstone fill	3	<0.1	0.9	19.8	0.2

To understand atmospheric pressure conditions in the days leading up to each of the gas monitoring visits historical weather data has been obtained from an internet resource (www.wunderground.com). The data relates to the closest monitoring available for the site, which in this case was Leeds and Bradford Airport. For each of the gas monitoring visits the average sea level atmospheric pressure recorded on the three days leading up to the visit and on the day of the monitoring are presented in Table 5.

Table 5: Regional atmospheric pressure prior to gas monitoring

Monitoring date	Pressure 3 days before (mb)	Pressure 2 days before (mb)	Pressure 1 day before (mb)	Pressure on same day
31 July 2013	1003	1007	1010	1012
15 August 2013	1014	1020	1020	1014
29 August 2013	1021	1019	1022	1019

4.3 Refinement of the initial conceptual site model

The ground conditions encountered at the site are as expected, comprising a significant and variable thickness made ground of reworked mudstone, sandstone and siltstone overlying coal measures bedrock. Little evidence of contamination or anthropogenic material was encountered.

Based on visual inspection of the soils at the site the potential for them to be significantly contaminated is considered to be low. Hydrocarbon odours were noted at one location, and a small quantity of anthropogenic material was recorded, but neither were widespread. No obviously putrescible materials were noted, although possible coal fragments were present.

Following on from the site investigation the potential pollutant linkage to off-site receptors from hazardous ground gases generated on site is considered to represent a low risk, and is discounted from any further assessment. The reasons for this are as follows:

- no obviously putrescible or organic material was observed within the made ground
- the deep made ground on site is confirmed not to extend to the western boundary, where existing properties are present.

Although the investigation encountered little evidence of contaminated soils and groundwater or significant sources of ground gas, the other potential pollutant linkages identified in the initial conceptual site model cannot be discounted at this stage. These are all assessed further with reference to the results of monitoring and laboratory analyses.

Section 5 contains discussion of the results of the analyses of ground gases and soil and groundwater samples, and establishes the resulting risks to sensitive receptors.

5 QUANTITATIVE RISK ASSESSMENT

In line with CLR11 (EA, 2004a), there are two stages of quantitative risk assessment, generic and detailed. The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

5.1 Linkages for assessment

Section 2 presents the initial conceptual model which identified the potential pollutant linkages that required assessment by the site investigation. One of these has been discounted in the refined conceptual site model in Section 4. The remaining linkages together with the method of assessment are presented in Table 6.

Table 6: Linkages for generic quantitative risk assessment

Potentially relevant pollutant linkage	Assessment method
1. Direct contact between future site users and impacted soils	Human health GAC in Appendix H for a proposed commercial end use.
2. Chemical attack and permeation of water supply pipes	Comparison of soil data to GAC in Appendix J for plastic water supply pipes using UKWIR (2010) guidance.
3. Migration of contaminants to underlying groundwater in Secondary A aquifer	Comparison of groundwater data to GAC in Table 1 of Appendix I based on EQS values.
4. Migration of ground gases into future buildings on site and inhalation by occupants	Gas screening values (GSV) have been calculated using maximum methane and carbon dioxide concentrations with maximum flow rates recorded at the site. The GSV have been compared with the revised Wilson and Card classification presented within CIRIA report C665 (Wilson et al., 2007) owing to the proposed development comprising buildings with a ground floor slab.
5. Migration of ground gases resulting in damage to future buildings on site	

Chemical attack of buried concrete is a geotechnical issue, and as such is discussed in the geotechnical section of this report (Section 6).

5.2 Methodology and results

The methodology and results of the GQRA are presented for each relevant pollutant linkage in turn.

5.2.1 Direct contact with impacted soil by future site users

The laboratory results certificates for soil samples are presented in Appendix F. These results have been compared against the relevant Human Health GAC, presented in Appendix H. All determinant concentrations in all of the samples are below the available GAC, and as such no potentially significant risks associated with the soil contamination have been identified and the potential pollutant linkage is discounted.

Furthermore, the scheduled laboratory screening for asbestos found no detectable asbestos fibres within the samples of made ground.

5.2.2 Permeation of potable water supply pipes

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in Appendix I for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

The results for almost all of the soil samples indicate that a relevant linkage is unlikely to exist associated with organic contaminants and therefore pollutant polyethylene (PE) and/or polyvinyl chloride (PVC) water supply pipes are expected to be suitable for use on the development. However, the results for the soil sample recovered from 1.2m bgl in trial pit TP5, where olfactory evidence of organic contamination was recorded, indicate concentrations of petroleum hydrocarbons to be above the threshold for PE pipe materials.

The laboratory results for sample TP5 (1.2m) indicate a mineral oil ($>C_{10} – C_{35}$) concentration of 2,270mg/kg. The supply pipes GACs for mineral oil $C_{11} – C_{20}$ and mineral oil $C_{21} – C_{40}$ are 10mg/kg and 500mg/kg, respectively, for PE water supply pipes. Although the laboratory results do not correspond exactly to the bandings for which the GACs are defined, it is evident that the GACs for PE pipe are exceeded.

Given the above, it is considered that PE or PVC water supply pipes can be used across most of the site, without the requirement for any mitigation or remediation. However, in the area around trial pit TP5, PE water pipes are not suitable for use. In this area alternative pipe materials (including PVC) are required. It is recommended that during development works the routes of water supply pipes are inspected for evidence of hydrocarbon contamination of soils, and that if encountered further assessment be undertaken.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not

be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the routes of the supply pipes are known. In addition, it is recommended that the local water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

5.2.3 Migration of contaminants to groundwater in Secondary A aquifer

The analytical results for the groundwater samples are presented in the laboratory results certificates in Appendix G. Most of the determinants are below the GACs (which are based on EQS values) or below laboratory detection limits. Concentrations of copper and zinc were recorded to marginally exceed the lowest GACs for these compounds. These GACs are variable dependant on the hardness of the receiving surface water body and the potential receiving surface water body has not been identified. The concentration of nickel in the sample from BH4 was also found to marginally exceed the GAC (0.031mg/l compared to GAC of 0.020mg/l).

The site and much of the wider area has been affected by coal mining, and there is no evidence of groundwater abstractions in the vicinity. As such, the underlying Secondary A aquifer is not considered to be a particularly sensitive water body. The marginal exceedances detected of the most stringent GAC values are unlikely to pose a significant risk to this groundwater, and this potential pollutant linkage is discounted.

5.2.4 Migration of hazardous ground gasses

The results have been assessed in accordance with the guidance provided in *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (Wilson et al., 2007). In the assessment of risks and selection of appropriate mitigation measures, the report identifies two types of development, termed Situation A (modified Wilson and Card method), appropriate to all development excluding traditional low-rise construction, and Situation B (National House-Building Council, NHBC) only appropriate to traditional low-rise construction with ventilated sub-floor voids.

Both methods are based on calculations of the limiting borehole gas volume flow for methane and carbon dioxide, renamed as the gas screening value (GSV). The GSV (litres of gas per hour) is calculated by multiplying borehole flow rate (litres per hour) and gas concentration (percent by volume).

In both situations, it is important to note that the GSV thresholds are guideline values and not absolute. The GSV thresholds may be exceeded in certain circumstances, if the site conceptual model indicates it is safe to do so. Similarly, consideration of additional factors such as very high concentrations of methane, should lead to consideration of the need to adopt a higher risk classification than the GSV threshold indicates.

The site is to be redeveloped with commercial properties and therefore falls under Situation A.

Situation A relates to all development types except low-rise housing and, by combining the qualitative assessment of risk with the gas monitoring results, provides a semi-quantitative estimate of risk for a site. The method uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flows for methane and carbon dioxide. Having calculated the worst case GSVs for methane and carbon dioxide, the Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

The ground gas monitoring data are included in Appendix E. This has identified a maximum methane concentration of 0.2% and a maximum concentration of carbon dioxide of 20.3%. A maximum gas flow rate of 2.5l/hr has been recorded. The calculated GSV for methane is 0.005l/hr and the GSV for carbon dioxide is 0.51l/hr. Based on these GSVs the site has been characterised CS2.

CIRIA C665 provides details of the typical scope of protective measures to be adopted for the relevant site characterisation. These include the installation of gas-resistant membranes with either a suspended or ground-bearing floor slab.

It should be noted that for low risk sites (Characteristic Situation 2), CIRIA C665 recommends a minimum thickness of gas resistant membrane of 2000 gauge, as the report considers that the standard unreinforced 1200 gauge membrane/DPM is unlikely to survive the construction process intact.

The gas monitoring programme carried out to-date provides some evidence for an initial assessment of redevelopment requirements. However, further monitoring is to be completed to enable the confident assessment of risk and subsequent design of an appropriate gas protection scheme for the proposed development.

5.3 Environmental assessment conclusions

The results of the GQRA indicate that relevant pollutant linkages between impacted soils and future site users in the proposed commercial development are absent. In addition the pollutant linkage between subsurface contaminants and groundwater in the underlying Secondary A Aquifer has also been found to be absent. In respect of these two pollutant linkages the site is considered suitable for its proposed end-use without mitigation.

For the majority of the site the pollutant linkage relating to permeation of plastic water supply pipes by organic contamination has been found to be absent. However, in the area of hydrocarbon impact of soil at the location of trial pit TP5 the linkage is potentially complete. In the vicinity of this location PE water pipes may be susceptible to permeation, and alternative pipe materials (including PVC) should be used. It is possible that other similar pockets of hydrocarbon impact are present on site that have not been detected. As a result, excavations for laying water supply pipes should be inspected for evidence of hydrocarbon impact, and further assessment be undertaken should this be encountered.

Monitoring of ground gases undertaken to date indicates that the site should be classified as CS2, and this is considered to be consistent with the encountered ground conditions. As such, basic gas ingress protective measures are required in any new buildings at the site. However, further gas monitoring is still to be undertaken at the site, which may affect the results of the assessment.

6 GEOTECHNICAL SITE ASSESSMENT

In this section of the report we consider the foundation requirements of the proposed development, the possible mechanisms of ground settlement for the prevailing conditions and the geotechnical conditions recorded from the site investigation works. Based on this an assessment of potential settlement is presented together with an outline of foundation and ground treatment options.

6.1 Proposed development

The site is proposed for development with commercial units together with areas of car parking, road pavement and landscaping. Some limited cut and fill operations will be required to provide level development platforms.

The buildings will include essentially two separate structural elements. The first is the floor slab and the second the building structure which will be supported on a grid of columns spread across the building footprint.

6.2 Mechanisms of ground settlement

The site is undertaken by opencast backfill and such materials may be susceptible to the following types of settlement:

- self weight settlement – poorly consolidated backfill materials may settle under their own weight. The timescale is dependant on grain size and is generally short-term in granular soils and long-term in fine grained/cohesive soils

- inundation settlement – water entering loosely placed fill can induce significant settlement as particles are softened and collapse into the interstitial voids. The mechanism is most likely in loosely placed backfill with large sized weak fragments and would not be expected in backfill placed as an engineered fill. Water inundation may be from either rising groundwater from the base of the backfill or from surface water infiltration

- construction and loading induced settlement – loose or weak backfill would be susceptible to settlement induced by loading from new structures or from fill placed to provide a development platform.

6.3 Geotechnical conditions encountered

The made ground encountered within the trial pits was recorded as friable firm to stiff clay or moderately compact granular soils. In a number of pits hard or difficult digging is

recorded at depth. Within the cable percussion boreholes in situ SPT tests were carried out generally at 1.5m depth intervals. The results of these, which are included in Appendix D and Table 7 below, indicate relative densities in the range of medium dense to very dense throughout the backfill. These values are consistent with well compacted engineered fill.

Table 7: Borehole SPT N values

Depth at start of test (m) bgl	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8
1.5	37	26	42	26	21	16	28	17
3.0	>50	28	45	20	41	19	23	34
4.3	>50							
4.5	-	43	>50	27	32	23	21	31
4.8	>50 END							
5.5			>50 END					
6.0		>50		39		14	40	36
6.35					>50			
7.5		>50 END		>50	>50	>50	28	38
9.0				>50 END	26	39	27	21
10.5					>50 END	>50	28	22
12.0						37	29	30
12.9							>50 END	
15.0						>50		>50 END
16.5						>50 END		

Eight samples were tested for particle size determinations and the results are summarised in Table 8 below.

Table 8: Particle size determinations

Sample location and depth (m)	Cobbles (%)	Gravel (%)	Sand (%)	Clay/silt (%)
BH2 4.5	-	38	12	50

Sample location and depth (m)		Cobbles (%)	Gravel (%)	Sand (%)	Clay/silt (%)
BH3	3.0	-	28	15	57
BH4	6.0	-	30	12	58
BH5	7.5	-	27	19	54
BH6	9.0	-	27	18	55
TP8	3.3	33	48	7	13
TP12	1.2	4	55	15	26
TP15	1.7	24	50	7	19

The results indicate the samples generally comprise slightly sandy gravelly CLAY one of the trial pit samples is described as clayey sandy GRAVEL with some cobbles. The samples recovered from the trial pits have a higher proportion of coarse soil fractions, which possibly suggests the cobble sized constituents may have been broken-up by borehole drilling.

The laboratory geotechnical analyses included soils classification testing which indicates the shallow made ground to generally conform with the requirements of class 2C material (stony cohesive soil) as defined in the Department of Transport Highway Specification (Series 600) Document.

In respect of compaction testing the results are summarised in Table 9 below.

Table 9: Results of laboratory compaction tests

Sample location and depth (m)		Test type	Maximum dry density (Mb/m^3)	Optimum moisture content (%)	Initial moisture content (%)
TP4	0.30	2.5kg (light)	2.04	10	5.1
TP12	1.80	2.5kg (light)	2.13	9	5.7
TP14	1.40	2.5kg (light)	2.04	11	8.1
TP3	2.10	4.5kg (heavy)	2.04	10	8.7
TP7	0.50	4.5kg (heavy)	2.19	7	7.0

6.4 Assessment of settlement potential

The investigation has confirmed the presence of competent backfill across the area which is consistent with the material being places as an engineered backfill. Such materials are unlikely to be settling under self weight but this can only be verified by monitoring of ground surface levels (NB a number of ground markers have been established on site and are subject of ongoing monitoring).

Groundwater monitoring has recorded standing water at a range of levels with some installations dry and others with water levels at depths of 6.7m to 14.4m below ground level. Monitoring of these must continue in order to determine whether groundwater levels post-coaling have stabilised. This is required in order to assess the potential for inundation settlement associated with groundwater recovery at the base of the made ground. Inundation settlement can also be caused by surface water infiltration and although it is a possible mechanism it can be addressed by ground surface treatment in advance of construction (but usually after any regrading works). Surface infiltration tests can be carried out to confirm the potential or otherwise for groundwater percolation and this could be included as a stage of future loading tests (see below).

Although the investigation has indicated that the made ground present is generally of medium dense relative density (from SPT tests) it is difficult to accurately predict how the material will respond to loading. In order to assess this it will be necessary to carry out loading tests. These should be of a sufficient size to apply loading to the full thickness of backfill and of sufficient load to be representative of the proposed development. Monitoring should be carried out until rates of settlement become negligible between a number of consecutive visits generally a period of six months or more is adequate.

6.5 Outline of foundation and ground treatment options

The investigation works completed indicate the made ground present is competent but loading tests are require to confirm behaviour under the anticipated loading of the proposed commercial development.

If the loading tests record low settlements then it is anticipated that the development could be constructed on pad foundations placed within the backfill with the adoption of a ground bearing floor slab. It would be prudent, at this stage, to allow for ground surface treatment (High Energy Impact Compaction or similar) across the development area and the requirement for all cut and fill operations to form the final development platform to be carried out under strict engineering control.

If the loading tests record large settlements then development could still proceed but would require piled foundation to support both the building structure and floor slab. This scenario is considered very pessimistic and worst-case. The contours of fill thickness in Figure 3 could be used as estimates of rockhead depth in order to assist in determining pile depths.

6.6 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete is based on current BRE guidance (BRE, 2005). The desk study and site walkover indicate that, for the purposes of this assessment of the aggressive chemical environment, the site should be considered as one where disturbance of pyrite-bearing ground could result in

additional sulphate. A suite of chemical analyses appropriate to this site classification was carried out on soil and groundwater samples.

It is anticipated that the proposed development of the site will adopt a relatively shallow foundation solution, despite the presence of significant thicknesses of made ground. With this in mind, laboratory analyses for aggressive ground conditions were concentrated on shallow samples of the generally similar made ground material from across the site. A small area on the east of the site is outside the former opencast area, so the thickness of made ground is considerably less. Any construction here is likely to be founded directly on the underlying bedrock. To assess the potential for chemical attack of buried concrete on this part of the site, a single sample of the weathered bedrock material was also subjected to the same analyses. As such, the assessment for aggressive conditions is based on two separate site areas.

The “Characteristic value” for the made ground material over the majority of the site has been taken as the highest reported result from all of the relevant soil samples. The maximum water-soluble sulphate content in soil of 0.46g/l has been taken as the characteristic value. As this value is below the limiting value of 3.0g/l consideration of magnesium is not required. Based on Table C1 in the BRE guidance, Result one for Design Sulphate Class for the site is DS-1.

The maximum water-soluble sulphate content in groundwater of 0.818g/l has been taken as the characteristic value. As this value is below the limiting value of 3.0g/l consideration of magnesium is not required. Result two for Design Sulphate Class for the site is therefore DS-2.

Because of the possible presence of sulphides at the site a calculation was made using the measured concentrations of Total Sulphur and Acid Soluble Sulphate of the amount of Oxidisable Sulphide present. A maximum Oxidisable Sulphide content of 0.13% was calculated. Since this value is less than 0.3% no third result for Design Sulphate Class is required.

From consideration of results (one and two) a Design Sulphate Class of DS-2 may be adopted for the majority of the site. Based on the apparent permeability of made ground materials it has been assumed that groundwater conditions are mobile. From consideration of the characteristic pH value (pH value 7.51 in sample TP5 (0.8m)), an Aggressive Chemical Environment for Concrete classification of AC-2 may be assumed for design purposes for buildings located over the most of the site (founded within the areas of deep made ground).

For the western site area The “Characteristic value” for the mudstone bedrock is taken as the only available water-soluble sulphate content in soil result of 0.10g/l (sample TP16 (2.5m)). As this value is below the limiting value of 3.0g/l consideration of magnesium is not required. Based on Table C1 in the BRE guidance, Result one for Design Sulphate Class for the site is DS-1.

Groundwater was not observed during the investigation of the western part of the site, therefore there is no second result for Design Sulphate Class based on groundwater considerations.

Because of the possible presence of sulphides at the site a calculation was made using the measured concentrations of Total Sulphur and Acid Soluble Sulphate of the amount of Oxidisable Sulphide present. The Total Sulphur concentration was recorded to be <0.01%, so when the Acid Soluble Sulphate concentration was subtracted from the Total Potential Sulphate the Oxidisable Sulphide content was calculated as <0.1%. Since this value is less than 0.3% no third result for Design Sulphate Class is required.

From consideration of result one for greenfield a Design Sulphate Class of DS-1 may be adopted for the western part of the site. Based on the possible variable permeability of bedrock materials it has been assumed that groundwater conditions are mobile. From consideration of the characteristic pH value (pH 4.7 in sample TP16 (2.5m)), an Aggressive Chemical Environment for Concrete classification of AC-2z may be assumed for design purposes for buildings located over the western part of the site (founded directly on the shallow bedrock).

7 REUSE OF MATERIALS AND WASTE

7.1 Reuse of suitable materials

In accordance with the *CL:AIRE Code of Practice* (2011) (CoP) materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Thus, contaminated material does not become waste until the aforementioned criteria are met.

Under the CoP, soils may be re-used on the site where they were produced provided they are:

- certain to be used
- are suitable for use both chemically and geotechnically
- only the required quantity is used.

The CoP requires the preparation of a materials management plan (MMP) that confirms the three criteria above will be met. This plan needs to be reviewed by a 'Qualified Person' who will then issue a declaration form to the EA.

Therefore, before any excavation works begin on-site, an MMP will need to be prepared to establish whether specific materials are classified as waste and how excavated materials will be treated and/or re-used in line with *The Definition of Waste: Development Industry Code of Practice, Version 2* (CL:AIRE, 2011). The MMP is likely to form part of the site waste management plan for the site.

The importation of made ground soils (irrespective of contamination status) or crushed demolition materials is not currently permitted under the CoP and requires either a standard rules environmental permit or a U1 waste exemption (see below).

7.2 Treatment to meet suitable-for-use criteria

Where materials do not meet the suitable for use criteria it may be possible to treat them under an environmental permit (mobile treatment licence) to enable them to be reused onsite.

To enable the treatment options to be determined, an options appraisal and a remediation strategy document will be necessary to support discussion of the issues with regulators and third parties.

7.3 Reuse of waste materials

If material is discarded as waste then its reuse on site may still be possible. Waste soils can be reused on site under a standard rules environmental permit or a U1 waste exemption from the Environmental Permitting (England and Wales) Regulations 2010 provided that they are suitable for the proposed use. However, it should be noted that these have strict limits on the quantity of material that can be reused.

7.4 Groundwater

When there is an intention to discard groundwater, chemical test results will indicate the appropriate disposal options. This could include disposal to treatment facility, via consent (issued by the water authority) to foul sewer or via consent (issued by the EA) to a watercourse.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Environmental

8.1.1 Conclusions

The results of the analysis of soil and groundwater samples indicate that pollutant linkages between impacted soils and future site users and between subsurface contaminants and groundwater in the underlying Secondary A Aquifer are absent.

Permeation of plastic water supply pipes by organic contamination has been found not to be a viable pollutant linkage for the majority of the site. However, in the area of hydrocarbon impact of soil at the location of trial pit TP5 the linkage is potentially complete.

Monitoring of ground gases undertaken to date indicates that the site should be classified as CS2, and this is considered to be consistent with the encountered ground conditions.

8.1.2 Recommendations

In respect of the pollutant linkages between impacted soils and future site users and between subsurface contaminants and groundwater in the underlying Secondary A Aquifer the site is considered suitable for its proposed end-use without mitigation.

PE water supply pipes installed in the vicinity of trial pit TP5 may be susceptible to permeation, and alternative pipe materials (including PVC) should be used. It is possible that other similar pockets of hydrocarbon impact are present on site that have not been detected. As a result, excavations for laying water supply pipes should be inspected for evidence of hydrocarbon impact, and further assessment be undertaken should this be encountered.

Basic gas ingress protective measures are required in any new buildings at the site, likely to comprise the installation of a 2000 gauge gas resistant membrane across the floor slab, with all service entries sealed. However, further gas monitoring is still to be undertaken, which may affect the results of the assessment.

8.2 Geotechnical

8.2.1 Conclusions

The investigation has confirmed the presence of competent backfill across the area which is consistent with it having been placed as an engineered fill. Across the plot fill thicknesses vary considerably generally from 5m or so in the west to 20m in the east.

Groundwater within the backfill is recorded at a range of depths.

8.2.2 Recommendations

In order to assess the behaviour of the backfill to loading it will be necessary to carry out a loading test. This should be of a sufficient size (area) and loading to test the full depth of backfill and be representative of the proposed development. It is recommended that surface groundwater infiltration is tested as part of this additional work.

During the intrusive investigation one borehole location (BH6) was installed with a series of magnets throughout the drilled section, to act as an extensometer. It is therefore recommended that the load test is constructed over this borehole position, with the extensometer continued through the full height of the load. The extensometer can then be subsequently monitored along with the monitoring pins and PGM's that are installed during the construction of the load to provide additional information on the behaviour of the fill materials under assessment.

Groundwater monitoring needs to continue to confirm that groundwater levels have recovered post opencast coal mining.

BIBLIOGRAPHY

British Standards Institution (2011), 'BS 10175:2011. Investigation of potentially contaminated sites: Code of practice'.

Building Research Establishment (2005), *BRE Special Digest 1: Concrete in aggressive ground* (London: BRE).

CL:AIRE (2011), *CL:AIRE Code of Practice. The Definition of Waste: Development Industry Code of Practice, Version 2* (London: CL:AIRE).

Environment Agency (2004a), *Model Procedures for the Management of Contaminated Land. Contaminated Land Report Number 11 (CLR11),* September (Bristol: Environment Agency).

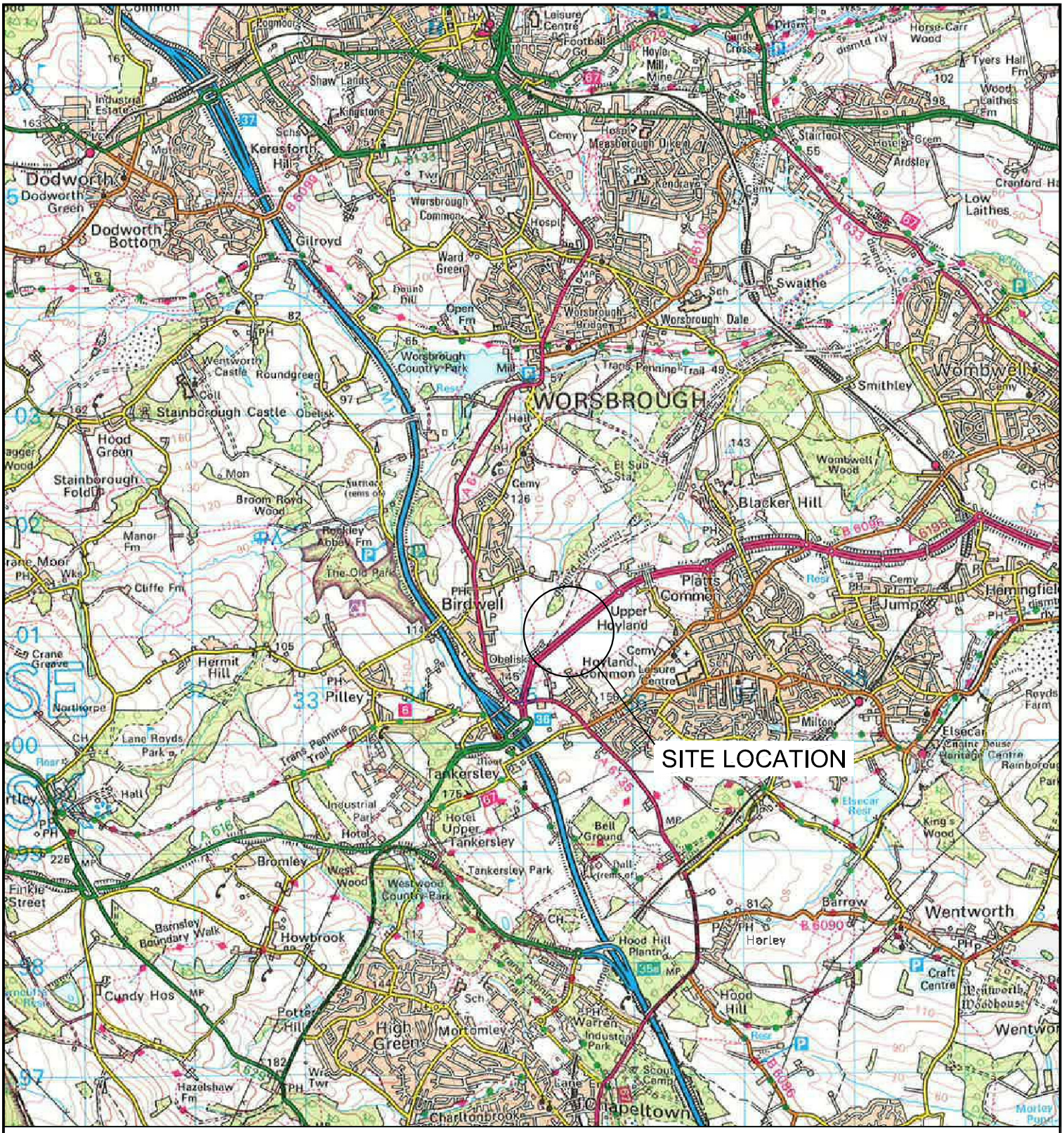
Environment Agency (2010a), 'GPLC1 – Guiding Principles of Land Contamination', 'GPLC2 – Frequency Asked Questions, Technical Information, Detailed Advice and References', and 'GPLC3 – Reporting Checklists', all March.

Rudland, D. J., Lancefield, R. M. and Mayell, P. N. (2001), *CIRIA C552. Contaminated Land Risk Assessment: A Guide to Good Practice* (London: CIRIA).

UK Water Industry Research (2010) *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (London: UKWIR).

Wilson, S., Oliver, S., Mallet, H., Hutchings, H. and Card, G. (2007), *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (London: CIRIA).

FIGURES



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Client: HARWORTH ESTATES

Project Title: ROCKINGHAM

Drawing Title: SITE LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date	Project No.	Drawing File
HD	30.09.13	GMG	30.09.13	GMG	30.09.13	321393	321393-R02(00)D001A

Scale	Orig Size	Dimensions	Drawing No.	Rev.
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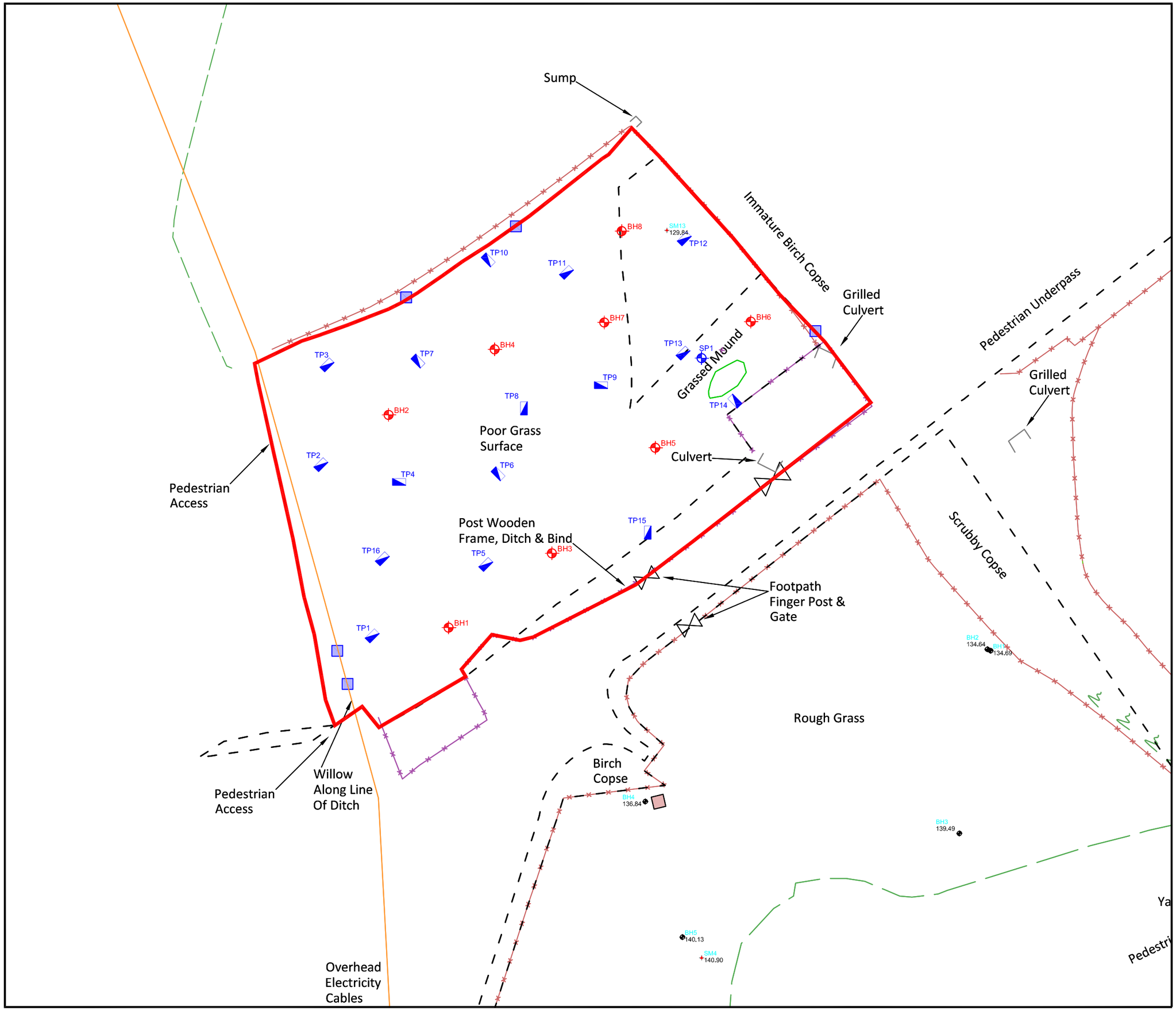

LEGEND:

- Site boundary
- BH206 — Borehole location
- TP4 — Trial pit location
- SP1 — Stockpile sample location

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
A	30.09.13	FIRST ISSUE	HD	GMG	GMG

Dimensions	Projection	Scale	Orig Size
m		1:2000	A3

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PROJECT
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TITLE
EXPLORATORY HOLE LOCATION PLAN

JOB No.:	DRAWING FILE:
321393	321393-R02(00)D002A

BY:	DATE:	CONTRACT NO.		REV:
HD	30.09.13		FIGURE 2	A

Scale 1 : 2,000

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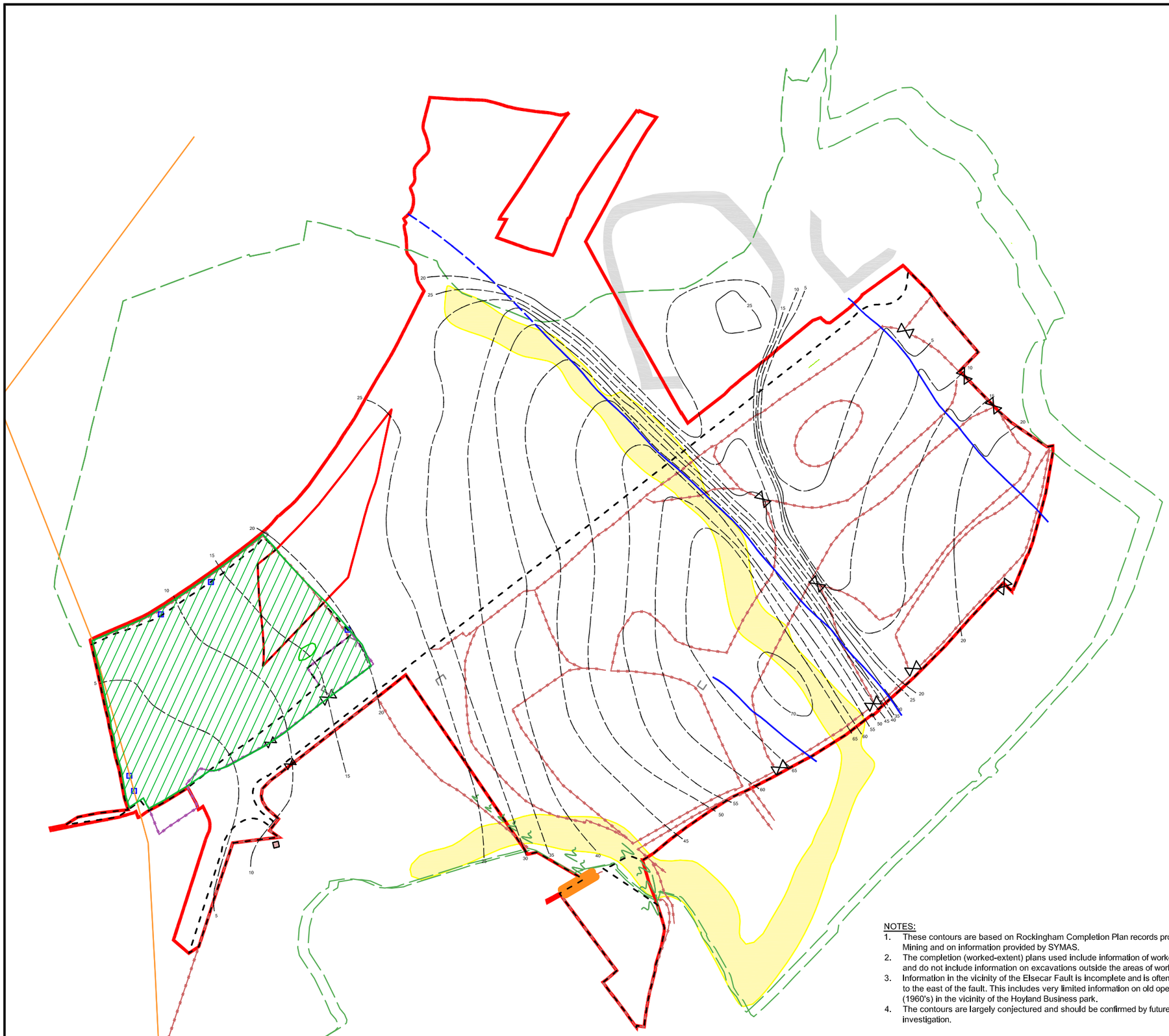

NOTES:

1. These contours are based on Rockingham Completion Plan records produced by RJB Mining and on information provided by SYMAS.
2. The completion (worked-extent) plans used include information of worked areas only and do not include information on excavations outside the areas of worked coal seams.
3. Information in the vicinity of the Elsecar Fault is incomplete and is often poor for the area to the east of the fault. This includes very limited information on old opencast workings (1960's) in the vicinity of the Hoyland Business park.
4. The contours are largely conjectured and should be confirmed by future drilling investigation.

LEGEND:

- Contours (isopachs) of fill thickness
- Geological fault
- Highwall taken from constraints plan
- Old opencast (1960's - approximate only)
- Site boundary
- Rockingham 1

N

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
A	01.10.13	FIRST ISSUE	HD	GMG	GMG

Dimensions	Projection	Scale	Orig Size
m		1:2,500	A1

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ROCKINGHAM

TITLE
CONTOURS OF APPROXIMATE BACKFILL THICKNESS

JOB No.:	DRAWING FILE:
321393	321393-R02(00)D003A

BY:	DATE:	CONTRACT NO.		REV:
HD	01.10.13		FIGURE 3	A

Scale 1 : 2,500

0 50 100 150 200 250m

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Harworth Estates (the "client") in accordance with the terms of a contract between RSK and the "client", dated July 2013. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be** well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

APPENDIX B
SUMMARY OF LEGISLATION AND POLICY RELATING TO CONTAMINATED LAND

Part IIA of the Environmental Protection Act 1990 (EPA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA of the EPA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2010 provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2010 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use.

PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF).

The new framework has only limited guidance on contaminated land, as follows:

- *"planning policies and decisions should also ensure that:*
    - *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
    - *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
    - *adequate site investigation information, prepared by a competent person, is presented".*

APPENDIX C
RISK ASSESSMENT METHODOLOGY

CLR11 outlines the framework to be followed for risk assessment in the UK. The framework is designed to be consistent with UK legislation and policies including planning. Under CLR11, three stages of risk assessment exist: preliminary, generic quantitative and detailed quantitative. An outline conceptual model should be formed at the preliminary risk assessment stage that collates all the existing information pertaining to a site in text, tabular or diagrammatic form. The outline conceptual model identifies potentially complete (termed possible) pollutant linkages (contaminant–pathway–receptor) and is used as the basis for the design of the site investigation. The outline conceptual model is updated as further information becomes available, for example as a result of the site investigation.

Production of a conceptual model requires an assessment of risk to be made. Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, both the likelihood and the consequences of an event must be taken into account when assessing risk. RSK has adopted guidance provided in CIRIA C552 for use in the production of conceptual models.

The likelihood of an event can be classified on a four-point system using the following terms and definitions based on CIRIA C552:

- highly likely: the event appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution
- likely: it is probable that an event will occur or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term
- low likelihood: circumstances are possible under which an event could occur, but it is not certain even in the long term that an event would occur and it is less likely in the short term
- unlikely: circumstances are such that it is improbable the event would occur even in the long term.

The severity can be classified using a similar system also based on CIRIA C552. The terms and definitions relating to severity are:

- severe: short term (acute) risk to human health likely to result in ‘significant harm’ as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. Short-term risk to an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in ‘Draft Circular on Contaminated Land’, DETR 2000)
- medium: chronic damage to human health (‘significant harm’ as defined in ‘Draft Circular on Contaminated Land’, DETR 2000), pollution of sensitive water resources, significant change in an ecosystem or organism forming part of that ecosystem

- mild: pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000). Damage to sensitive buildings, structures or the environment
- minor: harm, not necessarily significant, but that could result in financial loss or expenditure to resolve. Non-permanent human health effects easily prevented by use of personal protective clothing. Easily repairable damage to buildings, structures and services.

Once the probability of an event occurring and its consequences have been classified, a risk category can be assigned according to the table below.

		Consequences			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**Highly likely**	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very low	Very low

Definitions of these risk categories are as follows together with an assessment of the further work that may be required:

- Very high: there is a high probability that severe harm could occur or there is evidence that severe harm is currently happening. This risk, if realised, could result in substantial liability; urgent investigation and remediation are likely to be required.
- High: harm is likely to occur. Realisation of the risk is likely to present a substantial liability. Urgent investigation is required. Remedial works may be necessary in the short term and are likely over the long term.
- Moderate: it is possible that harm could arise, but it is unlikely that the harm would be severe and it is more likely that the harm would be relatively mild. Investigation is normally required to clarify the risk and determine the liability. Some remedial works may be required in the longer term.
- Low: it is possible that harm could occur, but it is likely that if realised this harm would at worst normally be mild.
- Very low: there is a low possibility that harm could occur and if realised the harm is unlikely to be severe.

APPENDIX D
EXPLORATORY HOLE RECORDS

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH1**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.40-0.60	1	ES				MADE GROUND (comprising sparse grass over firm to stiff grey slightly orange very friable gravelly clay. Gravel is fine to coarse angular to subangular of mudstone and siltstone. Occasional cobbles of angular to subangular mudstone) . . . becomes slightly damp and more cohesive from 0.60m	(1.50) 1.50	
0.90-1.20	2	ES						
1.00	4	D						
1.40	5	D						
1.50-1.95	3	SPT	N=37			MADE GROUND (comprising stiff brown grey gravelly friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular of mudstone, sandstone and siltstone. Possible weathered mudstone bedrock)	(1.00) 2.50	
1.50-1.75	7	B						
2.00-2.50	8	ES						
2.90	10	D				MADE GROUND (comprising stiff grey friable very gravelly clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular weak mudstone and siltstone. Possible weathered mudstone bedrock)	(2.00) 4.50	
3.00-3.30	6	SPT	13,12/17,33 for 75mm					
3.00-3.50	12	B						
4.30-4.47	9	SPT	25,37/13 for 20mm					
4.40	13	D				Grey MUDSTONE recovered as grey gravelly clay with fine to coarse angular to subangular weak mudstone gravel	4.80	
4.50-4.80	14	B						
4.80-4.95	11	SPT	25/50 for 75mm					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
2.50	4.50	00:40
4.50	4.80	01:00

General Remarks

1. Hand dug pit to 1.20m.
2. SPTs at 3.00m, 4.50m and 4.80m refused.
3. Groundwater was not encountered.
4. 6 inch casing ground level to 4.50m.
5. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH2**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.30-0.50	1	ES				MADE GROUND (comprising grass over firm to stiff grey gravelly friable clay with occasional cobbles and rare boulders. Gravel is fine to coarse. Gravel, cobbles and boulders are angular to subangular mudstone, sandstone and siltstone)	(1.40)	
1.00-1.30	2	ES				. . . mudstone boulder at 0.40m, width of pit (0.4m x 0.4m), broken with rig		
1.00	4	D					1.40	
1.40	5	D				MADE GROUND (comprising firm to stiff grey mottled orange friable gravelly clay with occasional cobbles and rare boulders. Gravel, cobbles and boulders are angular to subangular mudstone, sandstone and siltstone)		
1.50-1.95	3	SPT	N=26					
1.50-1.95	6	ES						
1.50-1.95	7	B						
2.00-2.30	3	ES						
2.90	8	D						
3.00-3.45	6	SPT	N=28				(4.60)	
3.00-3.45	10	B						
3.00-3.45	9	ES						
4.40	11	D						
4.50-4.95	9	SPT	N=43					
4.50-4.95	12	ES						
4.50-4.95	13	B						
5.80-6.00	15	ES					6.00	
5.90	14	D				Grey weathered MUDSTONE recovered as grey gravelly clay with many cobbles of angular mudstone		
6.00-6.40	12	SPT	8,12/14,14,16,6 for 25mm				(1.30)	
6.00-6.40	16	ES						
6.00-6.50	17	B						
7.40	18	D					7.30	
7.50-7.59	15	SPT	25/50 for 40mm			Grey MUDSTONE recovered as clayey angular mudstone, gravel and cobbles	(0.50)	
7.50-7.80	19	ES					7.80	
7.50-7.80	20	B						
7.80-7.93	17	SPT	25,10/50 for 30mm					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
7.30	7.50	00:30
7.50	7.80	00:30

General Remarks

1. Hand dug inspection pit to 1.20m.
2. 6 inch casing ground level to 7.50m.
3. SPTS at 6.00, 7.50m and 7.80m refused.
4. Groundwater was not encountered.
5. Standpipe installed to 7.80m: 1.00m plain, 6.80m slotted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH3**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**19.07.13**	**---**	**---**	**1** of **1**
	End: **19.07.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.00-0.50	1	B				MADE GROUND (comprising grass over firm to stiff grey very gravelly friable clay with occasional cobbles. Gravel is fine to coarse, cobbles and boulders are angular to subangular mudstone, sandstone and siltstone. Occasional rootlets. Recovered as gravelly sand)	0.30	
0.50-0.70	2	ES				MADE GROUND (comprising stiff grey brown slightly sandy gravelly very friable clay with occasional cobbles. Gravel is fine to coarse, cobbles and boulders are angular to subangular mudstone, sandstone and siltstone)	(4.40)	
1.00	3	D						
1.40	4	D						
1.50-1.95	NR	SPT	N=42					
1.50-1.50	5	ES						
1.50-1.95	6	B						
2.70	7	D						
3.00-3.45	NR	SPT	N=45					
3.00-3.45	8	B						
3.50-4.00	9	ES						
3.90	10	D						
4.50-4.89	NR	SPT	5,5/8,14,20,8 for 15mm				4.70	
4.50-5.00	11	B				Grey laminated MUDSTONE	(0.99)	
5.40	12	D						
5.50-5.69	NR	SPT	17,8/,37,13 for 15mm				5.69	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

1. Hand dug inspection pit to 1.20m.
2. Groundwater was not encountered.
3. SPT refused at 4.50m and 5.50m.
4. Standpipe installed to 5.50m: 1.00m plain, 4.50m slotted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH4**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**18.07.13** End: **19.07.13**	**---**	**---**	**1** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.30-0.50	1	B				MADE GROUND (comprising grass over firm to stiff grey brown slightly sandy gravelly friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular mudstone, sandstone and siltstone. Occasional rootlets)	(0.90)	
0.30-0.50	2	ES					0.90	
1.00	3	D				MADE GROUND (comprising firm to stiff becoming stiff grey occasionally mottled orange gravelly friable clay with occasional cobbles. Gravel and cobbles are angular to subangular mudstone, sandstone and siltstone)		
1.00-1.20	4	ES						
1.40	5	D						
1.50-1.95	NR	SPT	N=26					
1.50-1.95	6	B						
2.00-2.30	7	ES						
2.90	8	D						
3.00-3.45	NR	SPT	N=20					
3.00-3.45	9	B					(6.10)	
4.40	10	D						
4.50-4.95	NR	SPT	N=27					
4.50-4.95	11	B						
5.90	12	D						
6.00-6.45	NR	SPT	N=39	▽				
6.00-6.45	13	B		1			7.00	
7.40	14	D				MADE GROUND (comprising stiff grey very gravelly clay with occasional cobbles. Gravel is fine to coarse, gravel and cobbles are angular to subangular, mainly mudstone)		
7.50-7.72	NR	SPT	10,15/39,11 for 25mm					
7.50-8.00	15	B					(2.00)	
							9.00	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
18/07/13		9.29	-		6.80

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

1. Hand dug inspection pit to 1.20m.
2. Water strike at 6.80m rising to 6.30m after 20 minutes.
3. SPT refused at 7.50m, penetrated 22cm.
4. Refusal at 0m, penetrated 29cm.
5. Standpipe installed to 9.00m: 1.00m plain, 8.00m slotted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH4**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**18.07.13** End: **19.07.13**	**---**	**---**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
8.90 9.00-9.29	16 NR	D SPT	10,14/14,36 for 60mm			Grey laminated MUDSTONE	9.29	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH5**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**19.07.13** End: **22.07.13**	**---**	**---**	**1** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (comprising patchy grass over grey very gravelly slightly sandy clay with occasional rootlets. Cobbles and rare boulders. Gravel is fine to coarse. Gravel, boulders and cobbles are angular to subangular, mainly mudstone with sandstone and siltstone)	0.30	
0.30-0.50	1	ES						
0.30-0.50	2	B				. . . boulder at 0.10m measuring 0.6 x 0.7 x 0.3		
						MADE GROUND (comprising firm to stiff becoming stiff grey (occasionally mottled orange) gravelly very friable clay with occasional cobbles. Gravel and cobbles are angular to subangular, mainly mudstone with sandstone and siltstone. Recovered as gravelly sand)		
1.00-1.40	3	ES						
1.00	4	D						
1.40	5	D						
1.50-1.95	NR	SPT	N=21					
1.50-1.95	6	B						
2.90	7	D						
3.00-3.45	NR	SPT	N=41					
3.00-3.45	8	B						
3.50-4.00	9	ES						
4.40	10	D						
4.50-4.95	NR	SPT	N=32					
4.50-4.95	11	B					(9.90)	
5.90	12	D						
6.00	13	B						
6.35-6.70	NR	SPT	10,15/19,18,13 for 50mm			. . . suspected mudstone boulder at 6.35m		
7.40	14	D						
7.50-7.80	NR	SPT	8,14/19,31 for 75mm					
7.50-8.00	15	B						

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

1. Hand dug pit to 1.20m.
2. Groundwater was not encountered.
3. Standpipe installed to 10.50m: 1.00m plain, 9.50m slotted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH5**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**19.07.13** End: **22.07.13**	**---**	**---**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
8.90	16	D				MADE GROUND (comprising firm to stiff becoming stiff grey (occasionally mottled orange) gravelly very friable clay with occasional cobbles. Gravel and cobbles are angular to subangular, mainly mudstone with sandstone and siltstone. Recovered as gravelly sand) *(stratum text copied from layer at 0.30m depth from previous sheet)*	10.20	
9.00-9.45	NR	SPT	N=26					
9.00-9.45	17	B						
10.40	18	D				Grey laminated MUDSTONE	(0.75)	
10.50-10.67	NR	SPT	25,38/12 for 15mm				10.95	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH6**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**19.07.13** End: **22.07.13**	**---**	**---**	**1** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (comprising grass over grey/brown slightly sandy gravelly clay with occasional cobbles and rootlets. Gravel is fine to coarse. Gravel and cobbles are angular to subangular sandstone, mudstone and siltstone)	0.30	
0.30-0.50	1	B						
0.40-0.50	2	ES						
						MADE GROUND (comprising firm to stiff grey occasional mottled orange gravelly very friable clay with occasional cobbles. Gravel and cobbles are angular to subangular sandstone, mudstone and siltstone)		
1.00	3	D						
1.20-1.40	4	ES						
1.40	5	D						
1.50-1.95	NR	SPT	N=16					
1.50-1.95	6	B						
2.50-3.00	7	ES						
2.90	8	D						
3.00-3.45	NR	SPT	N=19					
3.00-3.45	9	B						
4.40	10	D						
4.50-4.95	NR	SPT	N=23					
4.50-4.95	11	B						
5.90	12	D						
6.00-6.45	NR	SPT	N=14					
6.00-6.45	13	B				. . . cluster of angular sandstone cobbles and boulders from 6.00m to 8.00m		
7.40	14	D						
7.50-7.82	NR	SPT	6,9/15,27,8 for 20mm					
7.50-8.00	15	B						
							(16.40)	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress

From	To	Duration (hh:mm)
16.90	17.20	01:00

General Remarks

1. Hand dug inspection pit to 1.20m.
2. SPTs refused at 10.50m, 13.50m and 15.00m.
3. Casing to 12.00m
4. Installed with magnet extensometers.
5. Groundwater was not encountered.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH6**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**19.07.13** End: **22.07.13**	**---**	**---**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
8.90	16	D				MADE GROUND (comprising firm to stiff grey occasional mottled orange gravelly very friable clay with occasional cobbles. Gravel and cobbles are angular to subangular sandstone, mudstone and siltstone) *(stratum text copied from layer at 0.30m depth from previous sheet)*		
9.00-9.45	NR	SPT	N=39					
9.00-9.45	17	B						
10.40	18	D						
10.50-10.86	NR	SPT	10,12/17,21,12 for 60mm					
10.50-11.00	19	B						
11.90	20	D						
12.00-12.45	NR	SPT	N=37					
12.00-12.45	21	B						
						. . . becomes very compact from approximately 13.00m		
13.40	22	D						
13.50-13.95	NR	SPT	N=31					
13.50-14.00	23	B						
14.90	24	D						
15.00-15.32	NR	SPT	10,12/19,16,5 for 20mm					
15.00-15.50	25	B						
16.40	26	D						
16.50-16.73	NR	SPT	9,16/36,14 for 35mm				16.70	
16.50-17.00	27	B				Grey laminated MUDSTONE	(0.50)	
							17.20	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH7**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**17.07.13**	**---**	**---**	**1** of **2**
	End: **17.07.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (comprising grass over firm to stiff brown grey slightly sandy very gravelly friable clay with occasional cobbles and rare rootlets. Gravel is fine to coarse. Gravel and cobbles are angular to subangular mudstone, siltstone and sandstone)	(0.60)	
0.40-0.50	1	ES					0.60	
0.40-0.60	2	B						
						MADE GROUND (comprising firm to stiff becoming stiff grey mottled orange gravelly very friable clay with occasional cobble.s Gravel and cobble sare angular to subangular mudstone, siltstone and sandstone)		
1.00-1.30	3	ES						
1.00	4	D						
1.40	5	D						
1.50-1.95	NR	SPT	N=28					
1.50-1.95	6	B						
2.00-2.10	7	ES						
2.90	8	D						
3.00-3.45	NR	SPT	N=23					
3.00-3.45	9	B					(5.90)	
4.40	10	D						
4.50-4.95	NR	SPT	N=21					
4.50-4.95	11	B						
5.90	12	D						
6.00-6.45	NR	SPT	N=40			. . . suspected mudstone boulder in SPT at 6.00m		
6.00-6.45	1	B					6.50	
						MADE GROUND (comprising firm to stiff black gravelly slightly sandy very friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular brick fragments, mudstone, sandstone and coal)		
7.00-7.30	13	ES						
7.40	14	D						
7.50-7.95	NR	SPT	N=28					
7.50-7.95	15	B						
						. . . brick fragments no longer present from 8.50m		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

1. Hand dug inspection pit to 1.20m.
2. Groundwater was not encountered.
3. Standpipe installed to 13.00m: 1.00m plain, 12.00m slotted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH7**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**17.07.13** End: **17.07.13**	**---**	**---**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
8.90	16	D				MADE GROUND (comprising firm to stiff black gravelly slightly sandy very friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular brick fragments, mudstone, sandstone and coal) *(stratum text copied from layer at 6.50m depth from previous sheet)*	(6.10)	
9.00-9.45	NR	SPT	N=27					
9.00-9.45	17	B						
10.40	18	D						
10.50-10.95	NR	SPT	N=28					
10.50-10.95	19	B						
11.90	20	D						
12.00-12.45	NR	SPT	N=29					
12.00-12.95	21	B						
							12.60	
12.90	22	D				Grey weak laminated MUDSTONE. Recovered as sandy mudstone gravel and cobbles	(0.52)	
13.00-13.12	NR	SPT	20/50 for 55mm				13.12	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH8**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13** End: **17.07.13**	**---**	**---**	**1** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.30-0.50	1	ES				MADE GROUND (comprising grass over firm to stiff grey slightly sandy gravelly very friable clay with occasional rootlets. Gravel is fine to coarse angular to subangular mudstone, sandstone and siltstone) . . . mudstone boulder at 0.50m, broken with rig	(1.00) 1.00	
1.00	2	D				MADE GROUND (comprising firm to stiff becoming stiff grey occasionally mottled orange slightly sandy gravelly friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular mudstone, sandstone and siltstone)	(6.70)	
1.30-1.50	3	ES						
1.40	4	D						
1.50-1.95	NR	SPT	N=17					
1.50-1.95	5	B						
2.90	6	D						
3.00-3.45	NR	SPT	N=34					
3.00-3.45	7	B						
4.40	8	D						
4.50-4.95	NR	SPT	N=31					
4.50-4.95	9	B						
5.90	10	D						
6.00-6.45	NR	SPT	N=36					
6.00-6.45	11	B						
6.20-6.50	12	ES						
7.40	13	D						
7.50-7.95	NR	SPT	N=38					
7.50-7.95	14	B						
8.50-8.70	15	ES				MADE GROUND (comprising stiff black very gravelly friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular mainly coal with some mudstone and siltstone)	7.70	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
15.20	15.40	00:15

General Remarks

1. Hand dug pit to 1.20m (with chiselling).
2. Groundwater was not encountered.
3. Standpipe installed to 15.40m: 1.40m plain, 14.00m slotted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham	**Harworth Estates Investments Ltd**	**BH8**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13** End: **17.07.13**	**---**	**---**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
8.90	16	D				MADE GROUND (comprising stiff black very gravelly friable clay with occasional cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular mainly coal with some mudstone and siltstone) *(stratum text copied from layer at 7.70m depth from previous sheet)* . . . rare angular to subangular gravel sized brick fragments from 9.50m	(7.10)	
9.00-9.45	NR	SPT	N=21					
9.00-9.45	17	B						
10.40	18	D						
10.50-10.95	NR	SPT	N=22					
10.50-10.95	19	B						
11.90	20	D						
12.00-12.45	NR	SPT	N=30					
12.00-12.45	21	B						
13.40	22	D						
13.50-13.95	NR	SPT	N=29					
13.50-13.95	23	B						
14.90	24	D				Grey weathered MUDSTONE recovered as clayey angular laminated fine to coarse mudstone gravel. Cobbles very friable	(0.60)	
15.00-15.22	NR	SPT	17,8/31,19 for 45mm					
15.15-15.40	25	B					15.40	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**Structural Soils Ltd**	**EJones**	

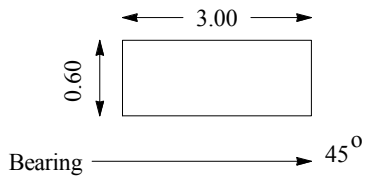
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP1**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				MADE GROUND (grass and sparse vegetation over firm grey sandy gravelly very friable clay with occasional cobbles - gravel and cobbles mostly angular weak grey and black mudstone - occasional orange/brown coloration) . . . occasional rootlets ground level to 0.30m . . . occasional angular boulders of grey sandstone from 1.00m	(1.80) 1.80	
						Grey fine grained MUDSTONE (recovered a angular gravel, cobbles and boulders)	(0.60) 2.40	
						. . . very hard digging - refusal at 2.40m		

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

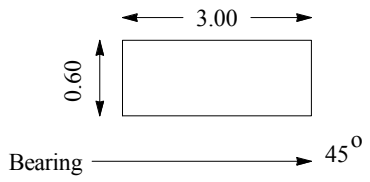
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP2**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.60	1	ES				MADE GROUND (grass and rough vegetation over firm to stiff grey sandy gravelly very friable clay with occasional cobbles and boulders - gravel cobbles are angular grey mudstone and fine grained sandstone - rare orange coloration - boulders are angular fine grained sandstone) . . . occasional rootlets ground level to 0.30m . . . becoming dark grey slightly friable with occasional orange coloration from 1.40m to 1.80m . . . slightly friable from 1.80m	(2.60) 2.60	
						. . . refusal at 2.60m due to possible grey bedrock		

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

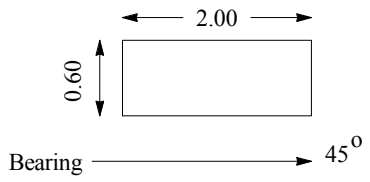
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP3**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.40	1	ES				MADE GROUND (grass and rough vegetation over firm to stiff grey sandy gravelly very friable clay with frequent cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone) . . . frequent rootlets between ground level and 0.20m	(0.80) 0.80	
2.10	2	B				MADE GROUND (brown and orange silty gravelly sand with occasional cobbles and boulders - gravel, cobbles and boulders are angular grey and orange sandstone) . . . rare brick and brick fragments from 2.50m	(2.20)	
2.90	3	ES					3.00	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

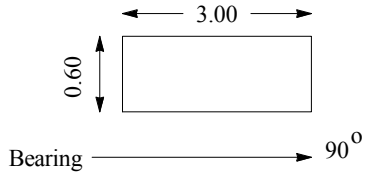
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP4**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.30	1	B				MADE GROUND (grass and rough vegetation over firm to stiff grey sandy very gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone) . . . occasional rootlets ground level to 0.20m		
1.10	2	ES				. . . becoming friable with gravel being mostly fine to medium grey mudstone from 0.80m cobbles are angular grey and orange fine grained sandstone from 0.80,		
2.80	3	ES				. . . occasional boulders of angular pale grey and orange fine grained sandstone from 1.50m. Boulders in ground possibly larger than those returned	(3.10)	
						. . . difficult digging due to hard ground from 3.00m to 3.10m	3.10	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

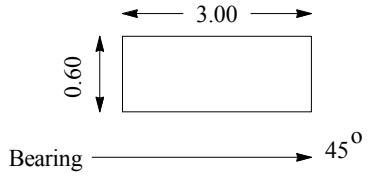
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP5**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (grass and sparse vegetation over firm to stiff grey sandy very gravelly very friable clay with frequent cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone) . . . occasional rootlets ground level to 0.20m	(0.70) 0.70	
0.80	1	ES				MADE GROUND (firm to stiff grey brown sandy gravelly friable clay - occasional angular cobbles of grey, pale grey and orange fine grained sandstone - gravel is angular grey mudstone and fine grained sandstone) . . . dark grey in pockets with slight diesel odour between 1.00m and 1.50m		
1.20	2	ES				. . . hard digging between 1.40m and 1.80m due to occasional grey angular sandstone boulders. Boulders in ground possibly larger than those returned	(1.40) 2.10	
2.00	3	ES				MADE GROUND (firm to stiff grey sandy gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone) . . . apparent large mudstone boulder to northwest end of pit between 2.10m and 2.60m . . . friable from 2.50m	(1.10) 3.20	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

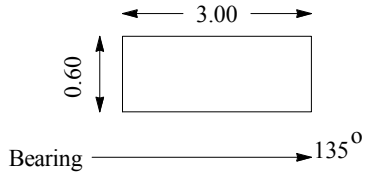
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP6**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.60	1	ES				MADE GROUND (grass and sparse vegetation over firm to stiff grey sandy very gravelly very friable clay with frequent cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone - rare angular boulders of grey and orange fine grained sandstone) . . . occasional rootlets ground level to 0.20m	(3.10)	
						. . . frequent angular boulders of grey fine grained sandstone from 2.60m and slow progress. Boulders in ground possibly larger than those returned	3.10	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

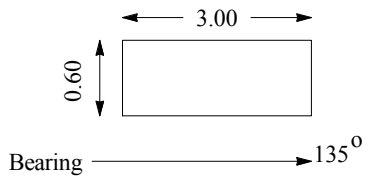
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP7**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**15.07.13**	**---**	**---**	**1** of **1**
	End: **15.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.50	1	B				MADE GROUND (grass and sparse vegetation over firm to stiff grey sandy very gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone)		
1.20	2	ES				. . . occasional angular boulders of grey fine grained sandstone from 1.30m and hard digging. Boulders in ground possibly larger than those returned	(2.90)	
							2.90	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

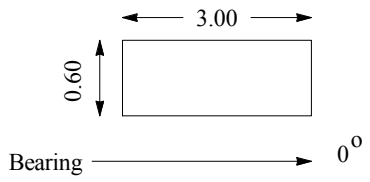
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP8**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.40	1	ES				MADE GROUND (grass and sparse vegetation over firm to stiff grey sandy very gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone - rare angular boulders of grey mudstone) . . . brown and slightly organic with rootlets between ground level and 0.20m	(3.50)	
						. . . grey and orange with occasional angular cobbles of fine grained sandstone from 2.00m		
3.30	2	B				. . . frequent grey angular boulders of fine grained sandstone from 2.50m (generally broken up during excavation)	3.50	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

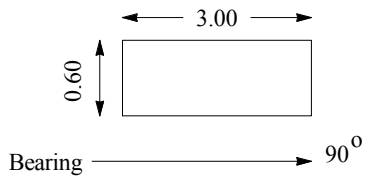
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP9**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.10	1	ES				MADE GROUND (grass and sparse vegetation over firm to stiff grey sandy very gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone) . . . brown and slightly organic between ground level and 0.20m		
2.60	2	ES				. . . rare angular boulders of mudstone and fine grained sandstone from 1.00m	(3.60) 3.60	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

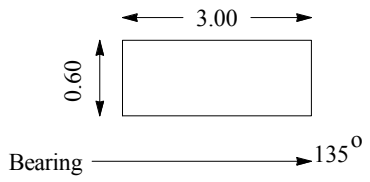
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP10**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (grass over firm to stiff grey sandy very gravelly very friable clay with occasional boulders - gravel and cobbles are angular grey mudstone - rare boulders of angular grey mudstone) . . . occasional rootlets ground level to 0.20m	(3.50)	
1.50	2	B						
2.20	2	ES						
							3.50	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

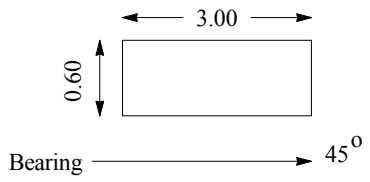
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP11**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.70	1	ES				MADE GROUND (firm to stiff grey sandy very gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone - rare angular boulders of grey fine grained sandstone with orange staining) . . . occasional rootlets ground level to 0.20m . . . boulders becoming occasional from 1.00m . . . many large flat boulders between 1.40m and 2.00m broken up during excavation . . . frequent boulders from 2.50m (returned boulders up to 0.3m x 0.5m x 0.1m but these possibly broken during excavation)	(3.00) 3.00	
						. . . difficult digging - refusal at 3.00m		

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

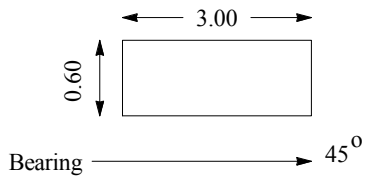
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP12**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.30	1	ES				MADE GROUND (grass over firm to stiff grey sandy gravelly clay with frequent cobbles and boulders - gravel, cobbles and boulders are angular grey mudstone and frequent sandstone - returned boulders are up to 0.3m x 0.6m x 0.5m but these probably broken during excavation) . . . brown and slightly organic between ground level and 0.20m		
						. . . rare boulders from 1.20m		
1.80	2	B					(3.60)	
3.00	3	ES						
							3.60	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

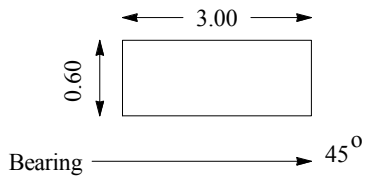
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP13**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (grass over firm to stiff grey/brown slightly organic sandy gravelly clay - gravel is angular grey sandstone and mudstone)	0.20	
						MADE GROUND (firm to stiff darker grey clayey very gravelly sand with occasional cobbles - gravel and cobbles are angular dark grey mudstone and fine grained sandstone)	(1.50)	
0.90	1	ES						
1.20	2	B					1.70	
						MADE GROUND (firm to stiff grey sandy gravelly very friable clay with frequent cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone with some orange staining - rare angular boulders of grey fine grained sandstone)	(1.70)	
							3.40	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

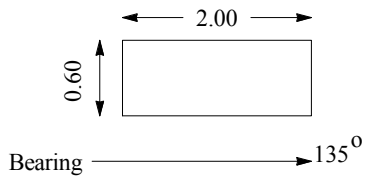
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP14**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (patchy grass over grey slightly sandy gravelly friable clay with occasional rootlets - gravel is angular grey mudstone)	(0.30) 0.30	
0.40	1	ES				MADE GROUND (firm to stiff grey sandy gravelly very friable clay with occasional cobbles and rare boulders - gravel, cobbles and boulders are angular mudstone and sandstone)		
						. . . slightly friable from 1.00m		
1.40	2	B				. . . small pocket of perched water at 1.60m		
						. . . two grey angular sandstone boulders at 1.80m (0.30m x 0.30m x 0.60m)	(3.20)	
						. . . seepage at 2.30m from southern side of pit		
							3.50	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.
4. Slight groundwater entry at 1.60m.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**EJones**	

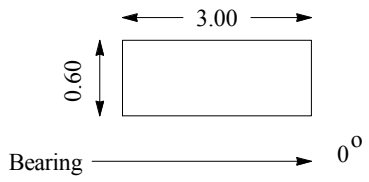
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP15**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND (pale brown sandy gravelly very friable clay with occasional rootlets - gravel is angular grey mudstone and sandstone)	0.20	
						MADE GROUND (firm to stiff grey sandy gravelly very friable clay with occasional cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone - rare angular boulders of grey mudstone and fine grained sandstone)		
0.90	1	ES						
						. . . possibly more boulders from 1.60m but being broken up by excavator (hard digging)	(2.80)	
1.70	2	B						
						. . . very hard digging from 2.50m, presumably as result of large boulders (some broken pieces returned)	3.00	
						. . . refusal at 3.00m due to hard digging		

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

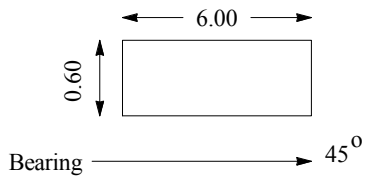
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
Rockingham	**Harworth Estates Investments Ltd**	**TP16**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
321393	**16.07.13**	**---**	**---**	**1** of **1**
	End: **16.07.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.70	1	B				MADE GROUND (grass over firm to stiff grey sandy gravelly clay with occasional cobbles - gravel and cobbles are angular grey mudstone and fine grained sandstone) . . . brown with occasional rootlets between ground level and 0.20m . . . horizon proven to 2.70m at northeast end of pit . . . frequent grey and orange angular sandstone boulders between 1.30m and 1.80m	(1.80) 1.80	
2.50	2	ES				(Southwest end of pit only) Very stiff grey mottled with dark grey, pale grey and orange closely randomly fissured CLAY - slightly sandy and slightly gravelly in places with gravel being angular mudstone - possible weathered mudstone bedrock	(1.20) 3.00	

Plan (Not to Scale)



General Remarks

1. The sides of the pit remained stable.
2. Groundwater was not encountered.
3. Backfilled with arisings on completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**RPark**	

APPENDIX E
GROUND GAS MONITORING DATA

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G1	Falling	Falling	998	998	GA2000 SN-GA10789 + PID SN-6741 + Interface probe SN-3355 + Weather: Rainy + Ground: Wet + Wind: Light + Air Temp: 20DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH2	1	50	G1	7.80	---	1.00 to 7.80	31/07/2013 09:00:00	-	998	-0.1	DRY	0.0	0.0	19.7	0.0	0.2	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	15 secs	-	998	-0.1	DRY	4.1	0.0	16.5	0.0	-	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	30 secs	-	998	-0.1	DRY	4.2	0.0	15.5	0.0	-	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	60 secs	-	998	-0.1	DRY	4.2	0.0	15.3	0.0	-	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	90 secs	-	998	-0.1	DRY	4.3	0.0	15.3	0.0	-	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	120 secs	-	998	-	DRY	4.2	0.0	15.2	0.0	-	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	180 secs	-	998	-	DRY	4.2	0.0	15.3	0.0	-	0.0	0.0
BH2	1	50	G1		---	1.00 to 7.80	240 secs	-	998	-	DRY	4.1	0.0	15.4	0.0	-	0.0	0.0
BH3	1	50	G1	5.50	5.42	1.00 to 5.50	31/07/2013 10:00:00	-	998	-0.7	DRY	0.2	0.0	19.2	0.0	0.9	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	15 secs	-	998	-0.7	DRY	13.5	0.0	8.4	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	30 secs	-	998	-0.7	DRY	15.4	0.0	5.1	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	60 secs	-	998	-0.7	DRY	16.8	0.0	3.1	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	90 secs	-	998	-0.7	DRY	17.3	0.0	2.5	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	120 secs	-	998	-0.7	DRY	17.7	0.0	2.1	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	180 secs	-	998	-	DRY	18.7	0.0	1.3	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	240 secs	-	998	-	DRY	20.2	0.0	0.4	0.0	-	0.0	0.0
BH3	1	50	G1		5.42	1.00 to 5.50	300 secs	-	998	-	DRY	20.3	0.0	0.4	0.0	-	0.0	0.0
BH4	1	50	G1	9.00	---	1.00 to 9.00	31/07/2013 09:15:00	-	998	0.0	-	0.0	0.0	19.7	0.0	0.0	0.0	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH4	1	50	G1		---	1.00 to 9.00	15 secs	-	998	0.0	-	0.2	0.0	19.5	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	30 secs	-	998	0.0	-	0.6	0.0	19.0	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	60 secs	-	998	-	-	2.8	0.0	15.4	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	90 secs	-	998	-	-	3.0	0.0	14.5	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	120 secs	-	998	-	-	3.5	0.0	13.7	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	180 secs	-	998	-	-	3.7	0.0	12.8	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	240 secs	-	998	-	-	3.8	0.0	112.7	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	300 secs	-	998	-	-	3.9	0.0	12.4	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	360 secs	-	998	-	-	2.2	0.0	15.5	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	420 secs	-	998	-	-	1.8	0.0	16.0	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	600 secs	-	998	-	-	0.2	0.0	19.1	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	660 secs	-	998	-	-	0.1	0.0	19.4	0.0	-	0.0	0.0
BH4	1	50	G1		---	1.00 to 9.00	720 secs	-	998	-	-	0.1	0.0	19.4	0.0	-	0.0	0.0
BH5	1	50	G1	10.50	---	1.00 to 10.50	31/07/2013 09:00:00	-	998	-0.1	-	0.0	0.0	19.7	0.0	0.6	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	15 secs	-	998	-0.2	-	3.8	0.0	10.3	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	30 secs	-	998	-0.1	-	3.9	0.0	9.4	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	60 secs	-	998	-0.1	-	4.0	0.0	8.8	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	90 secs	-	998	-0.2	-	4.1	0.0	8.4	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	120 secs	-	998	-0.1	-	4.4	0.0	7.8	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	180 secs	-	998	-	-	4.9	0.0	6.6	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	240 secs	-	998	-	-	5.7	0.0	5.1	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	300 secs	-	998	-	-	6.6	0.0	3.7	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	360 secs	-	998	-	-	7.0	0.0	3.4	0.0	-	0.0	0.0
BH5	1	50	G1		---	1.00 to 10.50	420 secs	-	998	-	-	7.5	0.0	3.3	0.0	-	0.0	0.0
BH7	1	50	G1	13.00	---	1.00 to 13.00	31/07/2013 10:40:00	-	998	-0.1	-	0.0	0.0	19.9	0.0	0.5	0.0	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH7	1	50	G1		---	1.00 to 13.00	15 secs	-	998	-0.1	-	2.0	0.0	18.3	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	30 secs	-	998	-0.1	-	2.0	0.0	18.2	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	60 secs	-	998	-0.1	-	2.0	0.0	18.1	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	90 secs	-	998	-0.1	-	2.0	0.0	18.1	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	120 secs	-	998	-	-	2.2	0.0	18.1	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	180 secs	-	998	-	-	2.5	0.0	17.9	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	240 secs	-	998	-	-	3.1	0.0	17.6	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	300 secs	-	998	-	-	3.8	0.0	17.3	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	360 secs	-	998	-	-	5.0	0.0	16.8	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	420 secs	-	998	-	-	5.7	0.0	16.5	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	480 secs	-	998	-	-	6.0	0.0	16.4	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	540 secs	-	998	-	-	6.4	0.0	16.2	0.0	-	0.0	0.0
BH7	1	50	G1		---	1.00 to 13.00	600 secs	-	998	-	-	6.6	0.0	16.1	0.0	-	0.0	0.0
BH8	1	50	G1	15.40	---	1.00 to 15.40	31/07/2013 11:05:00	-	998	0.2	-	0.2	0.0	19.8	0.0	-	0.0	0.0
BH8	1	50	G1		---	1.00 to 15.40	15 secs	-	998	0.2	-	0.0	0.0	19.8	0.0	-	0.0	0.0
BH8	1	50	G1		---	1.00 to 15.40	30 secs	-	998	0.2	-	0.0	0.0	19.8	0.0	-	0.0	0.0
BH8	1	50	G1		---	1.00 to 15.40	60 secs	-	998	0.2	-	0.0	0.0	19.8	0.0	-	0.0	0.0
BH8	1	50	G1		---	1.00 to 15.40	90 secs	-	998	0.2	-	0.0	0.0	19.8	0.0	-	0.0	0.0
BH8	1	50	G1		---	1.00 to 15.40	120 secs	-	998	-	-	0.0	0.0	19.8	0.0	-	0.0	0.0
BH8	1	50	G1		---	1.00 to 15.40	180 secs	-	998	-	-	0.0	0.0	19.8	0.0	-	0.0	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G2	-	-	-	-	GA2000 SN-MA008 + Weather: Cloudy + Ground: Dry + Wind: Strong + Air Temp: 24DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH2	1	50	G2	7.80	---	1.00 to 7.80	15/08/2013 11:40:00	995	995	-0.3	DRY	0.0	0.0	10.2	0.0	0.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	15 secs	995	995	-0.6	DRY	6.6	0.0	9.6	0.0	2.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	30 secs	995	995	-0.4	DRY	7.2	0.0	8.7	0.0	1.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	60 secs	995	995	-0.1	DRY	7.2	0.0	8.4	0.0	1.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	90 secs	995	995	-0.1	DRY	7.5	0.0	8.2	0.0	2.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	120 secs	995	995	-	DRY	7.5	0.0	8.1	0.0	0.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	180 secs	995	995	-	DRY	7.6	0.0	8.0	0.0	1.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	240 secs	995	995	-	DRY	7.9	0.0	7.8	0.0	0.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	300 secs	995	995	-	DRY	8.2	0.0	7.4	0.0	0.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	360 secs	995	995	-	DRY	8.5	0.0	7.1	0.0	1.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	420 secs	995	995	-	DRY	8.6	0.0	6.9	0.0	2.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	480 secs	995	995	-	DRY	8.7	0.0	6.8	0.0	0.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	540 secs	995	995	-	DRY	8.9	0.0	6.6	0.0	2.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	600 secs	995	995	-	DRY	9.0	0.0	6.5	0.0	1.0	0.0	
BH2	1	50	G2		---	1.00 to 7.80	660 secs	995	995	-	DRY	9.0	0.0	6.4	0.0	1.0	0.0	
BH3	1	50	G2	5.50	5.43	1.00 to 5.50	15/08/2013 11:10:00	999	999	0.0	DRY	0.0	0.0	20.6	0.0	0.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	15 secs	999	999	0.0	DRY	14.7	0.0	5.1	0.0	3.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	30 secs	999	999	0.0	DRY	15.4	0.2	3.4	0.0	1.0	0.0	

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RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

Page: **1** of **4**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH3	1	50	G2		5.43	1.00 to 5.50	60 secs	999	999	0.0	DRY	15.4	0.2	3.3	3.0	1.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	90 secs	999	999	-	DRY	15.4	0.2	3.5	3.0	0.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	120 secs	999	999	-	DRY	15.2	0.2	4.1	3.0	1.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	180 secs	999	999	-	DRY	15.3	0.1	4.3	3.0	1.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	240 secs	999	999	-	DRY	15.5	0.1	3.7	2.0	3.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	300 secs	999	999	-	DRY	16.2	0.1	2.9	1.0	2.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	360 secs	999	999	-	DRY	16.2	0.1	2.5	2.0	5.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	420 secs	999	999	-	DRY	16.4	0.1	2.4	2.0	1.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	480 secs	999	999	-	DRY	16.5	0.1	2.3	2.0	3.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	540 secs	999	999	-	DRY	16.5	0.1	2.2	2.0	3.0	0.0	
BH3	1	50	G2		5.43	1.00 to 5.50	600 secs	999	999	-	DRY	16.5	0.1	2.2	2.0	3.0	0.0	
BH4	1	50	G2	9.00	---	1.00 to 9.00	15/08/2013 12:10:00	995	995	-0.1	-	0.0	0.0	20.5	0.0	0.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	15 secs	995	995	0.0	-	3.4	0.0	15.8	0.0	1.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	30 secs	995	995	0.0	-	3.6	0.0	15.6	0.0	3.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	60 secs	995	995	0.0	-	4.1	0.0	14.5	0.0	2.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	90 secs	995	995	-	-	4.4	0.0	14.0	0.0	2.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	120 secs	995	995	-	-	4.8	0.0	13.6	0.0	2.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	180 secs	995	995	-	-	5.5	0.0	12.8	0.0	1.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	240 secs	995	995	-	-	6.4	0.0	12.0	0.0	3.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	300 secs	995	995	-	-	7.4	0.0	11.2	0.0	0.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	360 secs	995	995	-	-	8.2	0.0	10.6	0.0	0.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	420 secs	995	995	-	-	8.6	0.0	10.3	0.0	0.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	480 secs	995	995	-	-	8.8	0.0	10.1	0.0	1.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	540 secs	995	995	-	-	8.8	0.0	10.3	0.0	3.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	600 secs	995	995	-	-	8.8	0.0	10.4	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH4	1	50	G2		---	1.00 to 9.00	660 secs	995	995	-	-	8.5	0.0	10.8	0.0	0.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	720 secs	995	995	-	-	8.6	0.0	10.6	0.0	2.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	780 secs	995	995	-	-	9.3	0.0	9.7	0.0	2.0	0.0	
BH4	1	50	G2		---	1.00 to 9.00	840 secs	995	995	-	-	9.4	0.0	9.8	0.0	2.0	0.0	
BH5	1	50	G2	10.50	---	1.00 to 10.50	15/08/2013 10:30:00	999	999	0.7	-	0.0	0.0	20.2	0.0	0.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	15 secs	999	999	2.5	-	1.6	0.0	18.7	0.0	0.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	30 secs	999	999	1.0	-	1.8	0.0	18.2	0.0	5.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	60 secs	999	999	1.1	-	1.9	0.0	18.1	0.0	3.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	90 secs	999	999	0.6	-	2.0	0.0	18.1	0.0	3.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	120 secs	999	999	0.5	-	2.1	0.0	18.1	0.0	2.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	180 secs	999	999	-0.4	-	2.1	0.0	18.2	0.0	2.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	240 secs	999	999	-0.8	-	2.2	0.0	18.4	0.0	2.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	300 secs	999	999	-	-	2.2	0.0	18.6	0.0	1.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	360 secs	999	999	-	-	2.2	0.0	18.7	0.0	2.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	420 secs	999	999	-	-	2.3	0.0	18.7	0.0	2.0	0.0	
BH5	1	50	G2		---	1.00 to 10.50	480 secs	999	999	-	-	2.3	0.0	18.7	0.0	1.0	0.0	
BH7	1	50	G2	13.00	---	1.00 to 13.00	15/08/2013 12:45:00	994	994	-1.0	-	0.0	0.0	20.3	0.0	0.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	15 secs	994	994	-1.2	-	2.4	0.0	17.7	0.0	3.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	30 secs	994	994	-1.1	-	2.7	0.0	17.4	0.0	2.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	60 secs	994	994	-0.3	-	2.9	0.0	17.1	0.0	1.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	90 secs	994	994	0.7	-	3.0	0.0	17.6	0.0	1.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	120 secs	994	994	-0.9	-	3.0	0.0	17.1	0.0	1.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	180 secs	994	994	-0.2	-	2.9	0.0	17.3	0.0	1.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	240 secs	994	994	-1.1	-	2.9	0.0	17.5	0.0	2.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	300 secs	994	994	-0.2	-	2.8	0.0	17.8	0.0	1.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH7	1	50	G2		---	1.00 to 13.00	360 secs	994	994	-	-	3.0	0.0	17.9	0.0	2.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	420 secs	994	994	-	-	3.1	0.0	18.0	0.0	0.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	480 secs	994	994	-	-	3.1	0.0	18.0	0.0	1.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	540 secs	994	994	-	-	2.9	0.0	18.1	0.0	0.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	600 secs	994	994	-	-	2.8	0.0	18.2	0.0	2.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	660 secs	994	994	-	-	2.7	0.0	18.3	0.0	2.0	0.0	
BH7	1	50	G2		---	1.00 to 13.00	720 secs	994	994	-	-	2.7	0.0	18.3	0.0	1.0	0.0	
BH8	1	50	G2	15.40	---	1.00 to 15.40	15/08/2013 13:20:00	994	994	-5.5	-	0.0	0.0	20.9	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	15 secs	994	994	-6.2	-	0.6	0.0	20.4	0.0	1.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	30 secs	994	994	-4.1	-	0.8	0.0	20.3	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	60 secs	994	994	-3.5	-	1.0	0.0	20.1	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	90 secs	994	994	-3.5	-	1.1	0.0	20.0	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	120 secs	994	994	-	-	1.1	0.0	20.0	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	180 secs	994	994	-	-	1.2	0.0	19.9	0.0	1.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	240 secs	994	994	-	-	1.2	0.0	19.9	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	300 secs	994	994	-	-	1.3	0.0	19.8	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	360 secs	994	994	-	-	1.4	0.0	19.8	0.0	0.0	0.0	
BH8	1	50	G2		---	1.00 to 15.40	420 secs	994	994	-	-	1.4	0.0	19.8	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Spring Lodge
172 Chester Road
Helsby, Cheshire
WA6 0AR

Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

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IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G3	-	-	-	-	GA2000 SN-GA10789 + Interface probe SN-54247 + Weather: Cloudy + Ground: Dry + Wind: Light + Air Temp: 21DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH2	1	50	G3	7.80	---	1.00 to 7.80	29/08/2013 10:24:00	1007	1007	-0.1	DRY	0.0	0.0	20.8	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	15 secs	1007	1007	-0.1	DRY	5.5	0.0	15.6	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	30 secs	1007	1007	-0.1	DRY	6.6	0.0	12.3	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	60 secs	1007	1007	-0.1	DRY	9.1	0.0	9.5	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	90 secs	1007	1007	-	DRY	9.6	0.0	8.5	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	120 secs	1007	1007	-	DRY	9.7	0.0	8.4	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	180 secs	1007	1007	-	DRY	9.7	0.0	8.5	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	240 secs	1007	1007	-	DRY	9.7	0.0	8.5	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	300 secs	1007	1007	-	DRY	10.1	0.0	8.2	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	360 secs	1007	1007	-	DRY	10.3	0.0	8.0	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	420 secs	1007	1007	-	DRY	10.4	0.0	7.9	0.0	0.0	0.0	
BH2	1	50	G3		---	1.00 to 7.80	480 secs	1007	1007	-	DRY	10.4	0.0	7.9	0.0	0.0	0.0	
BH3	1	50	G3	5.50	4.43	1.00 to 5.50	29/08/2013 09:54:00	1007	1007	-0.1	DRY	0.0	0.0	20.6	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	15 secs	1007	1007	0.0	DRY	5.1	0.0	14.5	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	30 secs	1007	1007	0.0	DRY	5.8	0.0	12.8	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	60 secs	1007	1007	0.0	DRY	8.0	0.1	10.5	1.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	90 secs	1007	1007	-	DRY	8.5	0.1	10.0	1.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	120 secs	1007	1007	-	DRY	8.4	0.0	10.5	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

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Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH3	1	50	G3		4.43	1.00 to 5.50	180 secs	1007	1007	-	DRY	8.1	0.0	11.7	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	240 secs	1007	1007	-	DRY	7.6	0.0	13.6	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	300 secs	1007	1007	-	DRY	7.8	0.0	14.3	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	360 secs	1007	1007	-	DRY	8.0	0.0	13.9	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	420 secs	1007	1007	-	DRY	8.2	0.0	13.5	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	480 secs	1007	1007	-	DRY	8.4	0.0	13.2	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	540 secs	1007	1007	-	DRY	8.5	0.0	12.9	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	600 secs	1007	1007	-	DRY	8.6	0.0	12.7	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	660 secs	1007	1007	-	DRY	8.7	0.0	12.5	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	720 secs	1007	1007	-	DRY	8.9	0.0	12.2	0.0	0.0	0.0	
BH3	1	50	G3		4.43	1.00 to 5.50	780 secs	1007	1007	-	DRY	8.9	0.0	12.1	0.0	0.0	0.0	
BH4	1	50	G3	9.00	---	1.00 to 9.00	29/08/2013 10:49:00	1007	1007	-0.6	-	0.0	0.0	20.9	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	15 secs	1007	1007	0.0	-	2.9	0.0	19.7	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	30 secs	1007	1007	0.0	-	3.4	0.0	18.4	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	60 secs	1007	1007	0.0	-	3.6	0.0	18.5	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	90 secs	1007	1007	-	-	3.8	0.0	18.3	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	120 secs	1007	1007	-	-	4.3	0.0	18.0	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	180 secs	1007	1007	-	-	3.9	0.0	18.4	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	240 secs	1007	1007	-	-	4.2	0.0	18.2	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	300 secs	1007	1007	-	-	4.3	0.0	18.3	0.0	0.0	0.0	
BH4	1	50	G3		---	1.00 to 9.00	360 secs	1007	1007	-	-	4.3	0.0	18.3	0.0	0.0	0.0	
BH5	1	50	G3	10.50	---	1.00 to 10.50	29/08/2013 09:24:00	1007	1007	0.0	-	0.0	0.0	20.8	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	15 secs	1007	1007	0.0	-	5.8	0.0	15.9	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	30 secs	1007	1007	0.0	-	6.0	0.0	13.5	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	60 secs	1007	1007	0.0	-	6.0	0.0	13.1	0.0	0.0	0.0	

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Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH5	1	50	G3		---	1.00 to 10.50	90 secs	1007	1007	-	-	6.0	0.0	13.0	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	120 secs	1007	1007	-	-	6.0	0.0	13.0	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	180 secs	1007	1007	-	-	6.0	0.0	13.0	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	240 secs	1007	1007	-	-	5.9	0.0	13.1	0.0	0.0	0.0	
BH5	1	50	G3		---	1.00 to 10.50	300 secs	1007	1007	-	-	5.9	0.0	13.1	0.0	0.0	0.0	
BH7	1	50	G3	13.00	---	1.00 to 13.00	29/08/2013 11:11:00	1007	1007	0.1	-	0.0	0.0	20.8	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	15 secs	1007	1007	0.1	-	2.5	0.0	19.4	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	30 secs	1007	1007	0.1	-	2.6	0.0	19.1	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	60 secs	1007	1007	0.0	-	2.6	0.0	19.0	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	90 secs	1007	1007	0.0	-	2.6	0.0	19.0	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	120 secs	1007	1007	0.0	-	2.6	0.0	19.0	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	180 secs	1007	1007	-	-	2.7	0.0	19.0	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	240 secs	1007	1007	-	-	2.9	0.0	18.9	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	300 secs	1007	1007	-	-	3.1	0.0	18.9	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	360 secs	1007	1007	-	-	3.5	0.0	18.7	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	420 secs	1007	1007	-	-	3.8	0.0	18.5	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	480 secs	1007	1007	-	-	3.9	0.0	18.3	0.0	0.0	0.0	
BH7	1	50	G3		---	1.00 to 13.00	540 secs	1007	1007	-	-	3.9	0.0	18.5	0.0	0.0	0.0	
BH8	1	50	G3	15.40	---	1.00 to 15.40	29/08/2013 11:44:00	1007	1007	0.0	-	0.0	0.0	20.7	0.0	0.0	0.0	
BH8	1	50	G3		---	1.00 to 15.40	15 secs	1007	1007	0.0	-	0.9	0.0	20.2	0.0	0.0	0.0	
BH8	1	50	G3		---	1.00 to 15.40	30 secs	1007	1007	0.0	-	0.9	0.0	20.1	0.0	0.0	0.0	
BH8	1	50	G3		---	1.00 to 15.40	60 secs	1007	1007	0.0	-	0.9	0.0	20.0	0.0	0.0	0.0	
BH8	1	50	G3		---	1.00 to 15.40	90 secs	1007	1007	-	-	0.9	0.0	20.0	0.0	0.0	0.0	
BH8	1	50	G3		---	1.00 to 15.40	120 secs	1007	1007	-	-	0.9	0.0	20.0	0.0	0.0	0.0	
BH8	1	50	G3		---	1.00 to 15.40	180 secs	1007	1007	-	-	0.9	0.0	20.0	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

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Compiled By	Date	Checked By	Date	Contract Ref:
	02/10/13			321393

Contract: **Rockingham**

Page: **3** of **3**

APPENDIX F
LABORATORY CERTIFICATES FOR SOIL ANALYSIS

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

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/03358
Issue Number: 1 **Date:** 31 July, 2013

Client:
RSK STATS Helsby
Spring Lodge
172 Chester Road
Helsby
Cheshire
UK
WA6 0AR

Project Manager: Jon Clayton/Richard Park/Emily Jones
Project Name: Rockinghams
Project Ref: 321393
Order No: Not specified
Date Samples Received: 17/07/13
Date Instructions Received: 18/07/13
Date Analysis Completed: 31/07/13

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Iain Haslock
Analytical Consultant

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/1	13/03358/2	13/03358/4	13/03358/5	13/03358/6	13/03358/8	13/03358/9	13/03358/10	Units	Method ref
Client Sample No										
Client Sample ID	BH1	BH1	BH2	BH2	BH2	BH8	BH8	TP1		
Depth to Top	0.40	0.90	0.30	1.00	2.00	0.30	1.30	0.20		
Depth To Bottom	0.60	1.20	0.50	1.30	2.30	0.50	1.50			
Date Sampled	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	15-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	4AE	5		5A	5		5	4AE		
% Stones >10mm$_A$ #	1.7	<0.1	-	5.2	<0.1	-	<0.1	6.2	% w/w	A-T-044
Asbestos in soil$_D$ #	NAD	-	NAD	-	-	NAD	-	NAD		A-T-045
pH$_D$ M#	-	7.45	-	-	8.59	-	-	7.34	pH	A-T-031s
pH BRE$_D$ M#	7.87	-	-	8.17	-	-	8.13	-	pH	A-T-031s
Sulphate (water sol 2:1)$_D$ M#	-	0.32	-	-	0.07	-	-	0.14	g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D$ M#	460	-	-	41	-	-	90	-	mg/l	A-T-026s
Sulphate (acid soluble)$_D$ M#	-	820	-	-	<200	-	-	700	mg/kg	A-T-028
Sulphate BRE (acid sol)$_D$ M#	0.13	-	-	<0.02	-	-	0.04	-	% w/w	A-T-028
Sulphur BRE (total)$_D$	0.06	-	-	0.03	-	-	0.07	-	% w/w	A-T-024
Total Organic Carbon$_D$ M#	-	1.00	-	-	1.26	-	-	2.25	% w/w	A-T-032s
Arsenic$_D$ M#	-	<1	-	-	<1	-	-	3	mg/kg	A-T-024
Cadmium$_D$ M#	-	<0.5	-	-	<0.5	-	-	0.6	mg/kg	A-T-024
Copper$_D$ M#	-	28	-	-	55	-	-	35	mg/kg	A-T-024
Chromium$_D$ M#	-	54	-	-	69	-	-	54	mg/kg	A-T-024
Lead$_D$ M#	-	13	-	-	14	-	-	17	mg/kg	A-T-024
Mercury$_D$	-	0.24	-	-	0.43	-	-	0.29	mg/kg	A-T-024
Nickel$_D$ M#	-	41	-	-	33	-	-	50	mg/kg	A-T-024
Selenium$_D$ #	-	1	-	-	<1	-	-	2	mg/kg	A-T-024
Zinc$_D$ M#	-	84	-	-	35	-	-	90	mg/kg	A-T-024

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/1	13/03358/2	13/03358/4	13/03358/5	13/03358/6	13/03358/8	13/03358/9	13/03358/10	Units	Method ref
Client Sample No										
Client Sample ID	BH1	BH1	BH2	BH2	BH2	BH8	BH8	TP1		
Depth to Top	0.40	0.90	0.30	1.00	2.00	0.30	1.30	0.20		
Depth To Bottom	0.60	1.20	0.50	1.30	2.30	0.50	1.50			
Date Sampled	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	15-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	4AE	5		5A	5		5	4AE		
TPH CWG										
Ali >C5-C6$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Total Aliphatics$_A$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-022+23s
Aro >C5-C7$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-023s
Total Aromatics$_A$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	-	<0.1	-	-	<0.1	-	-	<0.1	mg/kg	A-T-022+23s
BTEX - Benzene$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s
MTBE$_A^{\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/1	13/03358/2	13/03358/4	13/03358/5	13/03358/6	13/03358/8	13/03358/9	13/03358/10	Units	Method ref
Client Sample No										
Client Sample ID	BH1	BH1	BH2	BH2	BH2	BH8	BH8	TP1		
Depth to Top	0.40	0.90	0.30	1.00	2.00	0.30	1.30	0.20		
Depth To Bottom	0.60	1.20	0.50	1.30	2.30	0.50	1.50			
Date Sampled	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	15-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	4AE	5		5A	5		5	4AE		
PAH 16										
Acenaphthene$_A^{M\#}$	-	<0.01	-	-	<0.01	-	-	0.03	mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	-	<0.01	-	-	<0.01	-	-	<0.01	mg/kg	A-T-019s
Anthracene$_A^{M\#}$	-	0.05	-	-	<0.02	-	-	0.05	mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	-	<0.04	-	-	<0.04	-	-	0.26	mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	-	<0.04	-	-	<0.04	-	-	0.29	mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	-	<0.05	-	-	<0.05	-	-	0.24	mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	-	<0.05	-	-	<0.05	-	-	0.14	mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	-	<0.07	-	-	<0.07	-	-	0.25	mg/kg	A-T-019s
Chrysene$_A^{M\#}$	-	<0.06	-	-	<0.06	-	-	0.39	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	-	<0.04	-	-	<0.04	-	-	<0.04	mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	-	<0.08	-	-	<0.08	-	-	0.72	mg/kg	A-T-019s
Fluorene$_A^{M\#}$	-	<0.01	-	-	<0.01	-	-	0.02	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	-	<0.03	-	-	<0.03	-	-	0.13	mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	-	0.05	-	-	<0.03	-	-	<0.03	mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	-	0.04	-	-	<0.03	-	-	0.23	mg/kg	A-T-019s
Pyrene$_A^{M\#}$	-	<0.07	-	-	<0.07	-	-	0.66	mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	-	0.14	-	-	<0.08	-	-	3.44	mg/kg	A-T-019s

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/11	13/03358/13	13/03358/14	13/03358/15	13/03358/16	13/03358/17	13/03358/21	13/03358/22	Units	Method ref
Client Sample No										
Client Sample ID	TP2	TP3	TP4	TP4	TP5	TP5	TP8	TP9		
Depth to Top	0.60	2.90	1.10	2.80	0.80	1.20	0.40	0.10		
Depth To Bottom										
Date Sampled	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	5A	5A	5AE	5A	5A	5AE	4E		
% Stones >10mm$_A$ #	<0.1	4.9	2.3	8.4	2.6	10.2	6.2	<0.1	% w/w	A-T-044
Asbestos in soil$_D$ #	-	-	-	-	-	-	-	NAD		A-T-045
pH$_D$ M#	7.25	-	7.62	7.93	-	-	7.97	7.50	pH	A-T-031s
pH BRE$_D$ M#	-	7.55	-	-	7.51	-	-	-	pH	A-T-031s
Sulphate (water sol 2:1)$_D$ M#	0.19	-	0.10	0.05	-	-	0.38	0.09	g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D$ M#	-	29	-	-	48	-	-	-	mg/l	A-T-026s
Sulphate (acid soluble)$_D$ M#	510	-	290	<200	-	-	1000	250	mg/kg	A-T-028
Sulphate BRE (acid sol)$_D$ M#	-	<0.02	-	-	<0.02	-	-	-	% w/w	A-T-028
Sulphur BRE (total)$_D$	-	<0.01	-	-	0.02	-	-	-	% w/w	A-T-024
Total Organic Carbon$_D$ M#	0.84	-	2.99	1.70	-	-	0.63	0.85	% w/w	A-T-032s
Arsenic$_D$ M#	<1	-	<1	3	-	-	8	2	mg/kg	A-T-024
Cadmium$_D$ M#	<0.5	-	<0.5	<0.5	-	-	<0.5	0.7	mg/kg	A-T-024
Copper$_D$ M#	29	-	34	30	-	-	27	24	mg/kg	A-T-024
Chromium$_D$ M#	51	-	55	45	-	-	46	40	mg/kg	A-T-024
Lead$_D$ M#	16	-	17	16	-	-	17	13	mg/kg	A-T-024
Mercury$_D$	0.32	-	0.31	0.25	-	-	0.25	<0.17	mg/kg	A-T-024
Nickel$_D$ M#	33	-	36	35	-	-	39	37	mg/kg	A-T-024
Selenium$_D$ #	<1	-	2	<1	-	-	<1	1	mg/kg	A-T-024
Zinc$_D$ M#	70	-	85	82	-	-	94	95	mg/kg	A-T-024

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/11	13/03358/13	13/03358/14	13/03358/15	13/03358/16	13/03358/17	13/03358/21	13/03358/22	Units	Method ref
Client Sample No										
Client Sample ID	TP2	TP3	TP4	TP4	TP5	TP5	TP8	TP9		
Depth to Top	0.60	2.90	1.10	2.80	0.80	1.20	0.40	0.10		
Depth To Bottom										
Date Sampled	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	5A	5A	5AE	5A	5A	5AE	4E		
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	-	0.77	<0.01	<0.01	mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	<0.1	-	<0.1	<0.1	-	62.3	<0.1	<0.1	mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	<0.1	-	<0.1	<0.1	-	743	<0.1	<0.1	mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	<0.1	-	<0.1	<0.1	-	1060	<0.1	<0.1	mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	<0.1	-	<0.1	<0.1	-	406	<0.1	<0.1	mg/kg	A-T-023s
Total Aliphatics$_A$	<0.1	-	<0.1	<0.1	-	2270	<0.1	<0.1	mg/kg	A-T-022+23s
Aro >C5-C7$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	<0.01	-	<0.01	<0.01	-	0.03	<0.01	<0.01	mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	-	0.22	<0.01	<0.01	mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	<0.1	-	<0.1	<0.1	-	17.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	<0.1	-	<0.1	<0.1	-	247	<0.1	<0.1	mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	<0.1	-	<0.1	<0.1	-	365	<0.1	<0.1	mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	<0.1	-	<0.1	<0.1	-	108	<0.1	<0.1	mg/kg	A-T-023s
Total Aromatics$_A$	<0.1	-	<0.1	<0.1	-	738	<0.1	<0.1	mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	<0.1	-	<0.1	<0.1	-	3010	<0.1	<0.1	mg/kg	A-T-022+23s
BTEX - Benzene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/11	13/03358/13	13/03358/14	13/03358/15	13/03358/16	13/03358/17	13/03358/21	13/03358/22	Units	Method ref
Client Sample No										
Client Sample ID	TP2	TP3	TP4	TP4	TP5	TP5	TP8	TP9		
Depth to Top	0.60	2.90	1.10	2.80	0.80	1.20	0.40	0.10		
Depth To Bottom										
Date Sampled	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	5A	5A	5AE	5A	5A	5AE	4E		
PAH 16										
Acenaphthene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	-	0.10	<0.01	mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	-	<0.01	<0.01	mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	-	<0.02	<0.02	-	-	0.17	<0.02	mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	-	0.08	<0.04	mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	-	<0.04	0.05	mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	-	<0.05	<0.05	-	-	<0.05	<0.05	mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	-	<0.05	<0.05	-	-	<0.05	<0.05	mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	-	<0.07	<0.07	-	-	<0.07	<0.07	mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	-	<0.06	<0.06	-	-	0.15	0.07	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	-	<0.04	<0.04	mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	-	<0.08	<0.08	-	-	0.46	<0.08	mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	-	0.05	<0.01	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	-	<0.03	<0.03	-	-	<0.03	0.04	mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03	-	<0.03	<0.03	-	-	0.08	<0.03	mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.03	-	<0.03	<0.03	-	-	0.54	<0.03	mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	-	<0.07	<0.07	-	-	0.34	<0.07	mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	<0.08	-	<0.08	<0.08	-	-	1.98	0.16	mg/kg	A-T-019s

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/11	13/03358/13	13/03358/14	13/03358/15	13/03358/16	13/03358/17	13/03358/21	13/03358/22	Units	Method ref
Client Sample No										
Client Sample ID	TP2	TP3	TP4	TP4	TP5	TP5	TP8	TP9		
Depth to Top	0.60	2.90	1.10	2.80	0.80	1.20	0.40	0.10		
Depth To Bottom										
Date Sampled	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	5A	5A	5AE	5A	5A	5AE	4E		
VOC										
Dichlorodifluoromethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Chloromethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Vinyl Chloride$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Bromomethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Chloroethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Trichlorofluoromethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,1-Dichloroethene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Carbon Disulphide$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Dichloromethane$_A$	-	-	-	-	-	<500	-	-	µg/kg	A-T-006
trans 1,2-Dichloroethene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,1-Dichloroethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
cis 1,2-Dichloroethene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
2,2-Dichloropropane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Bromochloromethane$_A^\#$	-	-	-	-	-	<25	-	-	µg/kg	A-T-006
Chloroform$_A^\#$	-	-	-	-	-	<125	-	-	µg/kg	A-T-006
1,1,1-Trichloroethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,1-Dichloropropene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Carbon Tetrachloride$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,2-Dichloroethane$_A^\#$	-	-	-	-	-	<10	-	-	µg/kg	A-T-006
Benzene VOC$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Trichloroethene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,2-Dichloropropane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Dibromomethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Bromodichloromethane$_A^\#$	-	-	-	-	-	*<50*	-	-	µg/kg	A-T-006
cis 1,3-Dichloropropene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Toluene VOC$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
trans 1,3-Dichloropropene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,1,2-Trichloroethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,3-Dichloropropane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006

Lab Sample ID	13/03358/11	13/03358/13	13/03358/14	13/03358/15	13/03358/16	13/03358/17	13/03358/21	13/03358/22	Units	Method ref
Client Sample No										
Client Sample ID	TP2	TP3	TP4	TP4	TP5	TP5	TP8	TP9		
Depth to Top	0.60	2.90	1.10	2.80	0.80	1.20	0.40	0.10		
Depth To Bottom										
Date Sampled	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	5A	5A	5AE	5A	5A	5AE	4E		
Tetrachloroethene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Dibromochloromethane$_A^\#$	-	-	-	-	-	<15	-	-	µg/kg	A-T-006
1,2-Dibromoethane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Chlorobenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,1,1,2-Tetrachloroethane$_A$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Ethylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
m & p Xylene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
o-Xylene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Styrene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Bromoform$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Isopropylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,1,2,2-Tetrachloroethane$_A$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,2,3-Trichloropropane$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
Bromobenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
n-propylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
2-Chlorotoluene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,3,5-Trimethylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
4-Chlorotoluene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
tert-Butylbenzene$_A^\#$	-	-	-	-	-	<10	-	-	µg/kg	A-T-006
1,2,4-Trimethylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
sec-Butylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
4-Isopropyltoluene$_A^\#$	-	-	-	-	-	5	-	-	µg/kg	A-T-006
1,3-Dichlorobenzene$_A$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,4-Dichlorobenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
n-Butylbenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,2-Dichlorobenzene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,2-Dibromo-3-chloropropane$_A$	-	-	-	-	-	<10	-	-	µg/kg	A-T-006
1,2,4-Trichlorobenzene$_A$	-	-	-	-	-	<15	-	-	µg/kg	A-T-006
Hexachlorobutadiene$_A^\#$	-	-	-	-	-	<5	-	-	µg/kg	A-T-006
1,2,3-Trichlorobenzene$_A$	-	-	-	-	-	<15	-	-	µg/kg	A-T-006

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/11	13/03358/13	13/03358/14	13/03358/15	13/03358/16	13/03358/17	13/03358/21	13/03358/22	Units	Method ref
Client Sample No										
Client Sample ID	TP2	TP3	TP4	TP4	TP5	TP5	TP8	TP9		
Depth to Top	0.60	2.90	1.10	2.80	0.80	1.20	0.40	0.10		
Depth To Bottom										
Date Sampled	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	15-Jul-13	16-Jul-13	16-Jul-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	5A	5A	5AE	5A	5A	5AE	4E		
TPH CWG										
Mineral Oil (>C10-C35)$_A$	-	-	-	-	-	2270	-	-	mg/kg	A-T-023s

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/24	13/03358/26	13/03358/28	13/03358/29	13/03358/30	13/03358/31	13/03358/32		Units	Method ref
Client Sample No										
Client Sample ID	TP10	TP12	TP13	TP14	TP15	TP16	SP1			
Depth to Top	2.20	0.30	0.90	0.40	0.90	2.50	0.30			
Depth To Bottom										
Date Sampled	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AE	4E		4A	5A	5	4E			
% Stones >10mm$_A$ #	4.6	<0.1	-	8.1	4.4	<0.1	<0.1		% w/w	A-T-044
Asbestos in soil$_D$ #	-	-	NAD	-	-	-	-			A-T-045
pH$_D$ M#	8.18	8.07	-	8.24	8.28	-	6.98		pH	A-T-031s
pH BRE$_D$ M#	-	-	-	8.24	-	4.70	-		pH	A-T-031s
Chloride BRE, SO4 equiv. (water sol 2:1)$_D$	-	-	-	-	-	<7	-		mg/l	A-T-026s
Nitrate BRE, SO4 equiv. (water sol 2:1)$_D$	-	-	-	-	-	0.5	-		mg/l	A-T-026s
Sulphate (water sol 2:1)$_D$ M#	0.08	0.02	-	0.43	0.32	-	0.04		g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D$ M#	-	-	-	429	-	100	-		mg/l	A-T-026s
Sulphate (acid soluble)$_D$ M#	240	<200	-	1000	800	-	500		mg/kg	A-T-028
Sulphate BRE (acid sol)$_D$ M#	-	-	-	0.10	-	0.03	-		% w/w	A-T-028
Sulphur BRE (total)$_D$	-	-	-	0.06	-	<0.01	-		% w/w	A-T-024
Total Organic Carbon$_D$ M#	0.58	0.61	-	1.20	0.68	-	-		% w/w	A-T-032s
Arsenic$_D$ M#	2	2	-	3	<1	-	8		mg/kg	A-T-024
Cadmium$_D$ M#	<0.5	<0.5	-	<0.5	<0.5	-	0.8		mg/kg	A-T-024
Copper$_D$ M#	28	25	-	28	28	-	26		mg/kg	A-T-024
Chromium$_D$ M#	48	47	-	51	45	-	32		mg/kg	A-T-024
Lead$_D$ M#	28	12	-	18	12	-	37		mg/kg	A-T-024
Mercury$_D$	0.17	0.19	-	<0.17	<0.17	-	<0.17		mg/kg	A-T-024
Nickel$_D$ M#	39	37	-	36	38	-	23		mg/kg	A-T-024
Selenium$_D$ #	<1	1	-	<1	<1	-	2		mg/kg	A-T-024
Zinc$_D$ M#	125	87	-	87	85	-	119		mg/kg	A-T-024

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/24	13/03358/26	13/03358/28	13/03358/29	13/03358/30	13/03358/31	13/03358/32		Units	Method ref
Client Sample No										
Client Sample ID	TP10	TP12	TP13	TP14	TP15	TP16	SP1			
Depth to Top	2.20	0.30	0.90	0.40	0.90	2.50	0.30			
Depth To Bottom										
Date Sampled	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AE	4E		4A	5A	5	4E			
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	0.02	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Total Aliphatics$_A$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-022+23s
Aro >C5-C7$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-023s
Total Aromatics$_A$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	<0.1	<0.1	-	<0.1	<0.1	-	<0.1		mg/kg	A-T-022+23s
BTEX - Benzene$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-022s

Envirolab Job Number: 13/03358

Client Project Name: Rockinghams

Client Project Ref: 321393

Lab Sample ID	13/03358/24	13/03358/26	13/03358/28	13/03358/29	13/03358/30	13/03358/31	13/03358/32		Units	Method ref
Client Sample No										
Client Sample ID	TP10	TP12	TP13	TP14	TP15	TP16	SP1			
Depth to Top	2.20	0.30	0.90	0.40	0.90	2.50	0.30			
Depth To Bottom										
Date Sampled	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13	16-Jul-13			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AE	4E		4A	5A	5	4E			
PAH 16										
Acenaphthene$_A^{M\#}$	<0.01	0.01	-	<0.01	<0.01	-	0.02		mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01	-	<0.01	<0.01	-	<0.01		mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02	-	<0.02	<0.02	-	0.03		mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	<0.04	-	<0.04	<0.04	-	0.10		mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	<0.04	-	<0.04	<0.04	-	0.16		mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	<0.05	-	<0.05	<0.05	-	0.15		mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05	-	<0.05	<0.05	-	0.10		mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	-	<0.07	<0.07	-	0.13		mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06	-	<0.06	<0.06	-	0.24		mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	-	<0.04	<0.04	-	<0.04		mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08	-	<0.08	<0.08	-	0.31		mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01	-	<0.01	<0.01	-	0.01		mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	<0.03	-	<0.03	<0.03	-	0.10		mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03	<0.03	-	<0.03	<0.03	-	<0.03		mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	<0.03	-	0.04	0.04	-	0.15		mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07	-	<0.07	<0.07	-	0.25		mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	<0.08	<0.08	-	<0.08	<0.08	-	1.76		mg/kg	A-T-019s

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural 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, crushed to pass a 2mm sieve.
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.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

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.
Superscript # indicates method 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.

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

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/03475
Issue Number: 1 **Date:** 08 August, 2013

Client:
RSK STATS Helsby
Spring Lodge
172 Chester Road
Helsby
Cheshire
UK
WA6 0AR

Project Manager: Jon Clayton / Emily Jones
Project Name: Rockingham I
Project Ref: 321393
Order No: Not specified
Date Samples Received: 19/07/13
Date Instructions Received: 25/07/13
Date Analysis Completed: 08/08/13

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Iain Haslock
Analytical Consultant

Envirolab Job Number: 13/03475

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03475/1	13/03475/2	13/03475/3	13/03475/4	13/03475/5	13/03475/9	13/03475/10	13/03475/11	Units	Method ref
Client Sample No										
Client Sample ID	BH3	BH3	BH3	BH4	BH4	BH5	BH5	BH6		
Depth to Top	0.50	1.40	3.50	0.30	1.00	1.00	3.50	0.40		
Depth To Bottom	0.70	1.50	4.00	0.50	1.20	1.40	4.00	0.50		
Date Sampled	19-Jul-13	19-Jul-13	19-Jul-13	19-Jul-13	18-Jul-13	19-Jul-13	22-Jul-13	22-Jul-13		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E		3A	4AE	5	3	3	4		
% Stones >10mm$_A$ #	<0.1	-	7.6	2.5	<0.1	<0.1	<0.1	<0.1	% w/w	A-T-044
Asbestos in soil$_D$ #	-	NAD	-	-	NAD	-	-	-		A-T-045
pH$_D$ M#	6.21	-	8.22	8.21	-	8.21	8.41	6.73	pH	A-T-031s
pH BRE$_D$ M#	-	-	-	-	8.74	8.21	-	-	pH	A-T-031s
Sulphate (water sol 2:1)$_D$ M#	1.13	-	0.11	0.02	-	0.34	0.16	0.73	g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D$ M#	-	-	-	-	74	343	-	-	mg/l	A-T-026s
Sulphate (acid soluble)$_D$ M#	3000	-	240	510	-	730	430	1900	mg/kg	A-T-028
Sulphate BRE (acid sol)$_D$ M#	-	-	-	-	0.02	0.07	-	-	% w/w	A-T-028
Sulphur BRE (total)$_D$	-	-	-	-	0.05	0.08	-	-	% w/w	A-T-024
Total Organic Carbon$_D$ M#	8.76	-	1.06	0.80	-	0.83	0.70	2.64	% w/w	A-T-032s
Arsenic$_D$ M#	14	-	3	12	-	6	5	42	mg/kg	A-T-024
Cadmium$_D$ M#	<0.5	-	<0.5	0.6	-	<0.5	0.8	0.8	mg/kg	A-T-024
Copper$_D$ M#	39	-	28	26	-	32	30	38	mg/kg	A-T-024
Chromium$_D$ M#	55	-	51	41	-	28	28	34	mg/kg	A-T-024
Lead$_D$ M#	18	-	14	18	-	16	15	21	mg/kg	A-T-024
Mercury$_D$	0.49	-	0.40	0.30	-	<0.17	<0.17	0.22	mg/kg	A-T-024
Nickel$_D$ M#	41	-	39	40	-	43	40	49	mg/kg	A-T-024
Selenium$_D$ #	<1	-	<1	<1	-	<1	<1	<1	mg/kg	A-T-024
Zinc$_D$ M#	84	-	82	121	-	99	90	142	mg/kg	A-T-024

Envirolab Job Number: 13/03475

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03475/1	13/03475/2	13/03475/3	13/03475/4	13/03475/5	13/03475/9	13/03475/10	13/03475/11	Units	Method ref
Client Sample No										
Client Sample ID	BH3	BH3	BH3	BH4	BH4	BH5	BH5	BH6		
Depth to Top	0.50	1.40	3.50	0.30	1.00	1.00	3.50	0.40		
Depth To Bottom	0.70	1.50	4.00	0.50	1.20	1.40	4.00	0.50		
Date Sampled	19-Jul-13	19-Jul-13	19-Jul-13	19-Jul-13	18-Jul-13	19-Jul-13	22-Jul-13	22-Jul-13		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E		3A	4AE	5	3	3	4		
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	5.5	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	16.1	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	21.8	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	84.3	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Total Aliphatics$_A$	128	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-022+23s
Aro >C5-C7$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	0.01	<0.01	mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	3.5	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	7.9	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	16.5	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	67.6	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Total Aromatics$_A$	95.4	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	223	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	mg/kg	A-T-022+23s
BTEX - Benzene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 13/03475

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03475/1	13/03475/2	13/03475/3	13/03475/4	13/03475/5	13/03475/9	13/03475/10	13/03475/11	Units	Method ref
Client Sample No										
Client Sample ID	BH3	BH3	BH3	BH4	BH4	BH5	BH5	BH6		
Depth to Top	0.50	1.40	3.50	0.30	1.00	1.00	3.50	0.40		
Depth To Bottom	0.70	1.50	4.00	0.50	1.20	1.40	4.00	0.50		
Date Sampled	19-Jul-13	19-Jul-13	19-Jul-13	19-Jul-13	18-Jul-13	19-Jul-13	22-Jul-13	22-Jul-13		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E		3A	4AE	5	3	3	4		
PAH 16										
Acenaphthene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	-	<0.02	<0.02	-	<0.02	<0.02	<0.02	mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	<0.05	mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	<0.05	mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	-	<0.07	<0.07	-	<0.07	<0.07	<0.07	mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	-	<0.06	<0.06	-	<0.06	<0.06	<0.06	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	-	<0.08	<0.08	-	<0.08	<0.08	<0.08	mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	-	<0.03	<0.03	-	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	0.03	-	<0.03	<0.03	-	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.07	-	<0.03	<0.03	-	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	-	<0.07	<0.07	-	<0.07	<0.07	<0.07	mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	0.10	-	<0.08	<0.08	-	<0.08	<0.08	<0.08	mg/kg	A-T-019s

Envirolab Job Number: 13/03475

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03475/14	13/03475/16	13/03475/19						Units	Method ref
Client Sample No										
Client Sample ID	BH7	BH7	BH8							
Depth to Top	0.40	2.00	8.50							
Depth To Bottom	0.50	2.10	8.70							
Date Sampled	17-Jul-13	17-Jul-13	17-Jul-13							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	4E		5A							
% Stones >10mm$_A^{\#}$	<0.1	6.0	2.6						% w/w	A-T-044
pH$_D^{M\#}$	7.07	8.19	9.12						pH	A-T-031s
pH BRE$_D^{M\#}$	-	8.19	-						pH	A-T-031s
Sulphate (water sol 2:1)$_D^{M\#}$	0.05	0.08	0.45						g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	-	77	-						mg/l	A-T-026s
Sulphate (acid soluble)$_D^{M\#}$	270	210	1200						mg/kg	A-T-028
Sulphate BRE (acid sol)$_D^{M\#}$	-	<0.02	-						% w/w	A-T-028
Sulphur BRE (total)$_D$	-	0.04	-						% w/w	A-T-024
Total Organic Carbon$_D^{M\#}$	0.96	0.80	22.7						% w/w	A-T-032s
Arsenic$_D^{M\#}$	6	6	27						mg/kg	A-T-024
Cadmium$_D^{M\#}$	0.5	0.7	<0.5						mg/kg	A-T-024
Copper$_D^{M\#}$	25	27	54						mg/kg	A-T-024
Chromium$_D^{M\#}$	23	25	44						mg/kg	A-T-024
Lead$_D^{M\#}$	10	15	25						mg/kg	A-T-024
Mercury$_D$	<0.17	<0.17	0.49						mg/kg	A-T-024
Nickel$_D^{M\#}$	38	39	35						mg/kg	A-T-024
Selenium$_D^{\#}$	<1	<1	<1						mg/kg	A-T-024
Zinc$_D^{M\#}$	68	88	45						mg/kg	A-T-024

Envirolab Job Number: 13/03475

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03475/14	13/03475/16	13/03475/19						Units	Method ref
Client Sample No										
Client Sample ID	BH7	BH7	BH8							
Depth to Top	0.40	2.00	8.50							
Depth To Bottom	0.50	2.10	8.70							
Date Sampled	17-Jul-13	17-Jul-13	17-Jul-13							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	4E		5A							
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	<0.1	<0.1	<0.1						mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	<0.1	<0.1	<0.1						mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	<0.1	<0.1	<0.1						mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	<0.1	<0.1	<0.1						mg/kg	A-T-023s
Total Aliphatics$_A$	<0.1	<0.1	<0.1						mg/kg	A-T-022+23s
Aro >C5-C7$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	<0.1	<0.1	5.5						mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	<0.1	<0.1	8.0						mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	<0.1	<0.1	9.8						mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	<0.1	<0.1	3.3						mg/kg	A-T-023s
Total Aromatics$_A$	<0.1	<0.1	26.6						mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	<0.1	<0.1	26.6						mg/kg	A-T-022+23s
BTEX - Benzene$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	<0.01	<0.05						mg/kg	A-T-022s

Envirolab Job Number: 13/03475

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03475/14	13/03475/16	13/03475/19						Units	Method ref
Client Sample No										
Client Sample ID	BH7	BH7	BH8							
Depth to Top	0.40	2.00	8.50							
Depth To Bottom	0.50	2.10	8.70							
Date Sampled	17-Jul-13	17-Jul-13	17-Jul-13							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	4E		5A							
PAH 16										
Acenaphthene$_A^{M\#}$	<0.01	<0.01	0.09						mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02	<0.02						mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04						mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	<0.04	<0.04						mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	<0.05	<0.05						mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05	0.14						mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	<0.07						mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06	<0.06						mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	0.10						mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08	<0.08						mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01	0.06						mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	<0.03	0.11						mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	0.04	<0.03	0.15						mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.04	<0.03	0.24						mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07	<0.07						mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	0.09	<0.08	0.89						mg/kg	A-T-019s

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural 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, crushed to pass a 2mm sieve.
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.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

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.
Superscript # indicates method 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.

APPENDIX G
LABORATORY CERTIFICATES FOR GROUNDWATER ANALYSIS

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

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/03655
Issue Number: 1 **Date:** 28 August, 2013

Client:
RSK STATS Helsby
Spring Lodge
172 Chester Road
Helsby
Cheshire
UK
WA6 0AR

Project Manager: Jon Clayton / Emily Jones
Project Name: Rockingham I
Project Ref: 321393
Order No: Not specified
Date Samples Received: 01/08/13
Date Instructions Received: 01/08/13
Date Analysis Completed: 14/08/13

Prepared by:

Liz Oliver
Client Service Manager

Approved by:

Iain Haslock
Analytical Consultant

UKAS TESTING 1247

Envirolab Job Number: 13/03655

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03655/1	13/03655/2							Units	Method ref
Client Sample No										
Client Sample ID	BH4	BH7								
Depth to Top	8.00	9.00								
Depth To Bottom										
Date Sampled	31-Jul-13	31-Jul-13								
Sample Type	Water - W	Water - W								
Sample Matrix Code										
pH (w)$_A^{\#}$	6.45	7.64							pH	A-T-031w
pH BRE (w)$_A^{\#}$	6.45	7.64							pH	A-T-031w
Sulphate (w)$_A^{\#}$	818	618							mg/l	A-T-026w
Sulphate BRE (w)$_A^{\#}$	818	618							mg/l	A-T-026w
Arsenic (dissolved)$_A^{\#}$	8	3							µg/l	A-T-025
Cadmium (dissolved)$_A^{\#}$	<1	<1							µg/l	A-T-025
Copper (dissolved)$_A^{\#}$	<1	4							µg/l	A-T-025
Chromium (dissolved)$_A^{\#}$	2	6							µg/l	A-T-025
Lead (dissolved)$_A^{\#}$	<1	<1							µg/l	A-T-025
Mercury (dissolved)$_A^{\#}$	<0.1	<0.1							µg/l	A-T-025
Nickel (dissolved)$_A^{\#}$	31	4							µg/l	A-T-025
Selenium (dissolved)$_A^{\#}$	<1	1							µg/l	A-T-025
Zinc (dissolved)$_A^{\#}$	11	9							µg/l	A-T-025

Envirolab Job Number: 13/03655

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03655/1	13/03655/2							Units	Method ref
Client Sample No										
Client Sample ID	BH4	BH7								
Depth to Top	8.00	9.00								
Depth To Bottom										
Date Sampled	31-Jul-13	31-Jul-13								
Sample Type	Water - W	Water - W								
Sample Matrix Code										
TPH CWG										
Ali >C5-C6 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Ali >C6-C8 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Ali >C8-C10 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Ali >C10-C12 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Ali >C12-C16 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Ali >C16-C21 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Ali >C21-C35 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Total Aliphatics $(w)_A$	<5	<5							µg/l	A-T-022+23w
Aro >C5-C7 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C7-C8 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C8-C9 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C9-C10 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C10-C12 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Aro >C12-C16 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Aro >C16-C21 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Aro >C21-C35 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Total Aromatics $(w)_A$	<5	<5							µg/l	A-T-022+23w
TPH (Ali & Aro) $(w)_A$	<5	<5							µg/l	A-T-022+23w
BTEX - Benzene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - Toluene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - Ethyl Benzene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - m & p Xylene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - o Xylene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
MTBE $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w

Envirolab Job Number: 13/03655

Client Project Name: Rockingham I

Client Project Ref: 321393

Lab Sample ID	13/03655/1	13/03655/2							Units	Method ref
Client Sample No										
Client Sample ID	BH4	BH7								
Depth to Top	8.00	9.00								
Depth To Bottom										
Date Sampled	31-Jul-13	31-Jul-13								
Sample Type	Water - W	Water - W								
Sample Matrix Code										
PAH 16MS (w)										
Acenaphthene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Acenaphthylene $(w)_A^{\#}$	0.06	0.04							µg/l	A-T-019w
Anthracene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Benzo(a)anthracene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Benzo(a)pyrene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Benzo(b)fluoranthene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Benzo(ghi)perylene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Benzo(k)fluoranthene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Chrysene $(w)_A^{\#}$	<0.01	0.01							µg/l	A-T-019w
Dibenzo(ah)anthracene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Fluoranthene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Fluorene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Indeno(123-cd)pyrene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Naphthalene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Phenanthrene $(w)_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Pyrene $(w)_A^{\#}$	<0.01	0.03							µg/l	A-T-019w
PAH (total 16) $(w)_A^{\#}$	0.06	0.08							µg/l	A-T-019w

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural 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, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
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.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

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.
Superscript # indicates method 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.

APPENDIX H
HUMAN HEALTH GENERIC ASSESSMENT CRITERIA

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

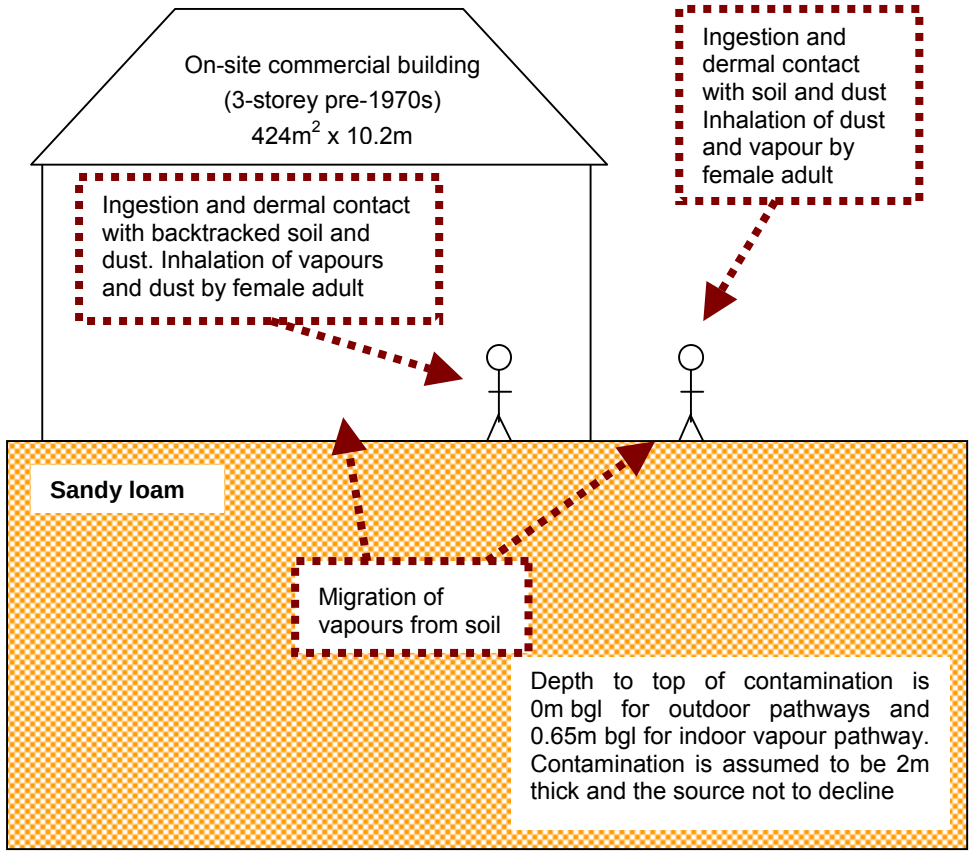


Table 1: Exposure assessment parameters for commercial scenario – inputs for CLEA model

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

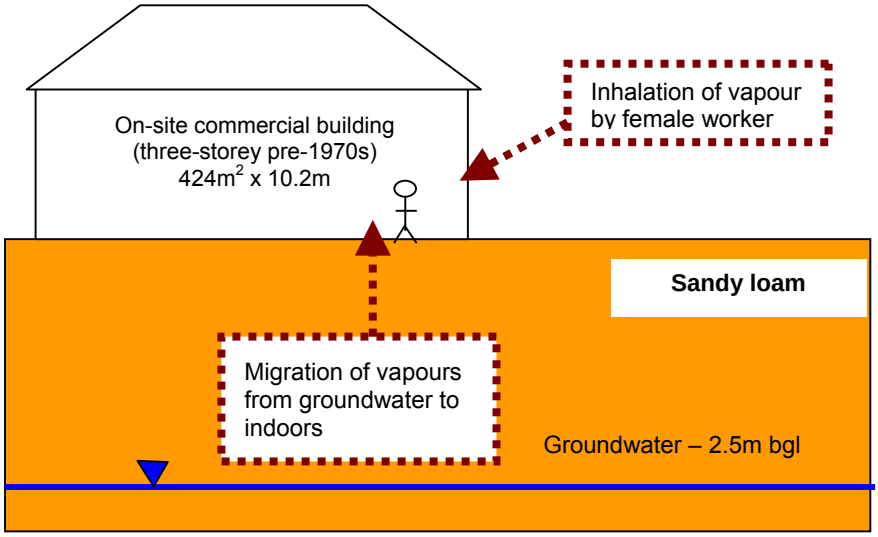


Table 4: Commercial – RBCA inputs

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)	5.60E-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^{4+})	(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	6.85E+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	(b)	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	(b)	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	(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
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	6.31E-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	3.64E+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_{9} (styrene)		6.50E+01	1.14E+05	3.00E+04	2.77E+04	6.20E+02	1.14E+05	7.30E+04	5.81E+04	1.52E+03	1.14E+05	1.73E+05	9.00E+04	3.61E+03
Aromatic hydrocarbons >EC_{9}–EC_{10}		6.50E+01	3.81E+04	3.76E+03	3.67E+03	6.13E+02	3.81E+04	9.16E+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 cellls 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).

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - COMMERCIAL

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.

APPENDIX I
GENERIC ASSESSMENT CRITERIA FOR CONTROLLED WATERS

APPENDIX I
GENERIC ASSESSMENT CRITERIA FOR CONTROLLED WATERS

The water environment in England and Wales is protected under a number of regulatory regimes, many regulated by the Environment Agency. The Environment Agency is consulted where there may be a risk that pollution of 'controlled waters' may occur or may have occurred in the past. Controlled waters are coastal waters, inland freshwaters and groundwaters. The EU Water Framework Directive (WFD) (2000/60/EC) is implemented via various regulations and guidance, covering aspects of groundwater, surface water and drinking water supply policy. The regulations mainly apply to England and Wales, therefore if you are working on a site in Scotland or Northern Ireland, please review the equivalent legislation and guidance provided by the Scottish Environmental Protection Agency (SEPA) or the Northern Ireland Environment Agency (NIEA).

The main objectives of the protection and remediation of groundwater under threat from land contamination are set out in the Environment Agency's Groundwater Protection: Principles and Practice (GP3) series of documents(1). When assessing risks to groundwater the following need to be taken into consideration:

- Where pollutants have not yet entered groundwater, all necessary and reasonable measures must be taken to:
    - *Prevent the input of hazardous substances into groundwater (see description of hazardous substances below)*
    - *Limit the entry of other (non-hazardous) pollutants into groundwater so as to avoid pollution, and to avoid deterioration of the status of groundwater bodies or sustained, upward trends in pollutant concentration*
- Where hazardous substances or non-hazardous pollutants have already entered groundwater, the priority is to:
    - *Minimise further entry of hazardous substances and non-hazardous pollutants into groundwater*
    - *Take necessary and reasonable measures to limit the pollution of groundwater or impact on the status of the groundwater body from the future expansion of a contaminant 'plume', if necessary by actively reducing its extent.*

Definitions

Hazardous Substances are defined in the Water Framework Directive 2000/60/EC as 'substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances which give rise to an equivalent level of concern. All List 1 substances under the old Groundwater Directive (80/68/EEC) are hazardous substances, all radioactive substances are hazardous substances.

Non-hazardous Substances are defined as 'substances capable of causing pollution that have not been classified as hazardous substances'. The non-hazardous list of pollutants does not simply replace the old WFD List II but includes a wider range.

For the current list of classified substances please visit the UKTAG website www.wfduk.org./jagdag/

When assessing the risks to surface waters, various standards apply, including Environmental Quality Standards which are protective of the water ecology[14].

The Water Supply (Water Quality) Regulations[2,3] are the primary source for assessing water bodies which may be used for public water supplies. There are also Private Water Supply Regulations which may be applicable in some cases.

This appendix presents the generic assessment criteria (GAC) that RSK considers are suitable for assessing risks to controlled waters.

The RSK GAC for controlled waters are presented in Table 1. In line with the Environment Agency's (2006b) Remedial Targets Methodology, the GAC for controlled waters are termed 'target concentrations'.

The target concentration can be derived by several means with consideration to:

- whether the substance is classified as hazardous or non-hazardous by the EU under the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC) implemented though the Environmental Permitting Regulations 2010
- background concentrations in the aquifer
- published guidance such as Environmental Quality Standards that are protective of ecology or The Water Supply (Water Quality) Regulations 2010 that are protective of drinking water
- Minimum Reporting Values (or method detection limits if MRV are not provided).

Table 1: Target concentrations for Controlled Waters

Analytes in bold are hazardous, *analytes in italics are non hazardous*, analytes in plain text are unclassified; according to JAGDAG Determination List June 2010

Target Concentrations shaded in GREEN are Statutory Values ORANGE are Non-Statutory Values

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Metals				
Arsenic	-	0.01[2]	0.05[13a]	0.025[13a]
Cadmium	0.0001[4]	0.005[2]	≤0.00008, 0.00008, 0.00009, 0.00015, 0.00025 [13b]	0.0002[13c]
Chromium (total)	-	0.05[2]	Use values for chromium III and VI	
Chromium (III)	-	Use value for total chromium	0.0047 [13a]	0.032[13c]
Chromium (VI)			0.0034 [13a]	0.0006[13a]
Copper	-	2.0[2]	0.001, 0.006, 0.01, 0.028[13e]	0.005[13a]
Lead	-	0.025 (before 25/12/2013), 0.01 (after 25/12/2013)[2]	0.0072[13c]	0.0072[13c]
Mercury	0.00001[4]	0.001[2]	0.00005[13c]	0.00005[13c]

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Nickel	-	0.02[2]	0.02[13c]	0.02[13c]
Selenium	-	0.01[2]	-	-
Zinc	-	5[3]	0.008, 0.05, 0.075, 0.125 [13e]	0.04[13a]
Chlorinated solvents				
Trichloroethene	0.0001[4]	0.01[2]	0.01[13c]	0.01[13c]
Tetrachloroethene	0.0001[4]	0.01[2]	0.01[13c]	0.01[13c]
1,1,1-Trichloroethane	0.0001[4]	-	0.1[13c]	0.1[13c]
1,1,2-Trichloroethane	0.0001[4]	-	0.4[13c]	0.3[13c]
Carbon tetrachloride (Tetrachloromethane)	0.0001[4]	0.003[2]	0.012[13c]	0.012[13c]
1,2-Dichloroethane	0.001[4]	0.003[2]	0.01[13c]	0.01[13c]
Vinyl chloride (Chloroethene)	-	0.0005[2]	-	-
Trihalomethanes	-	0.1[2, 5]	-	-
Chloroform (Trichloromethane) (one of the trihalomethanes included above)	0.0001[4]	0.1[2, 5]	0.0025[13c]	0.0025[13c]
Polycyclic aromatic hydrocarbons				
Acenaphthene	-	-	0.0058[10]	
Acenaphthylene	-	-	0.0058[10]	
Anthracene	-	-	0.0001[13c]	0.0001[13c]

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Benzo(a)anthracene	-	-	0.000018[10]	
Benzo(b)fluoranthene	-	0.0001[2]	0.00003[13f]	0.00003[13f]
Benzo(k)fluoranthene	-			
Benzo(g,h,i)perylene	-		0.000002[13g]	0.000002[13g]
Indeno(1,2,3-cd)pyrene	-			
Chrysene	-	-	0.00001[10]	
Dibenzo(a,h)anthracene	-	-	0.00001[10]	
Fluoranthene	-	-	0.0001[13c]	0.0001[13c]
Fluorene	-	-	0.0021[10]	
Phenanthrene	-	-	0.003[10]	
Pyrene	-	-	0.00004[10]	
Benzo(a)pyrene	-	0.00001[2]	0.00005[13c]	0.00005[13c]
Naphthalene	-	-	0.0024[13c]	0.0012[13c]
Petroleum hydrocarbons				
Total petroleum hydrocarbons	-	0.01[3]	0.01[3, 11]	
Benzene	0.001[4]	0.001[2]	0.01[13c]	0.008[13c
Toluene	0.004[4]	0.7[9]	0.05[13a]	0.04[13a]
Ethylbenzene	-	0.3[9]	0.02[12]	0.02[12]
Xylene	0.003[4]	0.5[9]	0.03[13c]	0.03[13c]

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Methyl tertiary butyl ether	-	0.015[7]		
Pesticides and herbicides				
Aldrin	0.000003[4]	0.00003[2]	0.00001[13d]	0.000005[13d]
Dieldrin	0.003[4]	0.00003[2]		
Endrin	0.000003[4]	0.0006[9]		
Isodrin	0.000003[4]	-		
Heptachlor	-	0.00003[2]		
Heptachlor epoxide	-	0.00003[2]		
Other pesticides	-	0.0001[2]		
Total pesticides	-	0.0005[2]		
Total DDT	0.000004[4]	0.001[9]	0.000025[13c]	0.000025[13c]
Azinphos – methyl	0.000001[4]	-	0.00001[1]	
Cyfluthrin	0.0001[4]	-	0.000001[14]	
Demeton	0.00005[4]	-	0.0005[14	
Dichlorvos	-	-	0.000001[13c]	0.00004[13c]
Dimethoate	0.00001[4]	-	0.00048[13a]	0.00048[13a]
Endosulphan	0.000005[4]	-	0.000005[13c]	0.0000005[13c]
Fenitrothion	0.000001[4]	-	0.00001[13c]	0.00001[13c]
Flucofuron	0.0001[4]	-	0.001[14]	

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Malathion	0.000001[4]	-	0.00001[13c]	0.00002[13c]
Mevinphos	0.000005[4]	-	0.00002[14]	-
Omethoate	0.0001[4]	-	0.00001[14]	
PCSDs (cyfluthrin, sulcofuron, flucofuron and **permethrin**)	-	-	0.00005[15]	
Permethrin	0.000001[4]	-	0.00001[13a]	0.00001[13]
Sulcofuron	0.0001[4]	-	0.025[8,14]	
Triazaphos	0.0001[4]	-	0.000005[8]	
Atrazine	0.00003[4]	-	0.0006[13c]	0.0006[13c]
Simazine	0.00003[4]	-	0.001[13c]	0.001[13c]
Bentazone	0.1[4]	-	0.5[13c]	0.5[13a]
Linuron	0.0001[4]	-	0.0005[13a]	0.0005[13a]
Mecoprop	0.00004[4]	-	0.018[13a]	0.018[13a]
Trifluralin	0.00001[4]	-	0.00003[13c]	0.00003[13c]
Miscellaneous				
Cyanide (Hydrogen cyanide)	-	0.05[2]	0.001[13a]	0.001[13a]
Phenol	0.0005[4]	-	0.0077[13a]	0.0077[13a]
Sodium	-	200[2]	-	
Chloride	-	250[2]	250[6,14]	-

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Ammonium (as NH_4^+)	-	0.5[2]	0.3[13a]	
Ammonia (NH_3)	-	-	0.025[15]	0.021[13a]
Sulphate	-	250[2]	400[6,14]	-
Iron	-	0.20[2]	1[13a]	1[13a]
Manganese	-	0.05[2]	0.03[6,14]	No EQS required [12]
Aluminium	-	0.2[2]	-	
Nitrate (as NO_3)	-	50[2]	-	
Nitrite (as NO_2)	-	0.1[2]	0.01[15]	-

Analytes in bold are hazardous, *analytes in italics are non hazardous*, analytes in plain text are unclassified;
according to JAGDAG Determination List June 2010

Notes:

1. Environment Agency. Groundwater Protection: Principles and Policy (GP3). Part 1 – 4. Part 4 and 5 under consultation.
2. Statutory Instrument 2000 No. 3184. The Water Supply (Water Quality) Regulations 2000, as amended by SI 2001/2885, SI 2002/2469, SI 2005/2035, SI 2007/2734 and SI 2010/991 (applying from April 20 2010)
3. Statutory Instrument 1989 No. 1147. The Water Supply (Water Quality) Regulations 1989, as amended.
4. Minimum reporting values listed in Annex (j) of Horizontal Guidance Note H1 (H1 Environmental Risk Assessment Framework, Environment Agency, April 2010 v2.0). Note target concentration for xylenes is 0.003mg/l each for o-xylene and m/p xylene.
5. Statutory Instrument 2000 No. 3184. The Water Supply (Water Quality) Regulations 2000 – sum of chloroform, bromoform, dibromochloromethane and bromodichloromethane.
6. Proposed list of EQS for implementation of the Dangerous Substances Directive (76/464.EEC).
7. Environment Agency MTBE guidance, 2006.
8. Freshwater Environmental Quality Standards: The Water Framework Directive 200/60/EC.
9. WHO (2004) guidelines for drinking-water quality.
10. WRc plc (2002), R&D Technical Report P45. Where predicted no-effect concentration is below the laboratory method detection limit (LMDL) for chrysene, dibenzo(a,h)anthracene and fluoranthene, the target concentration has been set at the LMDL of 0.00001mg/l.
11. Please note this is a very conservative value. If necessary please refer to EA, 2009. *Petroleum hydrocarbons in Groundwater Supplementary Guidance for Hydrogeological Risk Assessment, which* provides advice on risk rankings of TPH CWG fractions. It may be possible to eliminate low risk fractions and/or those not detected above LMDL from concern.
12. Environment Agency Chemical Standards Database (May 2011). http://evidence.environment-agency.gov.uk/ChemicalStandards/home.aspx
13. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
    - 13a. Annual mean concentration (mg/l) for 'Good' standard.
    - 13b. Applies to hardness ranges of <40mg/l $CaCO_3$, 40–<50mg/l $CaCO_3$, 50–<100mg/l $CaCO_3$, 100–<200mg/l $CaCO_3$ and >/=200mg/l $CaCO_3$. The target concentrations included in Table 1 are listed in order of increasing calcium carbonate concentrations.
    - 13c Annual Average EQS (surface waters).
    - 13d. Sum of aldrin, dieldrin, endrin and isodrin.
    - 13e. Applies to hardness ranges of 0–50mg/l $CaCO_3$, 50–100mg/l $CaCO_3$, 100–250mg/l $CaCO_3$ and >250mg/l $CaCO_3$. The target concentrations included in Table 1 are listed in order of increasing calcium carbonate concentrations; applies to annual mean concentration (mg/l) of $CaCO_3$. Applies to annual mean concentration of metal (mg/l) for 'Good' standard.

13f. Sum of benzo(b)fluoranthene and benzo(k)fluoranthene.

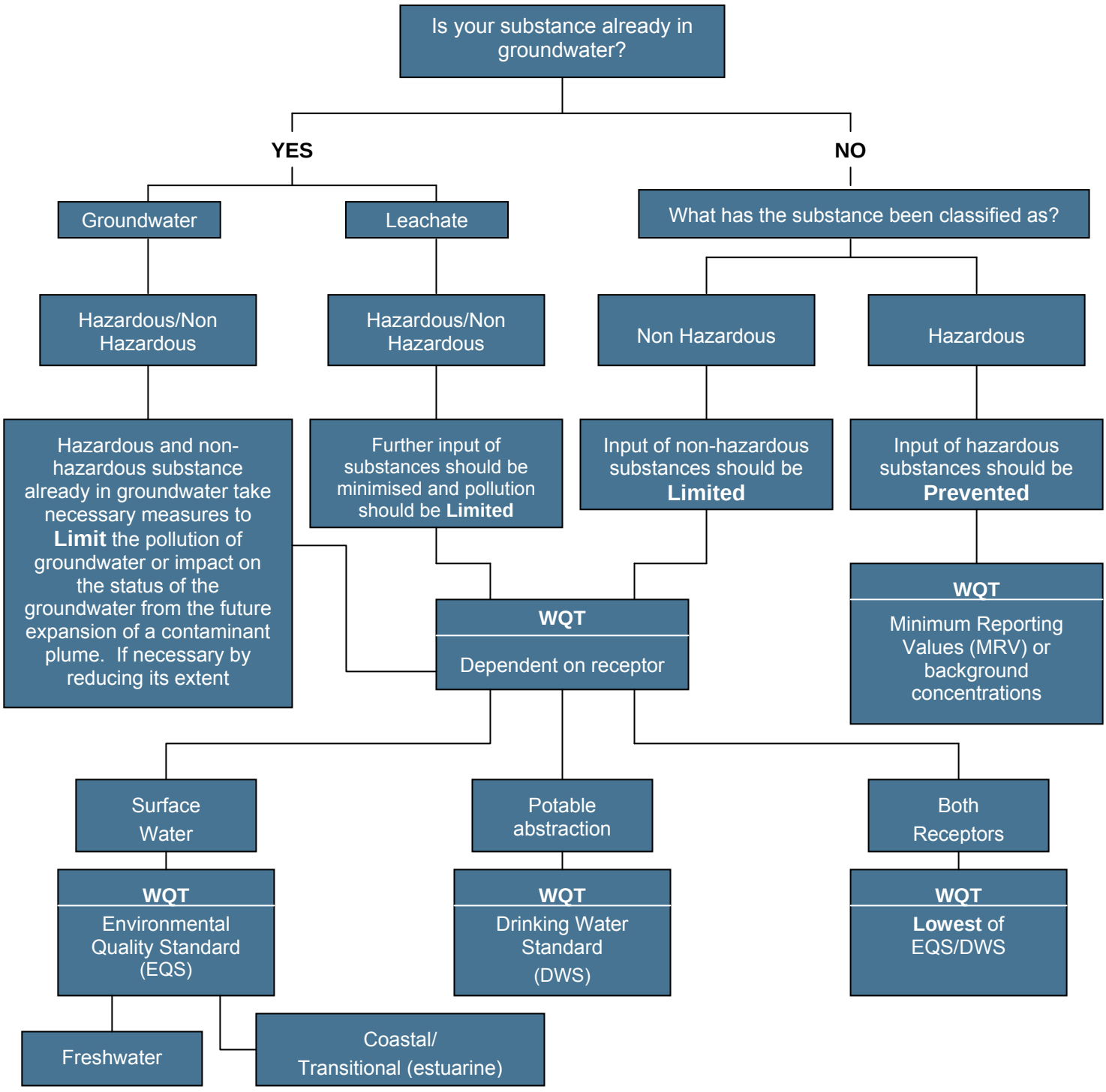
13g. Sum of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene.

14. Council Directive on Pollution Caused by Certain Dangerous Substances Discharged into the Aquatic Environment of the Community (Dangerous Substances Directive) - List II Substances. Council Directive 76/464/EEC and Surface Waters (Dangerous Substances) (Classification) Regulations 1998

15. Council Directive on the Quality of Fresh Waters Needing Protection or Improvement in Order to Support Fish Life (Freshwater Fish Directive). Surface Waters (Fishlife) (Classification) Regulations 1997.

Note: '-' A target concentration is not available.

FLOW CHART TO ASSIST WITH SELECTION OF TARGET CONCENTRATIONS



WQT = Water Quality Target

When leachate is being assessed the 'compliance point' is the groundwater body. Therefore dilution within the groundwater body may be applied with caution before comparing with the WQT.

When directly assessing a receptor, e.g., a river, the appropriate WQT should be selected.

APPENDIX J
GENERIC ASSESSMENT CRITERIA FOR POTABLE WATER SUPPLY PIPES

A range of pipe materials is available and careful selection, design and installation is required to ensure that water supply pipes are satisfactorily installed and meet the requirements of the Water Supply (Water Fittings) Regulations 1999 in England and Wales, the Byelaws 2000 in Scotland and the Northern Ireland Water Regulations. The regulations include a requirement to use only suitable materials when laying water pipes and laying water pipes without protection is not permitted at contaminated sites. The water supply company has a statutory duty to enforce the regulations.

Contaminants in the ground can pose a risk to human health by permeating potable water supply pipes. To fulfil their statutory obligation, UK water supply companies require robust evidence from developers to demonstrate either that the ground in which new plastic supply pipes will be laid is free from specific contaminants, or that the proposed remedial strategy will mitigate any existing risk. If these requirements cannot be demonstrated to the satisfaction of the relevant water company, it becomes necessary to specify an alternative pipe material on the whole development or in specific zones.

In 2010, UK Water Industry Research (UKWIR) published *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (Report Ref. No. 10/WM/03/21). This report reviewed previously published industry guidelines and threshold concentrations adopted by individual water supply companies.

The focus of the UKWIR research project was to develop clear and concise procedures, which provide consistency in the pipe selection decision process. It was intended to provide guidance that can be used to ensure compliance with current regulations and to prevent water supply pipe failing prematurely due to the presence of contamination.

The report concluded that in most circumstances only organic contaminants pose a potential risk to plastic pipe materials and Table 3.1 of the report provides threshold concentrations for polyethylene (PE) and polyvinyl chloride (PVC) pipes for the organic contaminants of concern. The report also makes recommendations for the procedures to be adopted in the design of site investigations and sampling strategies, and the assessment of data, to ensure that the ground through which water supply pipes will be laid is adequately characterised.

Risks to water supply pipes have therefore been assessed against the threshold concentrations for PE and PVC pipe specified in Table 3.1 of Report 10/WM/03/21, which have been adopted as the GAC for this linkage and are reproduced in Table A3 below.

Since water supply pipes are typically laid at a minimum depth of 0.75m below finished ground levels, sample results from depths between 0.5m and 1.5m below finished level are generally considered suitable for assessing risks to water supply. Samples outside these depths can be

used, providing the stratum is the same as that in which water supply pipes are likely to be located. The report specifies that sampling should characterise the ground conditions to a minimum of 0.5m below the proposed depth of the pipe.

It should be noted that the assessment provided in this report is a guide and the method of assessment and recommendations should be checked with the relevant water supply company.

Table A3: Generic assessment criteria for water supply pipes

		Pipe material	
		GAC (mg/kg)	
	Parameter group	**PE**	**PVC**
1	Extended VOC suite by purge and trap or head space and GC-MS with TIC (Not including compounds within group 1a)	0.5	0.125
1a	• BTEX + MTBE	0.1	0.03
2	SVOCs TIC by purge and trap or head space and GC-MS with TIC (aliphatic and aromatic C_5–C_{10}) (Not including compounds within group 2e and 2f)	2	1.4
2e	• Phenols	2	0.4
2f	• Cresols and chlorinated phenols	2	0.04
3	Mineral oil C_{11}–C_{20}	10	Suitable
4	Mineral oil C_{21}–C_{40}	500	Suitable
5	Corrosive (conductivity, redox and pH)	Suitable	Suitable
Specific suite identified as relevant following site investigation			
2a	Ethers	0.5	1
2b	Nitrobenzene	0.5	0.4
2c	Ketones	0.5	0.02
2d	Aldehydes	0.5	0.02
6	Amines	Not suitable	Suitable
Notes: where indicated as ‘suitable’, the material is considered resistant to permeation or degradation and no threshold concentration has been specified by UKWIR.			

APPENDIX K
CERTIFICATES OF GEOTECHNICAL ANALYSIS

TESTING VERIFICATION CERTIFICATE

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: **12/09/2013 12:08:04**.

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

Approved Signatory
Mark Athorne (Laboratory Quality Manager)

STRUCTURAL SOILS
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Contract:	Job No:
Rockingham	**780970**

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 780970 R02

Date 12-September-2013 Contract Rockingham

Client RSK Environment Ltd
Address Spring Lodge
172 Chester Road
Helsby
Cheshire WA6 0AR

For the Attention of Claire Lawrence

Samples submitted by client	01/08/2013	Client Reference	321393
Testing Started	01/08/2013	Client Order No.	
Testing Completed	29/08/2013	Instruction Type	Written

Ukas Accredited Tests Underatken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4
Particle Size Distribution wet sieve method BS1377:Part 2:1990,clause 9.2
Dry density/moisture content relationship 2.5kg rammer method BS1377:Part 4:1990 clause 3.3/3.4
Dry density/moisture content relationship 4.5kg rammer method BS1377:Part 4:1990 clause 3.5/3.6

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of

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
BH3	1	D	0.30	9.0	47	22	25	48	Grey slightly sandy slightly gravelly CLAY
BH7	1	D	0.40	7.5	39	21	18	72	Grey brown slightly sandy slightly gravelly CLAY

STRUCTURAL SOILS LTD

Contract: **Rockingham**

Contract Ref: **780970**

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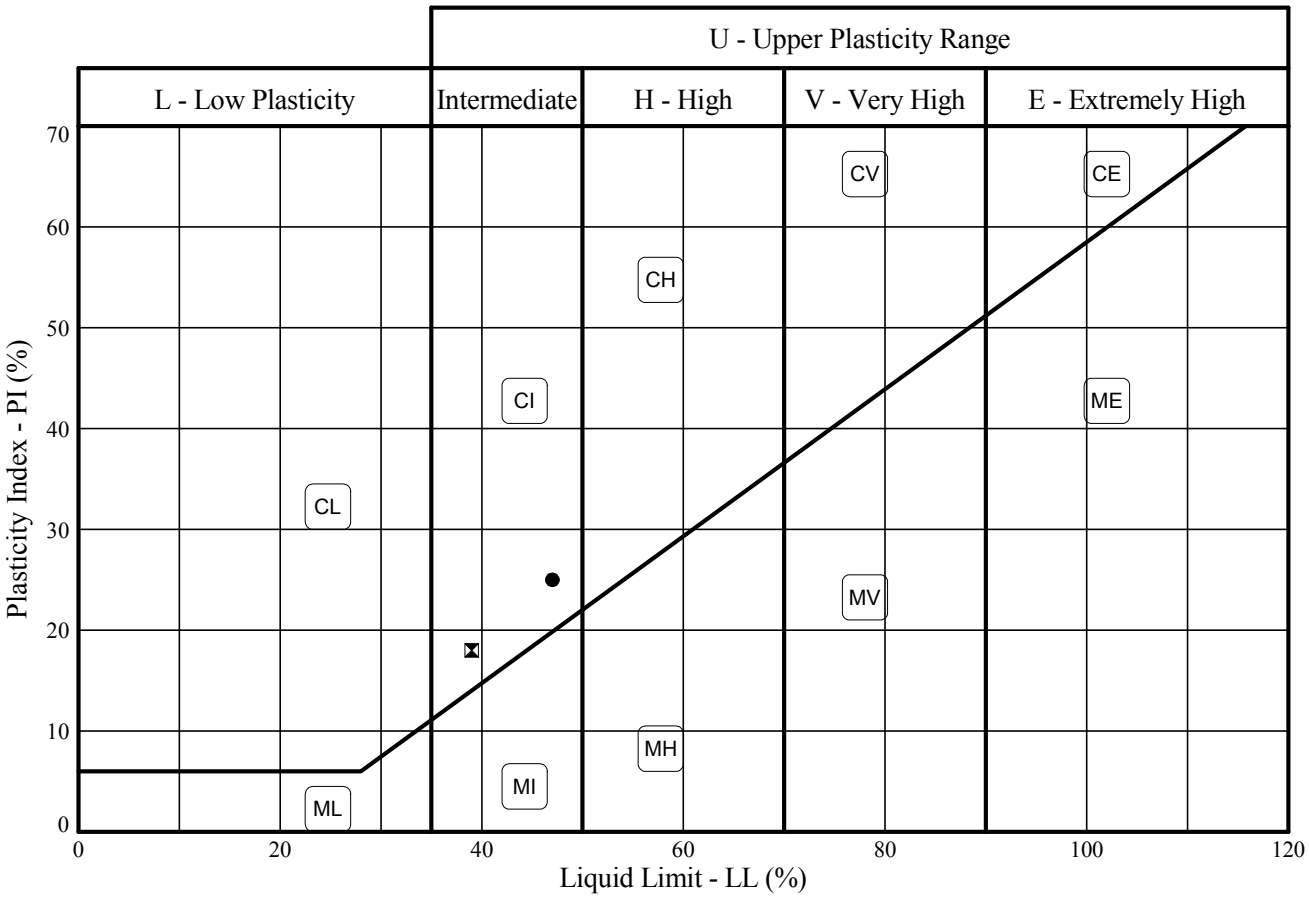
PLASTICITY CHART - PI Vs LL

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)							
●	BH3	1D	0.30	3.2/4.3/5.3/5.4	4.2.4	9.0	47	22	25	48
⊠	BH7	1D	0.40	3.2/4.3/5.3/5.4	4.2.4	7.5	39	21	18	72

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 J. BARRETT M. ATHORNE A. FROST M. RANDERSON R. CLARKSON M. FISHER C. COLE

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Compiled By		Date
C Cole	CATHERINE COLE	28/08/13

Contract	Contract Ref:
Rockingham	**780970**

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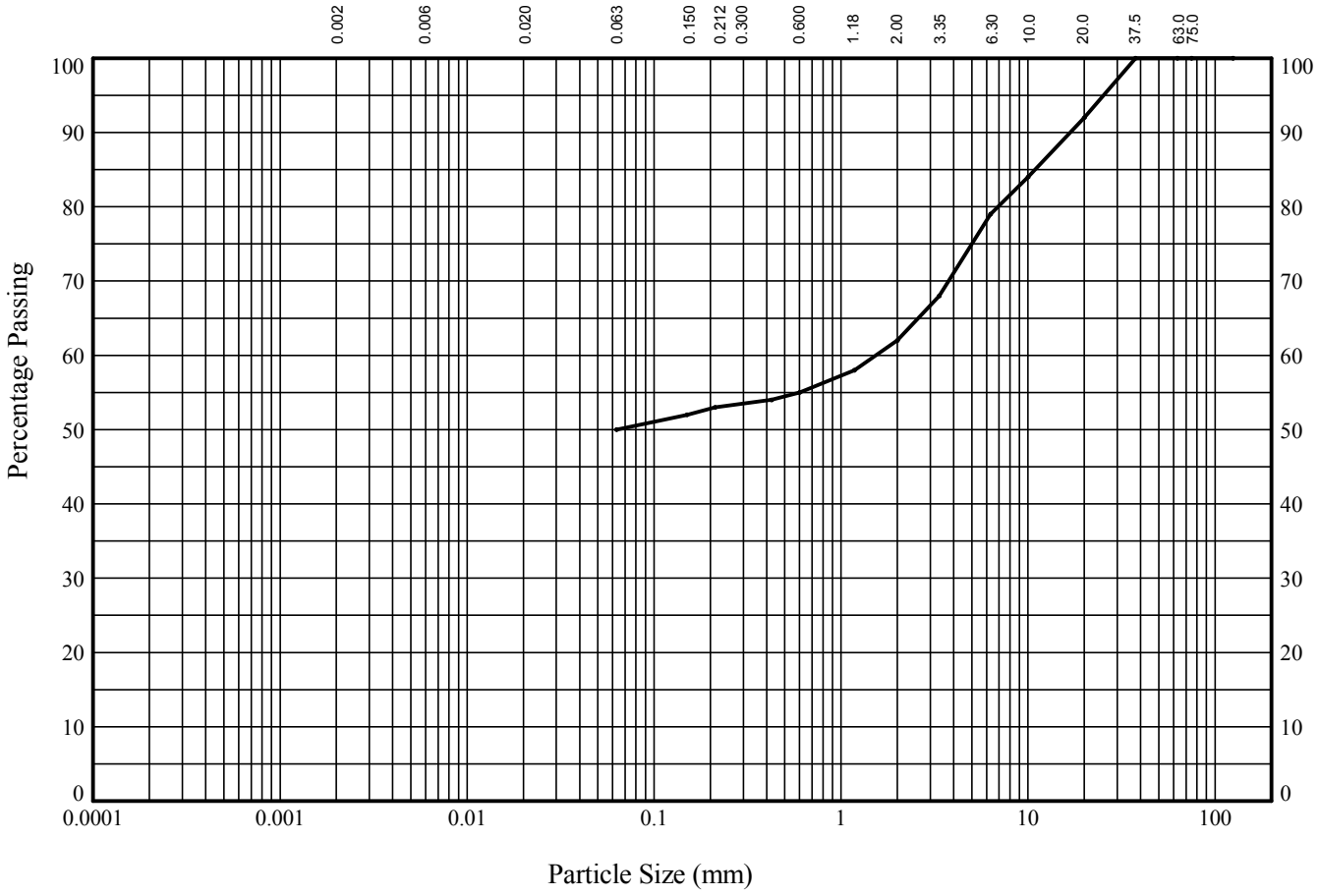
PARTICLE SIZE DISTRIBUTION TEST

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

Borehole : **BH2** Sample Ref: **1** Sample Type: **B** Depth (m): **4.50**



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	92
10.0	84
6.30	79
3.35	68
2.00	62
1.18	58
0.600	55
0.425	54
0.212	53
0.150	52
0.063	50

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**38**
SAND	**12**
SILT/CLAY	**50**

Soil Description:
Grey slightly sandy gravelly CLAY

Approved Signatories: D. TROWBRIDGE J. BARRETT M. ATHORNE A. FROST M. RANDERSON R. CLARKSON M. FISHER C. COLE

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Contract	Contract Ref:
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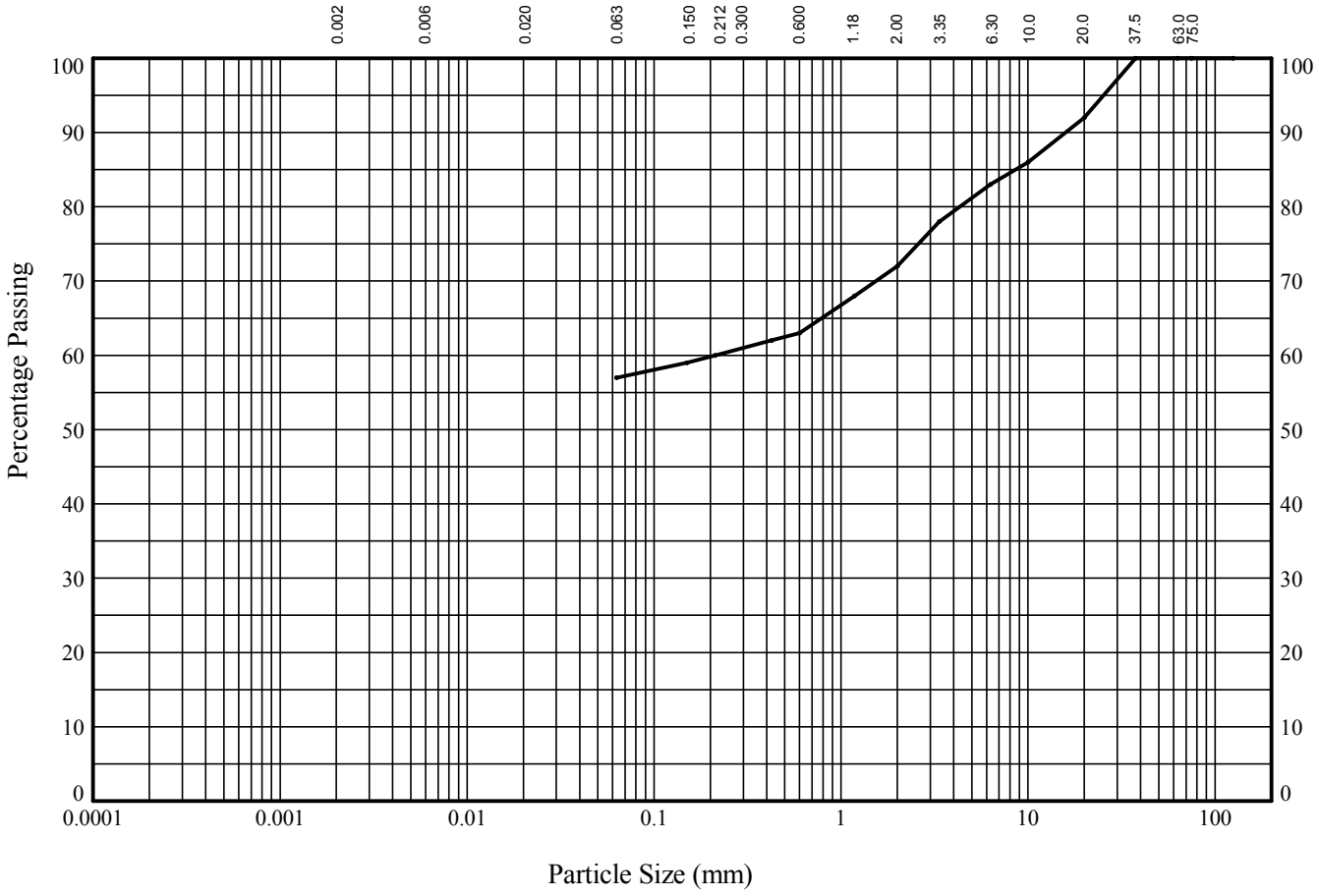
PARTICLE SIZE DISTRIBUTION TEST

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

Borehole : **BH3** Sample Ref: **2** Sample Type: **B** Depth (m): **3.00**



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	100
20.0	92
10.0	86
6.30	83
3.35	78
2.00	72
1.18	68
0.600	63
0.425	62
0.212	60
0.150	59
0.063	57

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**28**
SAND	**15**
SILT/CLAY	**57**

Soil Description:
Grey slightly sandy slightly gravelly CLAY

Approved Signatories: D. TROWBRIDGE J. BARRETT M. ATHORNE A. FROST M. RANDERSON R. CLARKSON M. FISHER C. COLE

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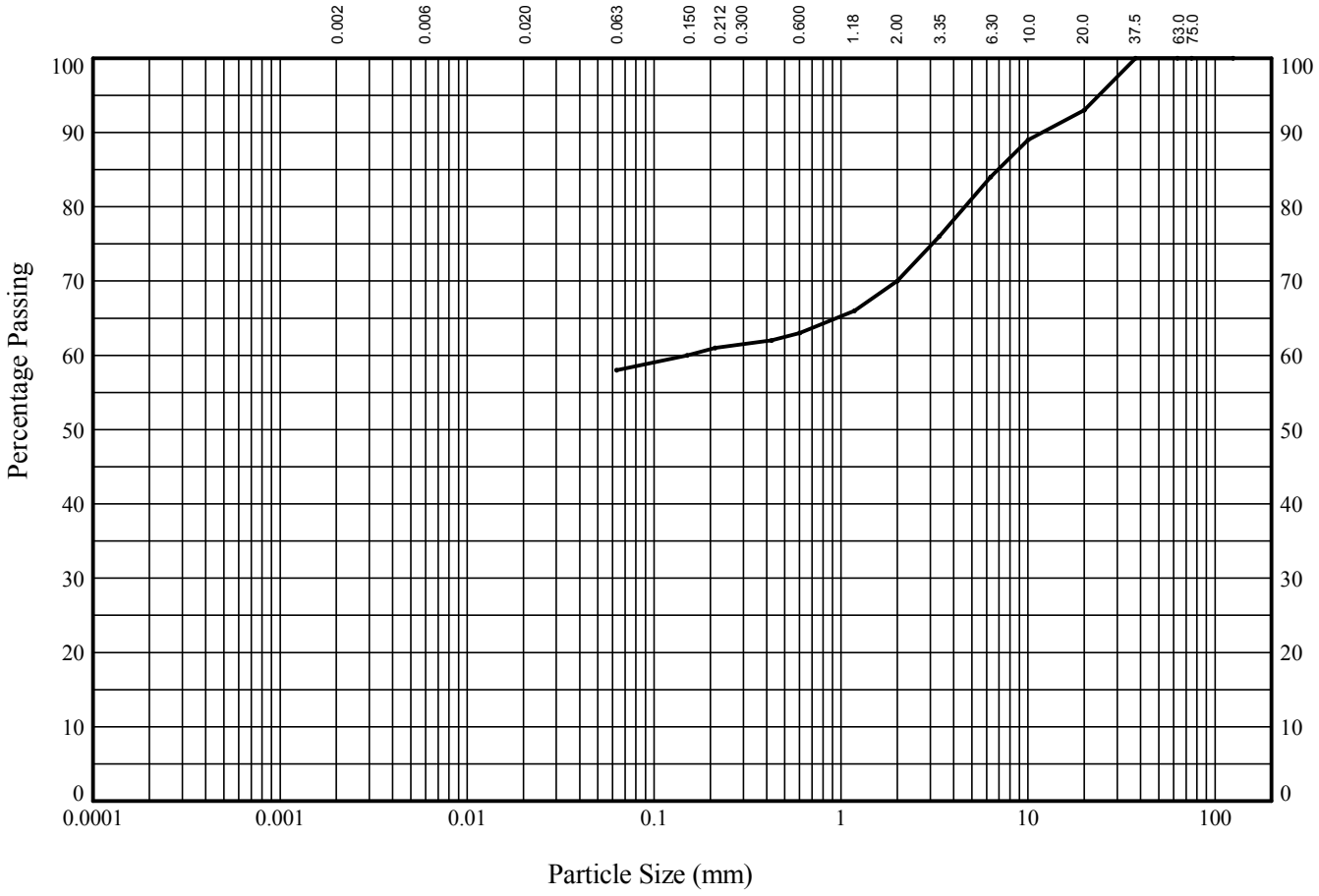
PARTICLE SIZE DISTRIBUTION TEST

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

Borehole : **BH4** Sample Ref: **1** Sample Type: **B** Depth (m): **6.00**



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	100
20.0	93
10.0	89
6.30	84
3.35	76
2.00	70
1.18	66
0.600	63
0.425	62
0.212	61
0.150	60
0.063	58

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**30**
SAND	**12**
SILT/CLAY	**58**

Soil Description:
Grey slightly sandy slightly gravelly CLAY

Approved Signatories: D. TROWBRIDGE J. BARRETT M. ATHORNE A. FROST M. RANDERSON R. CLARKSON M. FISHER C. COLE

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Contract	Contract Ref:
Rockingham	**780970**

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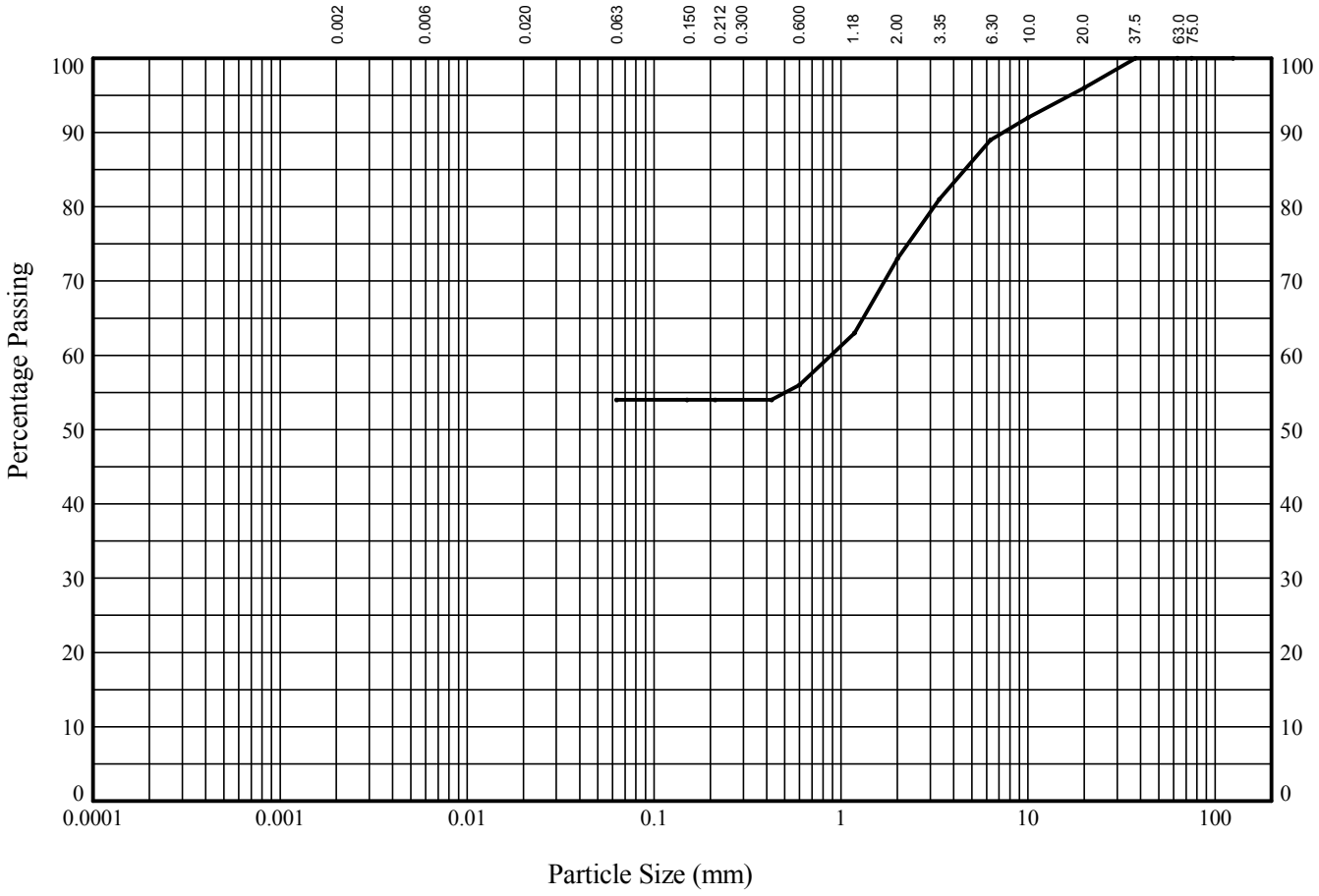
PARTICLE SIZE DISTRIBUTION TEST

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

Borehole : **BH5** Sample Ref: **1** Sample Type: **B** Depth (m): **7.50**



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	96
10.0	92
6.30	89
3.35	81
2.00	73
1.18	63
0.600	56
0.425	54
0.212	54
0.150	54
0.063	54

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**27**
SAND	**19**
SILT/CLAY	**54**

Soil Description:
Grey brown slightly sandy slightly gravelly CLAY

Approved Signatories: D. TROWBRIDGE J. BARRETT M. ATHORNE A. FROST M. RANDERSON R. CLARKSON M. FISHER C. COLE

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Contract	Contract Ref:
Rockingham	**780970**

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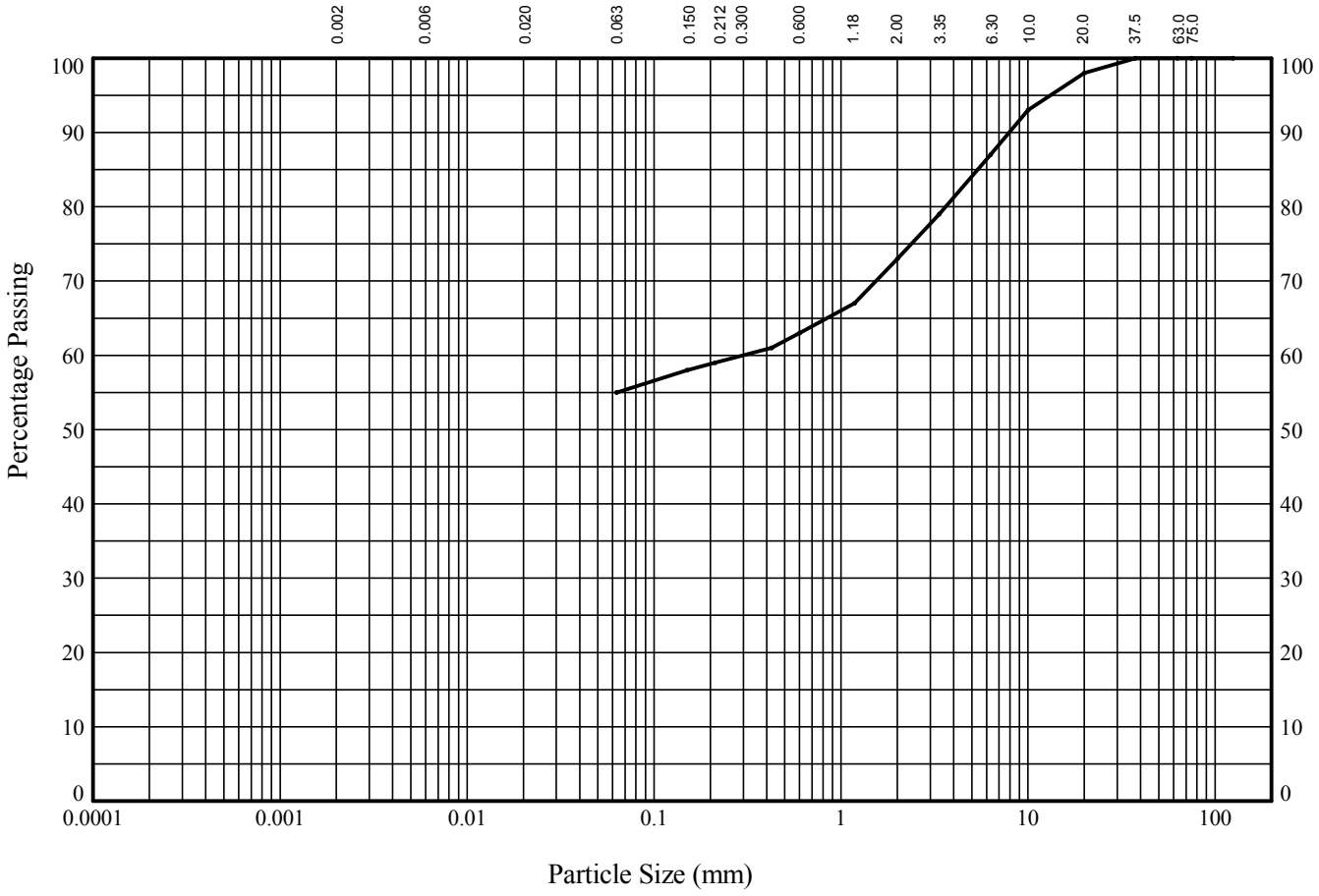
PARTICLE SIZE DISTRIBUTION TEST

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

Borehole : **BH6** Sample Ref: **1** Sample Type: **B** Depth (m): **9.00**



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	100
20.0	98
10.0	93
6.30	87
3.35	79
2.00	73
1.18	67
0.600	63
0.425	61
0.212	59
0.150	58
0.063	55

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**27**
SAND	**18**
SILT/CLAY	**55**

Soil Description:
Grey slightly sandy slightly gravelly CLAY

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Compiled By		Date
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Contract	Contract Ref:
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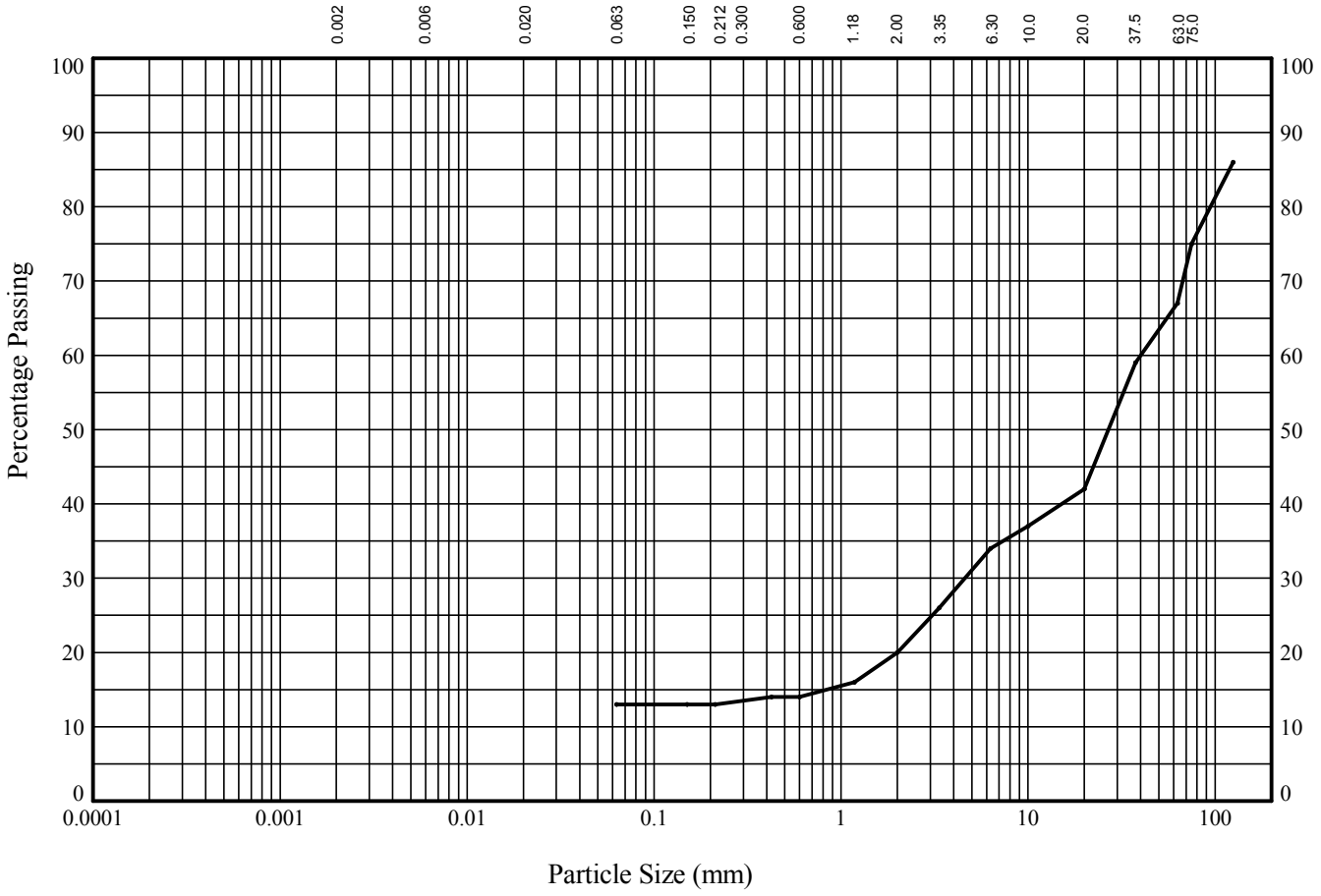
PARTICLE SIZE DISTRIBUTION TEST

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

Trial Pit : **TP8** Sample Ref: **1** Sample Type: **B** Depth (m): **3.30**



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

BS Test Sieve (mm)	Percentage Passing
125.0	86
75.0	75
63.0	67
37.5	59
20.0	42
10.0	37
6.30	34
3.35	26
2.00	20
1.18	16
0.600	14
0.425	14
0.212	13
0.150	13
0.063	13

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
COBBLES	**33**
GRAVEL	**47**
SAND	**7**
SILT/CLAY	**13**

Soil Description:
Grey clayey sandy GRAVEL with some cobbles

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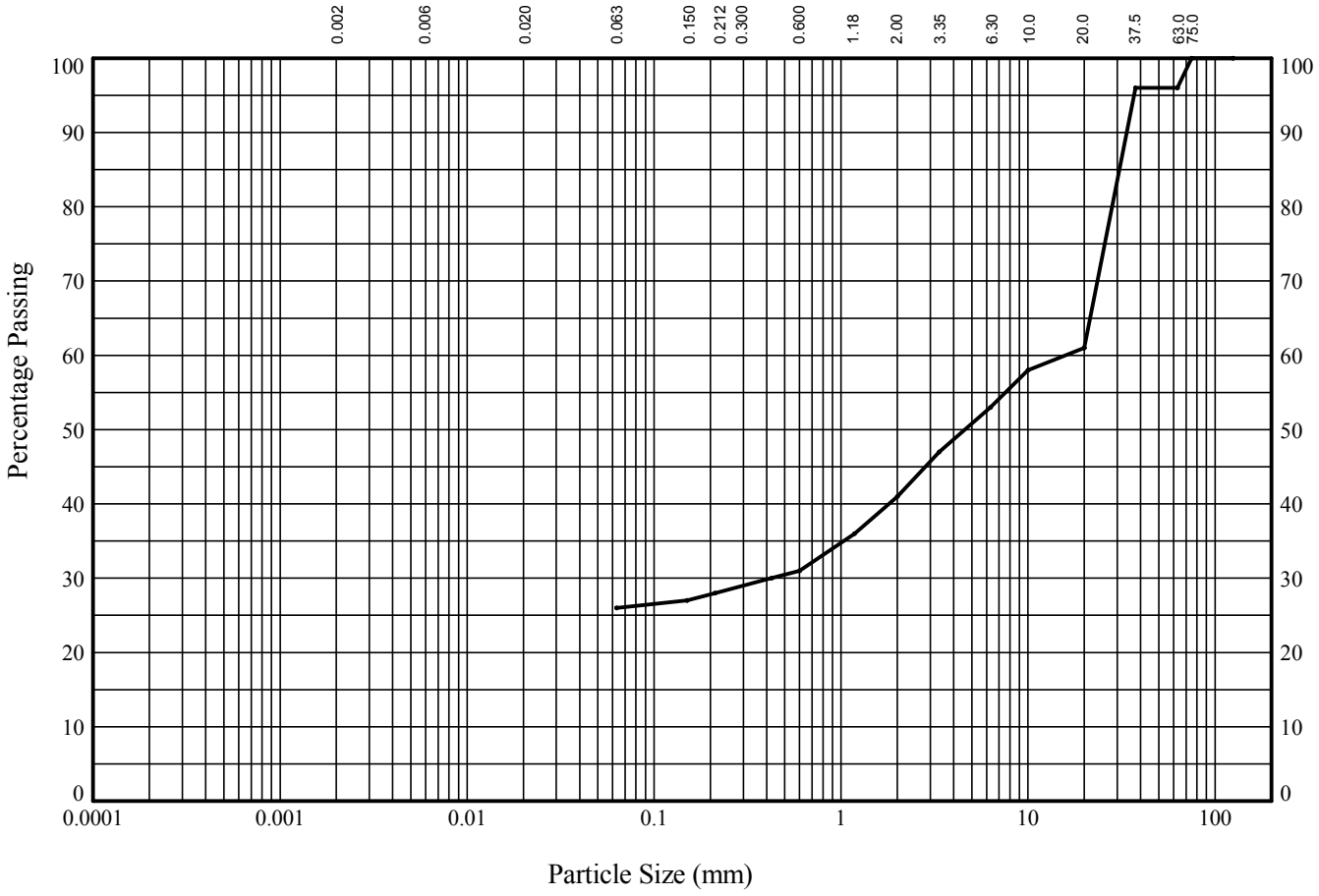
PARTICLE SIZE DISTRIBUTION TEST

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

Trial Pit : **TP13** Sample Ref: **1** Sample Type: **B** Depth (m): **1.20**



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	96
37.5	96
20.0	61
10.0	58
6.30	53
3.35	47
2.00	41
1.18	36
0.600	31
0.425	30
0.212	28
0.150	27
0.063	26

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
COBBLES	**4**
GRAVEL	**55**
SAND	**15**
SILT/CLAY	**26**

Soil Description:
Dark grey slightly sandy gravelly CLAY with occasional cobbles

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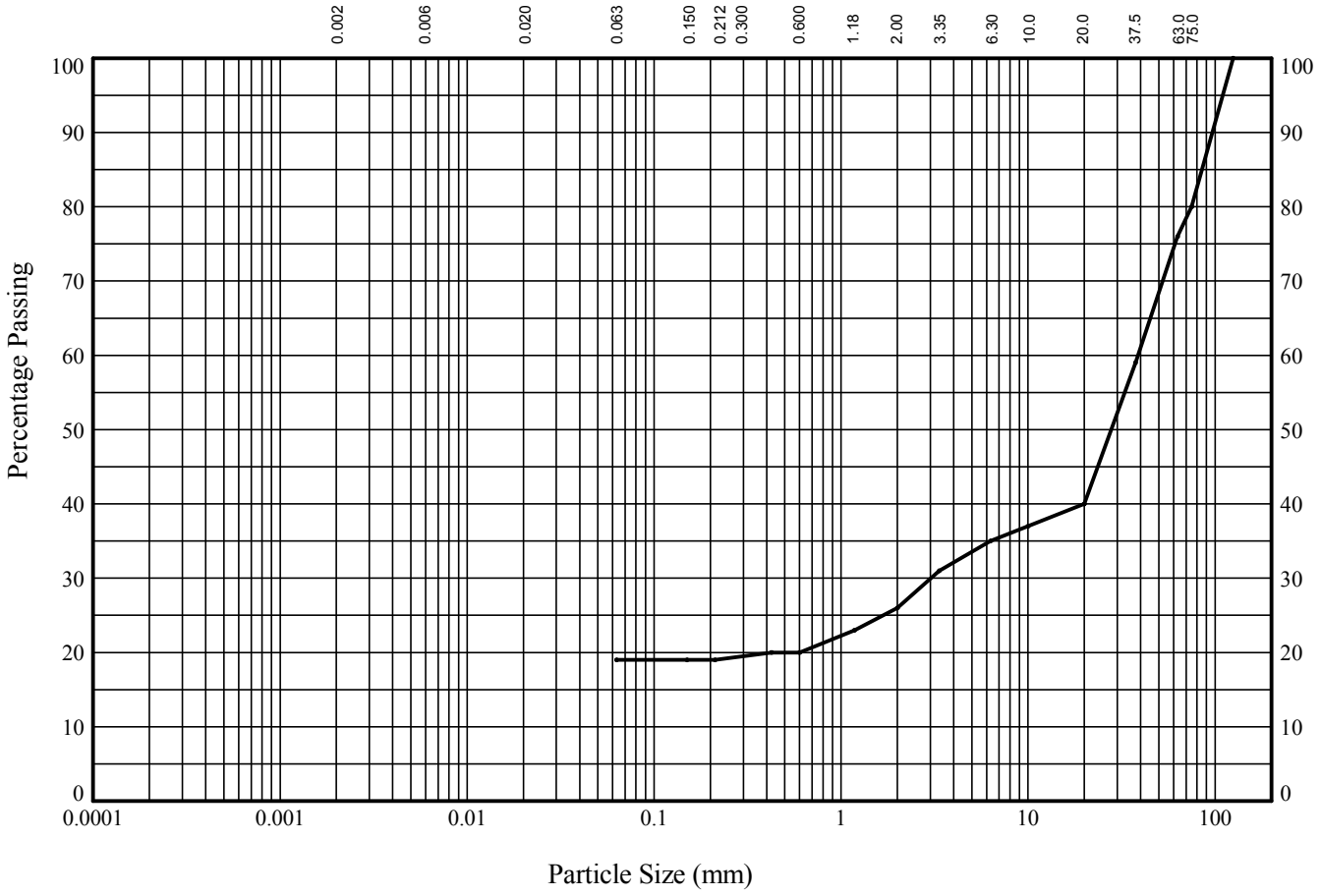
PARTICLE SIZE DISTRIBUTION TEST

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

Trial Pit : **TP15** Sample Ref: **1** Sample Type: **B** Depth (m): **1.70**



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	80
63.0	76
37.5	59
20.0	40
10.0	37
6.30	35
3.35	31
2.00	26
1.18	23
0.600	20
0.425	20
0.212	19
0.150	19
0.063	19

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
COBBLES	**24**
GRAVEL	**50**
SAND	**7**
SILT/CLAY	**19**

Soil Description:
Grey slightly sandy gravelly CLAY with many cobbles

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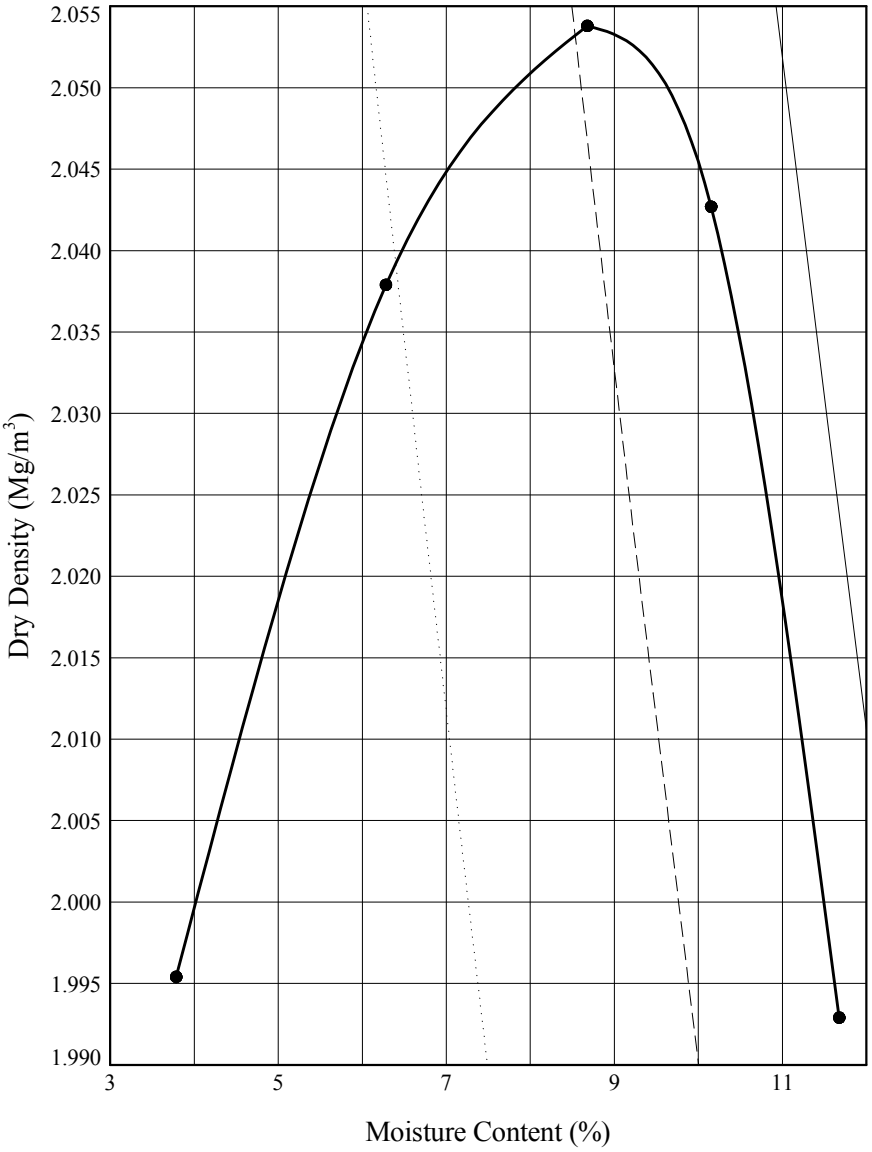
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

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: **B** Depth (m): **2.10**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **8.7**	Compaction Type	: **Heavy**	Maximum Dry Density (Mg/m^3)	: **2.04**
% Retained on 37.5mm BS Sieve	: **0**	Mass of Rammer (kg):	**4.5**	Optimum Moisture Content (%)	: **10**
% Retained on 20.0mm BS Sieve	: **6**	Type of Mould	: **CBR**	Method Used:	**Clause 3.6**
Particle Density - assumed (Mg/m^3)	: **2.65**			Remarks:	
Size of Soil Pieces	: **<20mm**	Separate samples were used.			

Sample Description	Key to Air Voids Lines		
Brown clayey SAND with fine to coarse gravel	——— 0%	– – – – 5%	····· 10%

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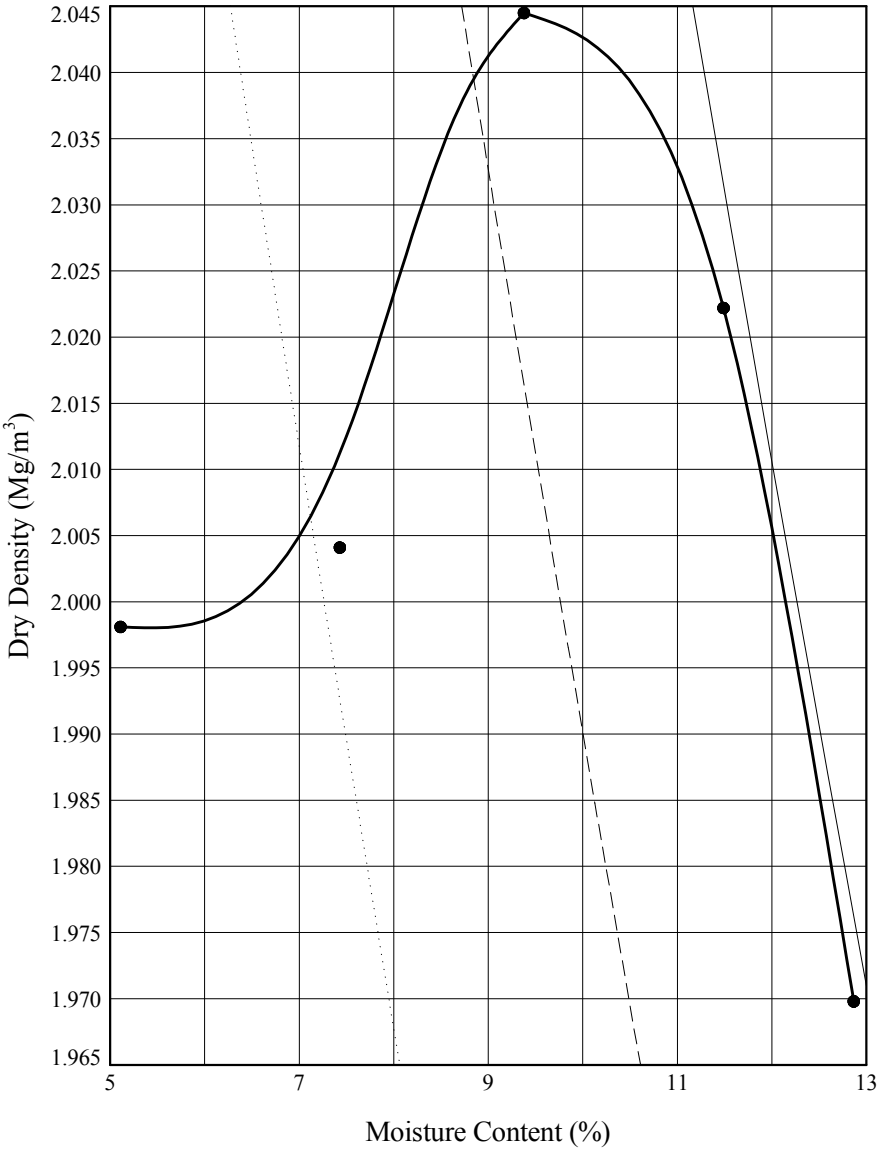
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

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

Trial Pit : **TP4** Sample Ref: **2** Sample Type: **B** Depth (m): **0.30**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **5.1**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m^3)	: **2.04**
% Retained on 37.5mm BS Sieve	: **0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	: **10**
% Retained on 20.0mm BS Sieve	: **30**	Type of Mould	: **CBR**	Method Used: **Clause 3.4**	
Particle Density - assumed (Mg/m^3)	: **2.65**			Remarks:	
Size of Soil Pieces	: **<20mm**	Single sample was used.			

Sample Description	Key to Air Voids Lines		
Grey clay with mudstone	——— 0%	– – – – 5%	····· 10%

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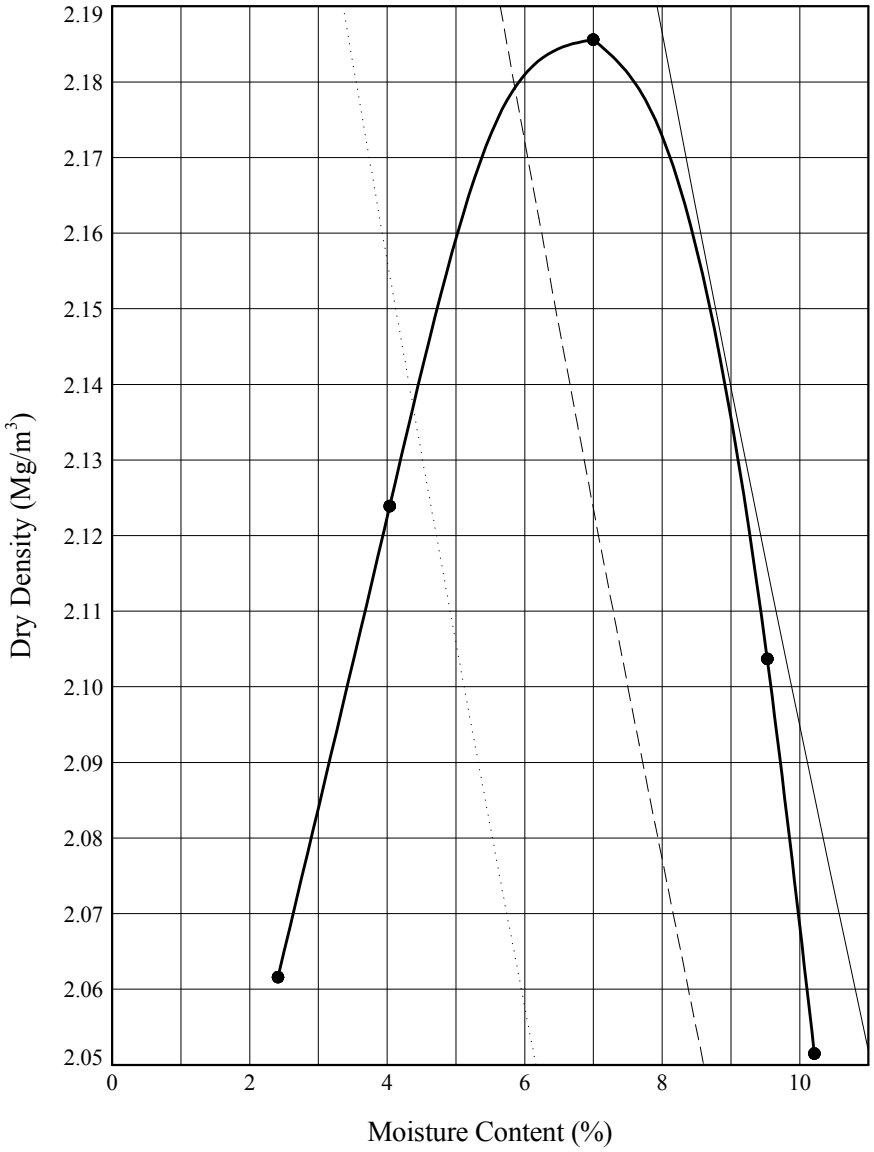
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

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

Trial Pit : **TP7** Sample Ref: **2** Sample Type: **B** Depth (m): **0.50**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **7.0**	Compaction Type	: **Heavy**	Maximum Dry Density (Mg/m^3)	: **2.19**
% Retained on 37.5mm BS Sieve	: **0**	Mass of Rammer (kg):	**4.5**	Optimum Moisture Content (%)	: **7**
% Retained on 20.0mm BS Sieve	: **26**	Type of Mould	: **CBR**	Method Used: **Clause 3.6**	
Particle Density - assumed (Mg/m^3)	: **2.65**			Remarks:	
Size of Soil Pieces	: **<20mm**	Single sample was used.			

Sample Description	Key to Air Voids Lines		
	——— 0%	– – – – 5%	····· 10%

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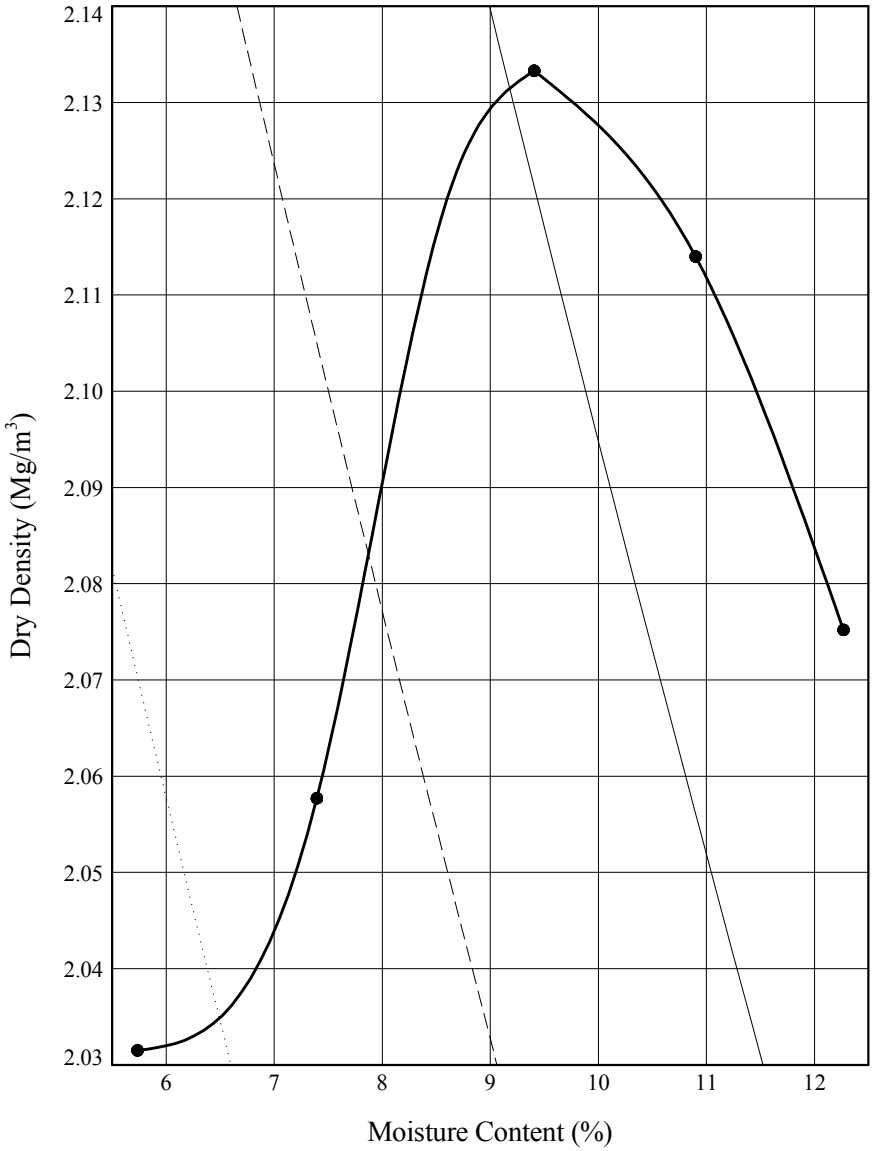
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

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

Trial Pit : **TP12** Sample Ref: **1** Sample Type: **B** Depth (m): **1.80**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **5.7**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	: **2.13**
% Retained on 37.5mm BS Sieve	: **0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	: **9**
% Retained on 20.0mm BS Sieve	: **30**	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		
Grey CLAY/MUDSTONE	——— 0%	– – – – 5%	····· 10%

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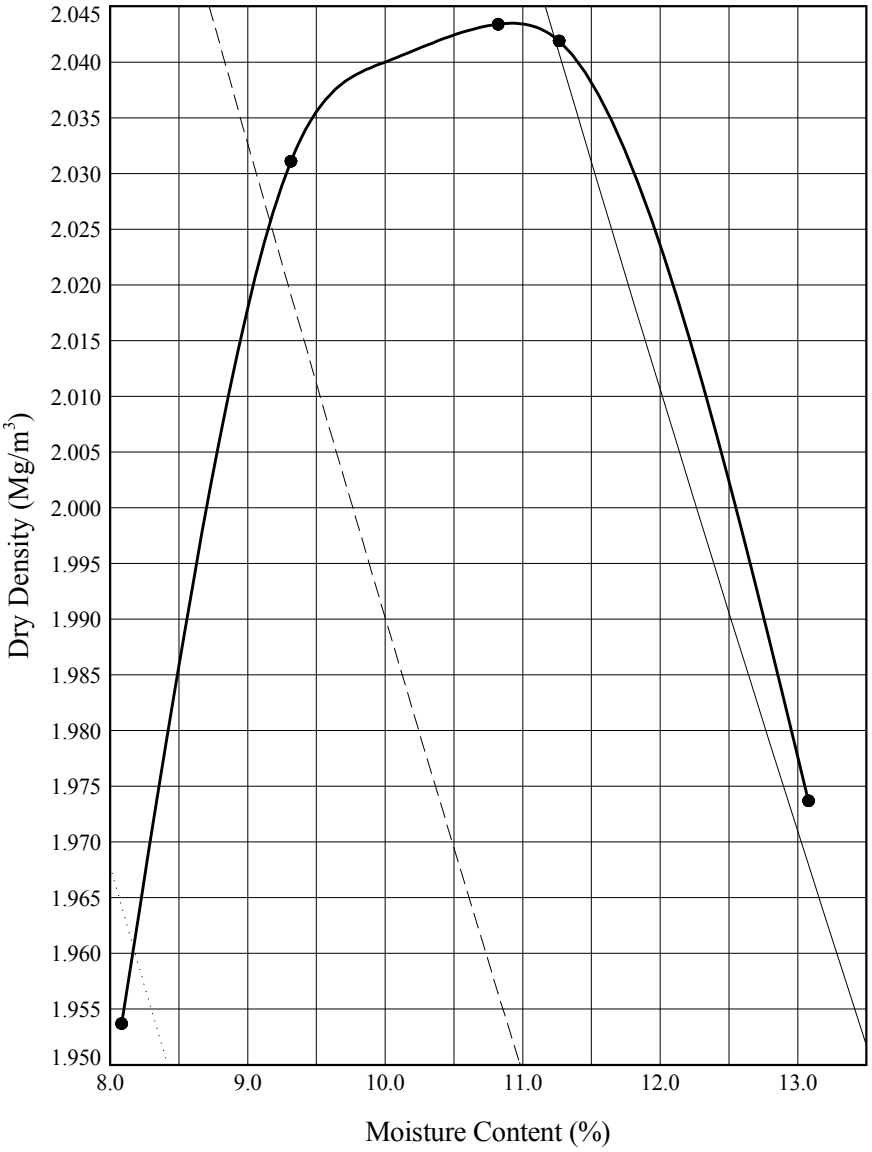
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

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

Trial Pit : **TP14** Sample Ref: **1** Sample Type: **B** Depth (m): **1.40**



Initial Sample Conditions			Test Details			Test Results		
Initial Moisture Content (%)	:	**8.1**	Compaction Type	:	**Light**	Maximum Dry Density (Mg/m³)	:	**2.04**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):		**2.5**	Optimum Moisture Content (%)	:	**11**
% Retained on 20.0mm BS Sieve	:	**29**	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		
Grey CLAY/MUDSTONE	——— 0%	– – – – 5%	····· 10%

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