

**PHASE 2
GEOTECHNICAL AND GEO-ENVIRONMENTAL
SITE INVESTIGATION**

BRADFORD ROAD, BIRKENSHAW

FOR

ROUSE HOMES



41333-002

July 2017

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- Appendix 4** Chemical Test Results (Chemtest Report No. 17/16774)
Residential with Home-grown Produce Assessment Values

EXECUTIVE SUMMARY

1. This report presents the findings of a Phase 2 Geotechnical and Geo-Environmental Site Investigation carried out by Eastwood & Partners for Rouse Homes. A Phase 1 report has previously been produced for the site by others, and should be read in conjunction with this report.
2. The 1.55 hectare site is located east of Bradford Road and north of Oakroyd Drive, in Birkenshaw, Bradford. It comprises the current West Yorkshire Fire and Rescue Headquarters. The main building is understood to contain a basement and generator.
3. A trial pit and borehole investigation has been undertaken. Topsoil was encountered in the south of the site, in the vegetated area in the central and west of the site, and in an embankment in the east of the site. The site is mainly underlain by made ground to depths of up to 0.7 m in the south and 1.1 m in the north. The made ground is underlain by firm to stiff clay and by sandstone in the north and mudstone in the south. Groundwater was not encountered in any of the trial pits or boreholes, although material was noted to be damp in some locations.
4. To the north of the fault, unreinforced strip or trench-fill footings are considered appropriate, taken through any made ground to found onto the natural clay at a minimum depth of 1000 mm below the lowest of the existing or finished ground level.
5. To the south of the fault, drilling and grouting of shallow mine workings will be required. Overlying plots will require reinforced thickened strip or trench fill foundations, taken through any made ground into the natural clay at a minimum depth of 1000 mm below the lowest of the existing or finished ground level.
6. Foundations overlying the fault should also be thickened and reinforced.
7. The natural ground is considered to be able to provide a safe bearing capacity of at least 150 kN/m², which will increase with depth to at least 200 kN/m² within the mudstone or sandstone bedrock.
8. Footings should be deepened in accordance with the NHBC Standards, Chapter 4.2 where plots are within influencing distance of trees. Heave precautions will be required where the footing depth due to past or present trees exceeds 1.5 m.
9. Where there is expected to be less than 600 mm of made ground below the floor, ground bearing slabs are considered appropriate. Otherwise, reinforced suspended or precast

concrete floors with an underlying void will be required. The latter will be required, with an increased void height of 300 mm, where heave precautions are needed.

10. Cohesive soils were encountered across the site, therefore soakaways are not considered viable.
11. Two gas monitoring wells have been installed in the centre of the site. A gas monitoring regime is currently being undertaken.
12. No radon precautions are required.
13. The results of the chemical testing undertaken indicate that the granular made ground in the north of the site locally contains elevated concentrations of arsenic and polycyclic aromatic hydrocarbons. It is recommended that the affected made ground is capped with a minimum of 600 mm of clean soil in gardens and landscaped areas or placed below hardstanding.
14. Arsenic was found to be elevated in three samples of topsoil. Additional testing is considered to demonstrate that the arsenic will not pose significant risks and therefore the topsoil is suitable for re-use.
15. Significant risks to controlled waters are not expected, and any slight risk to plant growth presented by the made ground will be mitigated through the measures outlined above.
16. It is considered that DS-3 AC-3 sulphate precautions should be used for concrete in contact with the made ground. Class DS-1 AC-2z is appropriate where concrete is in contact with the natural ground only.
17. It is recommended the chemical test results are forwarded to the water company to advise on the types of water supply pipes that need to be installed at the site.
18. The conclusions made in this report are subject to agreement by the approving bodies, such as the Local Authority and your warranty provider.

1.0 INTRODUCTION

1.1 Terms of Reference

This report presents the findings of a Phase 2 intrusive geotechnical and geo-environmental site investigation carried out by Eastwood & Partners (Consulting Engineers) Ltd for, and on behalf of, Rouse Homes. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

1.2 Context

A Phase 1 Land Quality Assessment has previously been prepared by PSA Design Limited in August 2014, referenced H1795-GR-01. This report will be referenced where applicable.

1.3 Aims and Objectives

The aims and objectives of this investigation were as follows:

- To detail the ground conditions and their geotechnical properties enabling outline foundation proposals to be made for the proposed residential development;
- To undertake chemical testing enabling refinement and subsequent further testing of the conceptual model;
- To carry out tiered risk assessment to establish the likely risks to future receptors, involving the use of generic assessment criteria and where unacceptable risks are identified, site specific assessment criteria within a detailed quantitative risk assessment;
- To identify feasible remediation options if unacceptable risks are highlighted; and
- To develop an appropriate remediation strategy where remediation is required.

1.4 Scope of Investigation

The Phase 2 investigation consisted of intrusive works and laboratory analysis. The findings were used to test the conceptual model and produce a final risk assessment.

The intrusive works comprised the completion of trial pits to enable:

- Examination of the upper few metres of ground;
- In situ description of soils, enabling any localised lateral and vertical changes in soil conditions to be logged;

- Assessment of any contamination identified using visual and olfactory methods; and
- Collection of soil samples for geotechnical and chemical testing.

Drilling of rotary boreholes to confirm the depth, thickness and condition of coal seams beneath the site was also undertaken. Gas monitoring wells have also been installed and a programme of gas monitoring is ongoing.

1.5 Limitations of Investigation

This report is based on the assumption that the site will be developed with residential properties of conventional construction with private gardens and areas of soft landscaping and that existing ground levels will not alter significantly. If this is not the case, further advice may be needed.

Where assessments of site areas affected in particular ways are given, these are approximate. All information, comments and opinions given in this report are based on the ground conditions encountered during the site work, on the results of laboratory testing carried out as part of the investigation and information gained from a geological, environmental and historical desk study. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata and water conditions between or below investigation points. It should be noted that groundwater and gas levels vary due to seasonal or other effects, and may at times differ from those measured during the investigation.

This report only considers the ground and groundwater and does not cover any buildings or their fabric or any existing hardstanding materials. Generally, testing has only been carried out for contaminants identified as potentially present with no assessment made of biological contamination. Risks to ecological receptors, such as bats, have not been considered.

2.0 THE SITE

The around 1.55 hectare site is located east of Bradford Road and north of Oakroyd Drive, in Birkenshaw, approximately 4 miles south east of Bradford. The site is centred on grid reference 420204, 428079 and is irregular in shape.

The site slopes from around 175 m in the north east down to around 168 m in the south east, at an approximate gradient of 1 in 28.

The site currently comprises the current West Yorkshire Fire and Rescue Headquarters. A large disused building is present in the north of the site, with several former houses present in the east and south of the site. The building in the north is understood to contain a basement and generator, with the remaining buildings converted from former housing to offices and storerooms.

Oakroyd Close runs roughly north to south east through the site, connecting the large building in the north of the site to Oakroyd Drive immediately south of the site. Hardstanding areas are present surrounding the building in the north and adjacent to the buildings in the east and south. A large vegetated area is present in the centre and west of the site, including mature trees approximately 10 m to 20 m in height.

We understand a full asbestos survey has been undertaken, and that any asbestos containing materials are due to be removed under controlled conditions by a specialist prior to demolition.

The surrounding area comprises residential developments to the north east, east and south, with a farm to the west and the remainder agricultural land.

3.0 SUMMARY OF PHASE 1 REPORT

A Phase 1 Land Quality Assessment has previously been undertaken for the site by PSA Design Limited, in August 2014 (reference H1795-GR-01). The pertinent points raised by the previous report are summarised in the following sections.

3.1 Site History

The earliest Ordnance Survey map, dated 1852 to 1854 (1:10,560 scale), shows the site to comprise two agricultural fields, these are incorporated into the gardens of Oakroyd Hall to the west of the site by 1892. There are no significant changes until 1955 when a large building and two smaller buildings are constructed in the north of the site. By 1970 the buildings have been named as WRCC Fire Service HQ. Oakroyd Close has been constructed and there are houses in the south and east of the site. The site then remains the same to the present day.

The surrounding land was mainly of agricultural use, with Halfway House Colliery 100 m south of the site and Blackbed & Fleece Collieries 150 m south east of the site until approximately 1892 when Oakroyd Hall was built 75 m west of the site. The hall had large gardens and wooded areas. Marsh Lane was constructed adjacent to the north western site boundary. The previously named collieries have closed by 1892. However, Oakroyd Colliery 250 m south west of the site has been opened and is then shown as closed by 1905. In the 1930's residential development occurs adjacent to the eastern boundary of the site and by 1955 Oakroyd Hall is renamed WRCC Ambulance HQ. In the 1960's a police station is built to the south east of the site and large buildings associated with the Fire Service are constructed west and south of the site.

3.2 Geology and Hydrogeology

The geological maps show the site to be underlain by Middle Coal Measures which dip at between 5° and 7° towards the north east. A fault orientated north east to south west crosses through the northern third of the site and downthrows to the south. To the north of the fault the solid geology is anticipated to be sandstone. To the south of the fault it is anticipated to be undifferentiated mudstones.

Groundwater is generally not expected to be found at shallow depth.

The underlying bedrock is identified as a Secondary A aquifer, and the site does not lie within a Groundwater Source Protection Zone.

3.3 Coal Mining

North of the fault

The Middleton Eleven Yards coal is shown to outcrop 50 m west of the site, orientated north to south. It is anticipated to be 1.5 m thick and dip to the east, with a depth of approximately 6.5 m below the north western boundary. The geological memoir indicates that the seam is dying out in this area. Within the detailed 1.5 m section, there are significant dirt or earth bands between not more than 0.08 m thick bands of coal. Therefore, it is not anticipated to be significantly worked below the site.

The next seam below the north of the site is anticipated to be the Blocking Bed coal. This is anticipated to be 0.8 m thick at a depth of 38 m below the site. The geological memoir indicates that seam is fair quality coal which has been worked near outcrop and is separated into three parts, by dirt bands.

South of the site

The Two Yards Bed is shown to outcrop 200 m south west of the site, orientated east to west. It is anticipated to be 1.8 m thick and dips to the north east, with a depth of approximately 21 m below the south and east of the site.

The geological memoir indicates that a large wash out within this seam means that it is not present over much of the area, however where it is present, it has been worked. The geological map shows several mine entries to the Two Yards Bed, within 100 m of the south and east of the site.

The next seam below the south of the site is anticipated to be Middleton Little coal. This is anticipated to be up to 0.2 m thick in this area and at a depth of around 36 m below the site. The seam is also noted to be of no value, therefore is unlikely to have been worked.

The Coal Authority report states that the property is in the likely zone of influence from workings in three seams of coal at 50 m to 180 m depth and last worked in 1919. It also records that there is coal at or close to the surface. This coal may have been worked at some time in the past. There are no known coal mine entries within the boundary of the site.

3.4 Ground Gas

Radon protective measures are not required.

There are no active or historic landfills within 500 m of the site.

Made ground is present across the surface of the site; however this is not expected to extend to significant depth.

Due to the potential presence of coal mining below the site there is a low risk of associated ground gases.

3.5 Flooding

According to the Groundsure report, the site is not within 250 m of an area at risk of flooding as identified in the Environment Agency database.

A Flood Risk Assessment has been undertaken for the site by PSA Design Limited, in June 2015 (reference H1795-FRA-01 Rev A).

3.6 Outline Conceptual Model

The following table details the possible sources and associated contaminants of concern, pathways and receptors, potentially present.

Source	Potential Contaminants	Potential Pathways	Potential Receptors
Made ground	- Heavy metals/metalloids, PAHs - Asbestos	Ingestion, inhalation, direct contact	- Future residents and visitors - Site construction workers - Plants
		Direct contact	Water supply pipes
		Migration through ground	Secondary A aquifer
	Sulphates	Direct contact	Sub-surface concrete structures
Fuel spills/leaks from vehicles using the site in the past or from previous diesel generator.	Hydrocarbons, PAH, BTEX compounds	Ingestion, inhalation, migration through ground, direct contact	- Future residents and visitors - Site construction workers - Plants - Water supply pipes - Secondary A aquifer
Ground/ Groundwater migration from off-site sources – including workshop, garage and electricity sub-stations.	Metalloids, PAHs, PCBs, Hydrocarbons	Ingestion, inhalation, migration through ground, direct contact	- Future residents and visitors - Site construction workers - Plants - Water supply pipes - Secondary A aquifer
Mine workings.	Methane and carbon dioxide	Inhalation	- Future residents and visitors - Site construction workers - Buildings

4.0 GROUND INVESTIGATION

4.1 Site Works

The site works were undertaken on 26 June 2017. Eleven trial pits, referenced TP1 to TP11, were excavated to determine the underlying ground conditions across the site. The trial pits reached depths of between 1.5 m and 2.9 m below ground level (bgl).

A rotary drilling investigation was also undertaken on the 26 and 27 June. Five rotary boreholes, referenced BH1 to BH5, were drilled to determine the depth and condition of the coal seams beneath the site. The boreholes reached depths of between 15 m and 30 m bgl.

Copies of the trial pit and borehole logs are presented in Appendix 2 and their locations are shown on the Exploratory Hole Location Plan, Drawing number 41333/001A in Appendix 1.

4.2 Laboratory Testing

Four samples of natural clay were sent for plasticity testing to Professional Soils Laboratory. The geotechnical test results are discussed in Section 6 and copies of the test certificates are included in Appendix 3.

Six samples of topsoil, seven samples of the made ground and six samples of natural ground were despatched for chemical testing. Soil samples were taken in 500 g plastic tubs and 250 ml amber glass jars and were analysed at Chemtest Limited, using MCERTs accredited methodologies where available. The chemical test results are presented in Appendix 4 and discussed further in Sections 7 and 8.

5.0 GROUND CONDITIONS

5.1 Surface Covering

Topsoil was encountered in TP1 to TP3 in the south of the site, TP6 to TP8 in the vegetated area in the central and west of the site, and TP11 in an embankment in the east of the site. The topsoil comprised sandy slightly gravelly clay, with gravel content varying across the site and including sandstone, brick fragments, occasional glass and roof tile fragments. This was recorded to depths of between 0.1 m to 0.4 m bgl.

A surface covering of made ground was encountered in the remainder of the trial pits and boreholes. In TP4 in the east of the site this comprised compacted gravel to a depth of 0.3 m bgl. In TP5, TP9 and TP10 in the hardstanding area in the north of the site a surface covering of macadam typically 0.1 m in thickness was present, over compacted gravel to depths of between 0.3 m and 0.5 m bgl.

5.2 Made Ground

Beneath the topsoil or surface covering of made ground, friable reworked clay, often found to be gravelly, was encountered in all trial pits except TP6 to TP8 in the central vegetated area. The made ground was shallower in the south, recorded to depths of between 0.4 m to 0.7 m, whereas beneath TP5, TP9 and TP10 in the north it was recorded to depths of between 1 m to 1.1 m bgl. In TP11 in the embankment in the east of the site, made ground comprising gravelly reworked clay was encountered to 1.8 m bgl, and included clinker, brown stained rubble and occasional timber and organic fragments.

5.3 Natural Ground

Natural ground was encountered in all trial pits, beneath the topsoil in TP6 to TP8, and beneath the made ground in the remainder of trial pits.

In TP5, TP9 and TP10 in the north of the site, friable sandy gravelly clay with frequent sandstone cobbles was found beneath the made ground, from depths of around 1 m bgl to depths of between 1.5 m and 2 m bgl. In TP9 weak to moderately weak sandstone cobbles were encountered below this clay.

Across the remainder of the site, stiff friable gravelly clay was encountered beneath the topsoil or made ground, to depths of between 1.6 m and 2.9 m bgl, before becoming weak mudstone recovered as shale at the base.

Infrequent cobble sized pockets of black sandy clay were also encountered between 1.4 m to 2.4 m bgl in TP6.

The boreholes encountered clay to depths of between 1.2 and 1.6 m, underlain by sandstone and mudstone bands. Solid coal was encountered in BH1 to BH3 at depths of between 4.4 m and 5.9 m. In BH1 and BH2 the coal had a thickness of 0.4 m and 0.5 m, whereas in BH3 the thickness of coal was 1.1 m. In BH4, soft ground was encountered between 12.1 m and 13.9 m and in BH5 broken ground was encountered between 13.3 m and 15.4 m bgl.

5.4 Groundwater

Groundwater was not encountered in any of the trial pits or boreholes, although material was noted to be damp in TP3 at 2.3 m and TP11 at 2.6 m bgl.

5.5 Evidence of Contamination

Brown stained rubble was encountered between 1.2 m and 1.8 m bgl within the made ground, although this had no odour.

Infrequent cobble sized pockets of black sandy clay were also encountered between 1.4 m to 2.4 m bgl in TP6.

Asbestos is expected to be present in the buildings currently on site. A full asbestos survey is understood to have been undertaken and any asbestos is expected to be removed by a specialist contractor prior to demolition.

No other visual or olfactory evidence of possible significant contamination was identified in any of the exploratory holes.

6.0 GEOTECHNICAL APPRAISAL

6.1 General

Topsoil was encountered in the south of the site, in the vegetated area in the central and west of the site, and in an embankment in the east of the site. The site is mainly underlain by made ground to depths of up to 0.7 m in the south and 1.1 m in the north. The made ground is underlain by firm to stiff clay progressing to sandstone in the north and mudstone in the south.

Groundwater was not encountered in any of the trial pits or boreholes, although material was noted to be damp in TP3 at 2.3 m and TP11 at 2.6 m bgl.

The natural ground is considered to be able to provide a safe bearing capacity of at least 150 kN/m², which will increase with depth to at least 200 kN/m² within the mudstone or sandstone bedrock.

Four samples of the natural ground were sent for plasticity testing. The results are included in Appendix 3 (PSL17/3199). The samples were classified as clay or very gravelly sandy silty clay. Modified plasticity indices of between 9% (TP9 at 1.4 m) and 50% (TP1 at 0.9 m) were recorded, which equate to unshrinkable to high volume change potential in accordance with NHBC Chapter 4.2 guidance. The deeper very gravelly sandy very silty clay indicated a lower plasticity index, whilst the shallower clay a higher plasticity index. We consider it prudent to adopt a worst case for foundation design, and therefore the natural clay should be assumed to be of high volume change potential.

To the north of the fault, BH1 to BH3 recorded solid coal at depths of between 4.4 m and 5.9 m with thicknesses of 0.4 m, 0.5 m and 1.1 m, respectively. This is anticipated to be the Middleton Eleven Yards coal, which is not expected to have been worked according to information contained within the geological memoir. No shallow mining is therefore expected to have taken place to the north of the fault.

To the south of the fault, BH4 identified soft ground between 12.1 m and 13.9 m and in BH5 broken ground was encountered between 13.3 m and 15.4 m bgl. The geological memoir indicates that where the Two Yard coal seam is not washed out, it has been worked and there are also mine entries shown within 100 m on the geological plan.

Workings require 10 times workable seam thickness in competent rock cover between the top of the seam and the underside of foundations for grouting to not be considered necessary. Due to the shallow depth of the seam to the south of the fault, plots, roads and drainage will require grouting in this area of the site.

No evidence of mine entries has been encountered on the site, however this cannot be ruled out and vigilance is required during construction. The gas monitoring programme is ongoing.

The Party Wall Act will need to be considered for structures associated with neighbouring properties along the site boundaries.

6.2 Foundations

To the north of the fault, unreinforced strip or trench-fill footings are considered appropriate, taken through any made ground present to found onto the natural clay at a minimum depth of 1000 mm below the lowest of the existing or finished ground level.

To the south of the fault, drilling and grouting of shallow workings will be required. Overlying plots will require thickened reinforced strip or trench fill foundations, taken through any made ground into the natural clay at a minimum depth of 1000 mm below the lowest of the existing or finished ground level.

Foundations overlying the fault i.e. where different variable ground conditions are recorded in the footing, should also be thickened and reinforced.

Foundations within clay soils will need to be deepened in accordance with NHBC Standards, Chapter 4.2 where existing or proposed trees are within influencing distance. Heave precautions will be required where foundations are more than 1500 mm deep due to existing trees. Foundations need not be deepened further upon reaching the non-shrinkable sandstone.

6.3 Ground Slabs

Where there is expected to be less than 600 mm of made ground below the floor, ground bearing slabs are considered appropriate. Otherwise, reinforced suspended or precast concrete floors with an underlying void will be required.

Where heave precautions are required, a precast concrete floor with an underlying minimum 300 mm high void will be required.

If gas protective measures are required, a precast concrete floor with an underlying minimum 150 mm ventilated void will be required and fully lapped and sealed gas membrane system.

6.4 Superstructure Precautions

Additional superstructure precautions should be allowed for in plots overlying shallow workings.

6.5 Excavation Problems

The sides of excavations may be unstable, particularly where made ground is present.

Temporary support will be required in accordance with current Health & Safety Regulations wherever access is required to trenches deeper than 1.2 m or less where there is risk of collapse.

6.6 Obstructions

No significant obstructions were encountered during the intrusive investigation. However, services are present on the site. Following demolition, below ground features such as foundations may remain.

6.7 Surface Water Drainage

Cohesive soils were encountered across the site, therefore soakaways are not considered viable.

7.0 CONTAMINATION APPRAISAL

7.1 Source Characterisation

This section of the report documents the works undertaken to obtain information to test and refine the outline conceptual model enabling a risk assessment to be produced and, where significant risks are expected, remediation recommendations.

7.2 Gas Precautions

A program of gas monitoring is ongoing at the site. One monitoring visit has been undertaken so far, recording a methane concentration of 0% by volume and a carbon dioxide concentration of 3.4%.

7.3 Unexpected Contamination

No visual or olfactory observations of unexpected potential contamination were noted within the exploratory holes at the site.

7.4 Chemical Testing

Six samples of topsoil, four samples of the made ground, three samples of reworked clay and six samples of natural ground were sent for chemical testing. Each of the samples were analysed for the suite of contaminants listed below:

Contaminant Type	Actual Contaminants
Metals/Metalloids	Arsenic, cadmium, chromium (III and VI), lead, mercury, nickel, selenium, copper and zinc
pH	pH
PAHs	Speciated Polycyclic Aromatic Hydrocarbons
Sulphates*	Acid soluble sulphate, water soluble sulphate and sulphur.

*Natural and Made ground samples only

Additional to this, two samples of made ground were tested for fractionated hydrocarbons (TPH CWG) and Total Organic Carbon (TOC). All the samples of topsoil and made ground were screened for asbestos.

All testing was undertaken by Chemtest Limited, using MCERTs accredited methodologies, where available.

7.5 Assessment Criteria

The proposed development of the site is to be for residential use, with each plot having a private garden. Therefore, the assessment criteria relating to residential with home-grown produce have been used. Tables detailing the relevant assessment concentrations used are included in Appendix 4.

7.6 Chemical Test Results

A copy of the test results (Chemtest Report no. 17/16774) is presented in Appendix 4.

Some preliminary risk assessment is undertaken in this section of the report where determinants can be readily discounted.

7.6.1 Topsoil

Three samples of topsoil, from TP3, TP6 and TP8, recorded elevated concentrations of arsenic of between 45 mg/kg and 52 mg/kg compared to the generic assessment value of 37 mg/kg.

No further samples recorded any elevated concentrations of contaminants.

7.6.2 Made ground

Metals/metalloids

Three samples of made ground, from TP4, TP9 and TP10, recorded elevated arsenic concentrations of between 43 and 48 mg/kg. The relevant human health generic assessment value for arsenic is 37 mg/kg.

Polycyclic Aromatic Hydrocarbons (PAH)

Three of the samples of made ground, from TP5, TP9 and TP10 in the north of the site beneath the macadam hard standing, recorded concentrations of PAH contaminants which exceed the generic assessment values for human health. Elevated contaminants are shown in the table below:

Contaminant	Assessment Value (mg/kg)	Elevated concentration (mg/kg)		
		TP5 0.1 m	TP9 0.5 m	TP10 0.9
Benzo[b]fluoranthene	2.6	8.3	3.5	3.2
Benzo[a]pyrene	2.2	21	2.4	2.3
Dibenz(a,h)Anthracene	0.24	2.7	-	-

None of the samples recorded the presence of asbestos.

7.6.3 Natural ground

None of the samples of natural material were found to exceed any of the respective assessment criteria for human health for any metals/metalloids or PAH contaminants.

None of the samples of natural ground were found to exceed the assessment criteria for phytotoxicity to plants.

7.6.4 Total Petroleum Hydrocarbons (TPH)

Two samples of Made Ground from TP5 and TP10, in the north, were tested for fractionated TPH (TPH CWG). These samples did not contain significant concentrations of hydrocarbons.

7.6.5 Sulphates

In accordance with BRE Special Digest 1 (2005), the site is taken as being Brownfield due to the presence of made ground. Groundwater is expected to be mobile through the upper layers of the ground.

Made Ground

The chemical test results indicate that the water soluble sulphate concentrations in the made ground range between <10 mg/l and 460 mg/l, compared with the upper limit of Design Sulphate Class 1 of 500 mg/l. The concentrations of total potential sulphate are calculated as being between 0.054% and 1.8%. However, as greater than five samples were tested, it is acceptable to use the average of the two highest values to obtain a characteristic value. The second highest value for total potential sulphate is 0.42%, therefore the characteristic value for the made ground is 1.1% compared with an upper design limit of 1.2% for DS-3. The pH of all of the made ground samples was between 7.2 and 10.5.

Based on these results, the made ground would be assigned a Design Sulphate Class of DS-3 and Aggressive Chemical Environment for Concrete (ACEC) Class of AC-3.

Natural Ground

The results from the samples of natural ground indicate that the water soluble sulphate concentrations are between <10 mg/l and 15 mg/l compared with the upper limit of Design Sulphate Class 1 of 500 mg/l. The concentrations of total potential sulphate calculated are between 0.03% and 0.07%, compared with an upper design limit of 0.24% for class DS-1. The pH of the natural ground samples were between 6.2 and 7.4.

Based on these results, the natural ground would be assigned a Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2z.

7.7 Significant Pollutant Linkages

The significant pollutant linkages identified are documented in the table below:

Source	Pathway	Receptor
- Locally elevated concentrations of arsenic within the topsoil and made ground. - Locally elevated levels of PAH compounds within the made ground in the northern part of the site.	Ingestion, inhalation, direct contact	- Future residents and visitors. - Site construction workers.
	Direct contact	Water supply pipes.
	Migration through the ground	Groundwater Secondary aquifer.
Sulphates within the made ground and low pH in the natural ground.	Direct contact	Sub-surface concrete structures

8.0 RISK ASSESSMENT

8.1 Human Health: Future Site Users

Made Ground

The results of the chemical testing undertaken during this investigation have indicated that the granular and gravelly clay made ground found in the north of the site (TP4 at 0.1 m, TP9 at 0.5 m and TP10 at 0.9 m) contains elevated concentrations of arsenic as well as a number of polycyclic aromatic hydrocarbon (PAH) compounds. Some of these levels are significantly above the generic human health assessment values. The significantly elevated levels of PAH may be due to deleterious material within the sample, but high levels of such compounds are quite frequently recorded in demolition type materials, particularly where macadam surfacing has been processed and included in the material.

Based on the results recorded, as well as the physical unsuitability of the granular made ground in the north of the site, it is considered that the material is not suitable to remain at the surface in garden or landscaped areas. The potential risks to human health presented by the made ground can be mitigated in one of two ways; either

- 1) By installing a capping layer of inert soil above the made ground where it remains below gardens and landscaped areas, or
- 2) By removing the made ground from all proposed private gardens in the northern part of the site and placing it below areas of hardstanding, such as roads, parking bays and private driveways.

If a capping layer is to be installed, this should comprise 600 mm of inert soil, including at least 150 mm of topsoil.

The reworked clay with occasional gravel underlying the granular made ground in the north, and below the topsoil in the south of the site does not require capping or removal from garden and landscaped areas and is suitable for re-use.

Topsoil

Elevated arsenic values of between 45 mg/kg and 52 mg/kg were recorded in three samples of the topsoil compared with the current assessment concentration of 37 mg/kg. The 95th percentile modified mean of the results is 52.5 mg/kg. Naturally elevated levels of arsenic are not unexpected in this area. The British Geological Survey arsenic map indicates that the site is

in an area where the concentration of arsenic within natural soils is expected to be greater than 33 mg/kg.

The assessment concentration is based on a comparison of predicted human exposure against a Health Criteria Value (HCV). The HCV for arsenic is based on epidemiological studies of people exposed via drinking water. Sequestration as a result of adsorption, partitioning, and/or chemical bonding as well as its potential presence in discrete mineral phases is likely to mean that the arsenic will be more tightly bound within the soil in comparison to the medium of the exposure study. The assessment concentration for arsenic also assumes that all of the contaminant is bioavailable referring to the fraction of the arsenic that can be absorbed by the human body through the gastrointestinal system, the pulmonary system and the skin. In reality, this is generally not the case and bioaccessibility testing would be expected to demonstrate that the concentrations recorded would be unlikely to present significant risks.

A Physiologically Based Extraction Test (PBET) can be used to determine the amount of arsenic that is bioaccessible, which is the fraction of a contaminant released into solution from the soil during digestion. The PBET is a laboratory based test that mimics the conditions of the gut. It stimulates leaching of a solid matrix to determine the total fraction of arsenic available for absorption during transit through the gastrointestinal tract. The bioavailable fraction will generally be lower than the bioaccessible fraction as there is likely to be incomplete absorption during transit through the gastrointestinal tract in reality.

A physiologically based extraction test (PBET) was ordered for the sample in which the highest arsenic concentration was recorded (TP6 0.1 m – 52 mg/kg). The results indicate a bioaccessible fraction of 1.4%. Since the bioaccessibility result is less than 10%, inhalation exposure becomes more significant than oral exposure, and the site specific criterion (SSAC) can be taken as 103 mg/kg. The highest arsenic value recorded was 52 mg/kg which is significantly below the SSAC and therefore it is not considered that the values recorded will pose significant risks to human health. We consequently consider that the topsoil is chemically suitable for re-use in garden and landscaped areas within a residential development. However, the topsoil was noted as containing fragments of glass, tile and brick fragments across the site, and therefore should be screened before re-use to remove any potentially harmful extraneous material.

8.2 Human Health: During Construction

Ground workers employed during the construction phase of the development are most at risk of harm due to them having direct contact with the affected soils. However, the contact is generally of short duration, and all competent ground workers will be aware of the potential risks

associated with soils of this nature. Therefore, the overall risk to the health of construction workers is considered to be low.

All ground workers employed on the site should be made aware that elevated concentrations of contaminants are present and normal site procedures such as the wearing of gloves when handling soils, and the washing of hands prior to eating should be implemented.

Any unusual, brightly coloured, ashy or odorous material or material suspected of containing asbestos encountered during construction should be brought to the attention of the site staff and investigated.

Any macadam surfacing may contain coal tar and this should be tested at an early stage to ensure that it can be dealt with.

8.3 Controlled Waters

Although some contaminants were found to be elevated within the made ground, they are not expected to be particularly soluble. The risk of contamination migrating downwards from the made ground towards the underlying Secondary (undifferentiated) aquifer is considered to be negligible. Furthermore, the levels of these contaminants were not elevated within the underlying natural ground.

8.4 Construction Materials

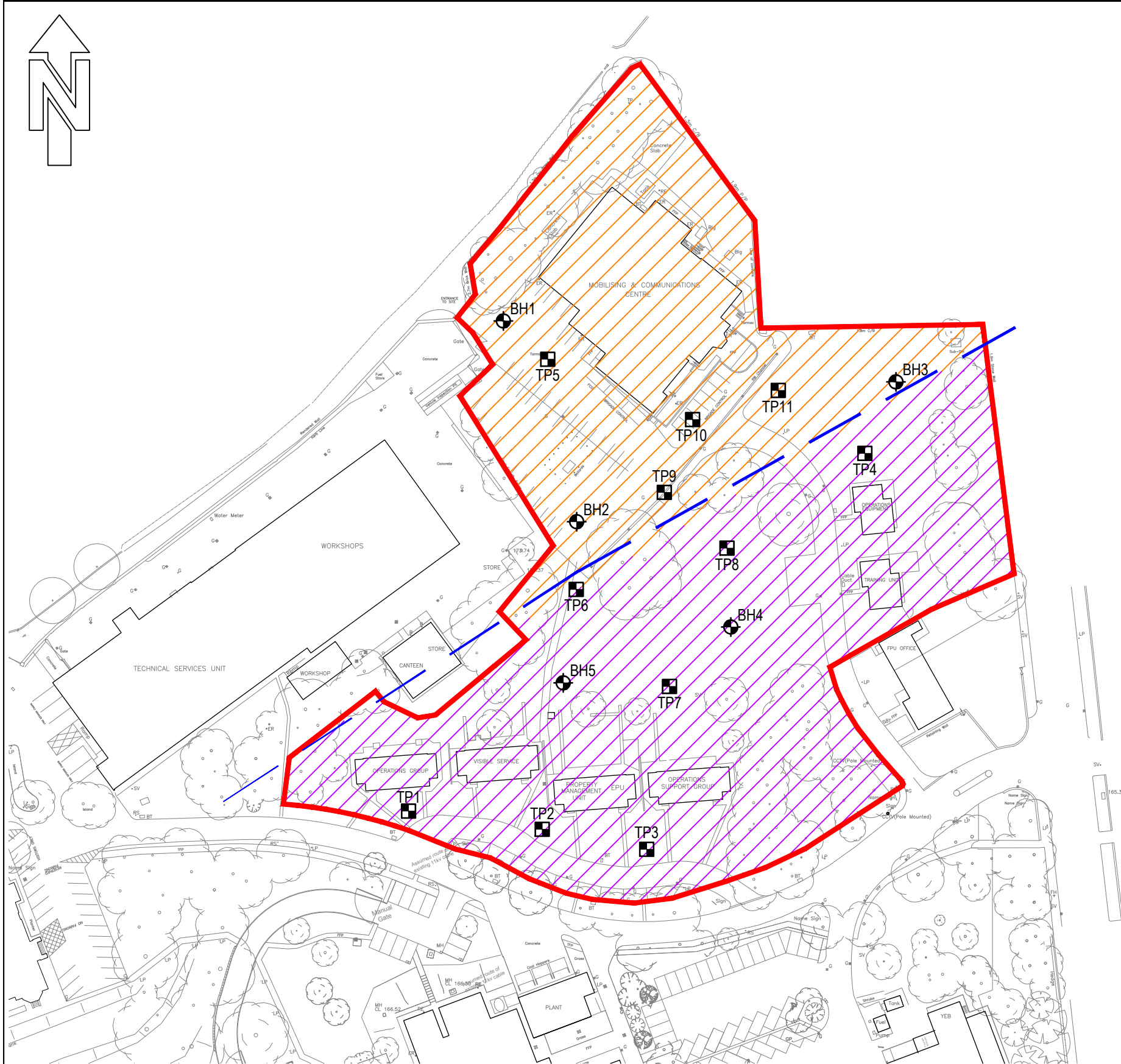
It is considered that DS-3 AC-3 sulphate precautions should be used on site for concrete in contact with the made ground.

Class DS-1 AC-2z is suitable where it is only in contact with the natural ground.

The chemical test results should be forwarded to the water supplier for review.

Appendix 1

Exploratory Hole Location Plan – Drawing 41333/001A



INFORMATION WITHIN THIS DRAWING IS NOT NECESSARILY PRODUCED TO SCALE.
ALWAYS USE FIGURED DIMENSIONS AND CO-ORDINATES - IF IN DOUBT, ASK.

KEY:



Approximate location of trial pits excavated by Eastwood & Partners on 26.06.17.



Approximate location of rotary borehole excavated by Eastwood & Partners on 26.06.17 & 27.06.17.



Approximate extent of area where drilling and grouting of shallow workings will be required.



Approximate zone where 600mm capping layer or removal of made ground is required.



Approximate location of geological fault.

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S11 9AS

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www.eastwoodandpartners.com



ROUSE HOMES

BRADFORD ROAD, BIRKENSHAW

EXPLORATORY HOLE LOCATION PLAN

A	First Issue.					
REV	DESCRIPTION			SIG	CHK	DATE
SCALE WHEN PLOTTED AT A3			DRAWING STATUS			
1:1000			INFORMATION			
DRAWN	CHECKED	DATE	DRAWING NUMBER		REV	
RH	SAE	29.06.17	41333/001		A	

Appendix 2

Trial Pit Logs – TP1 to TP11

Borehole Logs – BH1 to BH5

Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.30m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D					TOPSOIL: Grass over brown sandy slightly gravelly CLAY. Gravel is coarse subangular of sandstone, with occasional glass and roof tile fragments.	
0.30	D		0.20			MADE GROUND: Friable orange brown reworked CLAY, with occasional gravel sized coal and rare clinker fragments.	
			0.40			Stiff orange mottled grey CLAY, becoming grey mottled orange around 0.8 m bgl.	
0.90	IPP 1	225					
0.90	IPP 2	225					
0.90	IPP 3	225					
0.90	D						
			1.40			Stiff friable grey mottled brown slightly gravelly CLAY. Gravel is fine to medium angular of mudstone.	
1.50	D		1.60			Extremely weak to weak grey brown MUDSTONE, recovered as laminated coarse gravel with clay smearing along bedding.	
			2.30				
Trialpit Complete at 2.30 m							

Remarks: IPP= Penetrometer readings given as unconfined compressive strength in kN/m2

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.30m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.20	D		0.30			TOPSOIL: Grass over brown sandy slightly gravelly CLAY. Gravel is coarse subangular of sandstone, with occasional brick fragments.	
			0.70			MADE GROUND: Friable orange brown reworked CLAY, with occasional gravel sized coal and rare clinker fragments.	
1.00 1.00 1.00	IPP 1 IPP 2 IPP 3	200 225 225	1.50			Stiff grey mottled orange CLAY. Dead electricity cable at 0.7 m bgl.	1
			2.30			Friable dark greyish brown CLAY, becoming extremely weak weathered mudstone towards the base.	2
Trialpit Complete at 2.30 m							3
							4

Remarks: IPP= Penetrometer readings given as unconfined compressive strength in kN/m2

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.50m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D					TOPSOIL: Grass over brown sandy slightly gravelly CLAY. Gravel is coarse subangular of sandstone, with occasional glass and roof tile fragments.	
0.30	D		0.30			MADE GROUND: Friable orange brown reworked CLAY, with occasional gravel sized coal and rare clinker fragments.	
			0.60			Stiff grey mottled orange CLAY.	
0.80	IPP 1	250					
0.80	IPP 2	275					
0.80	IPP 3	225					
0.80	D						
			1.70			Friable dark greyish brown CLAY, becoming extremely weak weathered mudstone around 2.0 m bgl.	1
			2.10			Extremely weak to weak grey brown MUDSTONE, recovered as laminated coarse gravel with clay smearing along bedding.	2
			2.50			Material becomes damp around 2.3 m bgl	
Trialpit Complete at 2.50 m							3
							4

Remarks: Bucket scraping slightly at base. IPP= Penetrometer readings given as unconfined compressive strength in kN/m2

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.90m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D					MADE GROUND: Compacted gravel. Gravel is fine to coarse angular to subangular of mixed lithologies, mainly comprising limestone and granite. Plastic mesh layer at base of gravel.	
			0.30				
0.50	D					MADE GROUND: Friable orange brown reworked CLAY, with occasional gravel sized coal and rare clinker fragments.	
			0.70				
			1.00			Stiff orange mottled grey friable slightly sandy slightly gravelly CLAY. Gravel is medium to coarse angular of sandstone.	1
1.10	D					Friable orange brown mottled grey CLAY.	
			2.10				
			2.90			Friable dark greyish brown CLAY, becoming extremely weak weathered mudstone towards the base - recovered as laminated coarse gravel with clay smearing along bedding.	
						Trialpit Complete at 2.90 m	3
							4

Remarks:

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

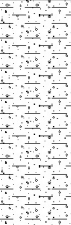
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Scale
 1:25

Client: Rouse Homes

Depth
 1.75m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D		0.05			MADE GROUND: TARMACADAM.	
			0.30			MADE GROUND: GRAVEL of mixed lithologies. Gravel is fine to coarse angular to subangular including limestone, macadam, brick and concrete. Large concrete boulder at 0.3 m bgl.	
0.60	D					MADE GROUND: Friable orange brown gravelly reworked CLAY. Gravel is coarse subangular sandstone.	
			1.00			Friable orange brown sandy gravelly CLAY, with frequent cobbles. Gravel is coarse subangular of sandstone, cobbles are also sandstone and increase in quantity close to the base.	1
1.30	D		1.75				
Trialpit Complete at 1.75 m							2
							3
							4

Remarks:

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

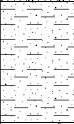
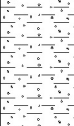
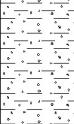
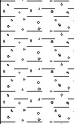
Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.40m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D					TOPSOIL: Grass over brown sandy CLAY with rootlets.	
0.50	D		0.40			Friable orange sandy CLAY.	
1.00	D		0.80			Stiff friable grey mottled orange gravelly CLAY. Gravel is coarse angular of mudstone, becoming cobble sized and flaggy with depth.	1
1.40	D					Infrequent cobble sized pockets of black sandy clay between 1.4 m and 2.4 m bgl.	
			2.40			Trialpit Complete at 2.40 m	2
							3
							4

Remarks:

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.00m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D	300 325 325	0.40			TOPSOIL: Grass over brown sandy CLAY with roots and rootlets, and rare brick fragments.	1
0.60	D					Stiff orange brown mottled grey slightly sandy CLAY, becoming grey mottled orange around 0.8 m bgl. Land drain struck around 0.6 m bgl	
1.20	IPP 1				Friable dark greyish brown CLAY, becoming extremely weak weathered mudstone towards the base - recovered as laminated coarse gravel with clay smearing along bedding.	2	
1.20	IPP 2						
1.20	IPP 3						
1.20	D	2.00			Trialpit Complete at 2.00 m	3	
1.60	D						
							4

Remarks: IPP= Penetrometer readings given as unconfined compressive strength in kN/m2

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

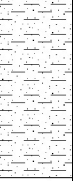
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Scale
 1:25

Client: Rouse Homes

Depth
 1.90m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D					TOPSOIL: Grass over brown slightly sandy CLAY with roots and rootlets, and rare brick fragments.	
0.60	D		0.40			Friable grey mottled orange slightly sandy CLAY, sand content decreasing with depth.	
1.10	D		1.00			Friable dark greyish brown CLAY, becoming extremely weak weathered mudstone towards the base - recovered as laminated coarse gravel with clay smearing along bedding.	1
1.60 1.60 1.60	IPP 1 IPP 2 IPP 3	300 350 350	1.90				
Trialpit Complete at 1.90 m							2
							3
							4

Remarks: IPP= Penetrometer readings given as unconfined compressive strength in kN/m2

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: 0.00 m AOD

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.30m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.20	D		0.10	-0.10		MADE GROUND: TARMACADAM	
						MADE GROUND: GRAVEL, comprising medium to coarse subangular limestone	
0.50	D		0.45	-0.45		MADE GROUND: Stiff dark brown gravelly reworked CLAY, with frequent gravel sized pieces of brick and clinker	
			0.70	-0.70		MADE GROUND: Friable orange brown reworked CLAY with occasional cobbles of sandstone and rare bricks	1
0.90	D		1.10	-1.10		Friable orange brown sandy gravelly CLAY, with frequent cobbles. Gravel is coarse subangular sandstone, cobbles are also sandstone and increase in quantity close to the base.	
1.40	D		2.00	-2.00		Weak to moderately weak flaggy sandstone COBBLES.	2
			2.30	-2.30		Trialpit Complete at 2.30 m	
							3
							4

Remarks:

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

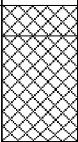
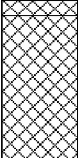
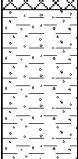
Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 1.50m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.20	D		0.10			MADE GROUND: TARMACADAM	
					MADE GROUND: GRAVEL, comprising medium to coarse subangular limestone		
0.90	D		0.45 0.50			MADE GROUND: GRAVEL, comprising medium to coarse subangular brick, mudstone and concrete. Concrete boulder present at 0.5 m bgl MADE GROUND: Stiff dark brown gravelly reworked CLAY. Gravel is fine to coarse angular to subangular of brick, clinker, and brown stained rubble.	
			1.00			Friable orange brown sandy gravelly CLAY. Gravel is coarse subangular of sandstone	
1.40	D		1.50				
Trialpit Complete at 1.50 m							
							2
							3
							4

Remarks:

Groundwater: None encountered



Project Name
 Bradford Road

Project No.
 41333

Co-ords: -
 Level: -

Date
 26/06/2017

Location: Birkenshaw

Dimensions: -

Scale
 1:25

Client: Rouse Homes

Depth
 2.90m

Logged By
 SAE

Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
0.10	D		0.10			TOPSOIL: Grass over brown slightly gravelly sandy CLAY with roots and rootlets. Gravel is fine subangular sandstone and brick fragments.	
0.40	D					MADE GROUND: Friable brown sandy gravelly reworked CLAY. Gravel is fine to coarse angular to subrounded of mixed lithologies including sandstone, brick fragments, ceramic, macadam, concrete fragments, rebar.	
1.40	D		1.20			MADE GROUND: Stiff dark brown gravelly reworked CLAY. Gravel is fine to coarse angular to subangular of brick, clinker, and brown stained rubble and occasional timber/organic fragments.	1
1.90	IPP 1	250	1.80			Friable grey mottled orange CLAY.	
1.90	IPP 2	300	2.00			Friable grey mottled orange gravelly CLAY. Gravel is medium subangular of mudstone	2
1.90	IPP 3	275					
1.90	D					Material becomes damp around 2.6 m bgl.	
			2.90			Trialpit Complete at 2.90 m	3
							4

Remarks: IPP= Penetrometer readings given as unconfined compressive strength in kN/m2

Groundwater: None encountered



Project Name
Bradford Road

Project No.
41333

Co-ords: -

Hole Type
Rotary

Location: Birkenshaw

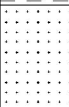
Level: -

Scale
1:160

Client: Rouse Homes

Dates: 26/06/2017

Logged By
DRILLER

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.20			CLAY.	1
								SANDSTONE	2
					3.60			Grey MUDSTONE	3
									4
					5.90			COAL	5
					6.30			Grey MUDSTONE	6
									7
					8.40			SANDSTONE	8
									9
									10
									11
									12
									13
									14
									15
									16
									17
									18
									19
									20
									21
									22
					23.80			Grey MUDSTONE	23
									24
									25
									26
									27
									28
									29
					30.00			End of Borehole at 30.00 m	30
									31

Remarks:



Project Name
Bradford Road

Project No.
41333

Co-ords: -

Hole Type
Rotary

Location: Birkenshaw

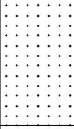
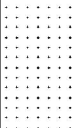
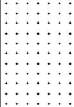
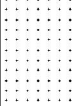
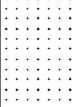
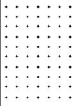
Level: -

Scale
1:160

Client: Rouse Homes

Dates: 26/06/2017

Logged By
DRILLER

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.40			CLAY.	1
								SANDSTONE.	2
					4.10			Grey MUDSTONE.	4
					4.70			COAL.	5
					5.20			Grey MUDSTONE.	6
					7.70			SANDSTONE.	8
									9
									10
									11
									12
									13
									14
									15
									16
									17
									18
									19
									20
									21
									22
									23
									24
					25.10			Grey MUDSTONE	25
									26
									27
									28
									29
					30.00			End of Borehole at 30.00 m	30
									31

Remarks:

Project Name
Bradford Road

Project No.
41333

Co-ords: -

Hole Type
Rotary

Location: Birkenshaw

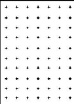
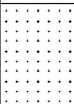
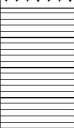
Level: -

Scale
1:160

Client: Rouse Homes

Dates: 26/06/2017

Logged By
DRILLER

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.30			CLAY.	1
								SANDSTONE.	2
					3.60				3
					4.40			Grey MUDSTONE.	4
					5.50			COAL.	5
								Grey MUDSTONE	6
									7
									8
					8.80			SANDSTONE.	9
									10
									11
									12
									13
									14
									15
									16
									17
									18
									19
									20
									21
					21.70			Grey MUDSTONE.	22
									23
									24
									25
									26
									27
									28
									29
					30.00			End of Borehole at 30.00 m	30
									31

Remarks:

Project Name
Bradford Road

Project No.
41333

Co-ords: -

Hole Type
Rotary

Location: Birkenshaw

Level: -

Scale
1:160

Client: Rouse Homes

Dates: 27/06/2017

Logged By
DRILLER

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.60			CLAY.	1
								SANDSTONE.	2
									3
									4
									5
									6
									7
					7.70			Grey MUDSTONE	8
									9
									10
									11
					12.10			SOFT GROUND	12
									13
					13.90			HARD STRATA- assumed to be mudstone.	14
					15.00			End of Borehole at 15.00 m	15
									16
									17
									18
									19
									20
									21
									22
									23
									24
									25
									26
									27
									28
									29
									30
									31

Remarks:



Project Name
Bradford Road

Project No.
41333

Co-ords: -

Hole Type
Rotary

Location: Birkenshaw

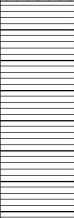
Level: -

Scale
1:160

Client: Rouse Homes

Dates: 27/06/2017

Logged By
DRILLER

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.60			CLAY	1
								SANDSTONE	2
									3
									4
									5
									6
									7
					8.40			Grey MUDSTONE	8
									9
									10
									11
									12
					13.30			BROKEN GROUND	13
									14
					15.40			HARD STRATA - assumed to be mudstone.	15
									16
					17.00			End of Borehole at 17.00 m	17
									18
									19
									20
									21
									22
									23
									24
									25
									26
									27
									28
									29
									30
									31

Remarks:

Appendix 3

Geotechnical Test Results (PSL17/3199)



LABORATORY REPORT



4043

Contract Number: PSL17/3199

Report Date: 13 July 2017
Client's Reference: 41333
Client Name: Eastwood & Partners
St Andrews House
23 Kingfield Road
Sheffield
S11 9AS

For the attention of: Stefani Ellis

Contract Title: Birkenshaw
Date Received: 4/7/2017
Date Commenced: 4/7/2017
Date Completed: 13/7/2017

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:


R Gunson
(Director)

A Watkins
(Director)

R Berriman
(Quality Manager)

L Knight
(Senior Technician)

S Eyre
(Senior Technician)

A Fry
(Senior Technician)

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awatkins@prosoils.co.uk

Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

PSL
Professional Soils Laboratory

Birkenshaw

Contract No:

PSL17/3199

Client Ref:

41333

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

[illegible]

SYMBOLS : NP : Non Plastic

*** : Liquid Limit and Plastic Limit Wet Sieved.**



PSL
Professional Soils Laboratory

Birkenshaw

Contract No:

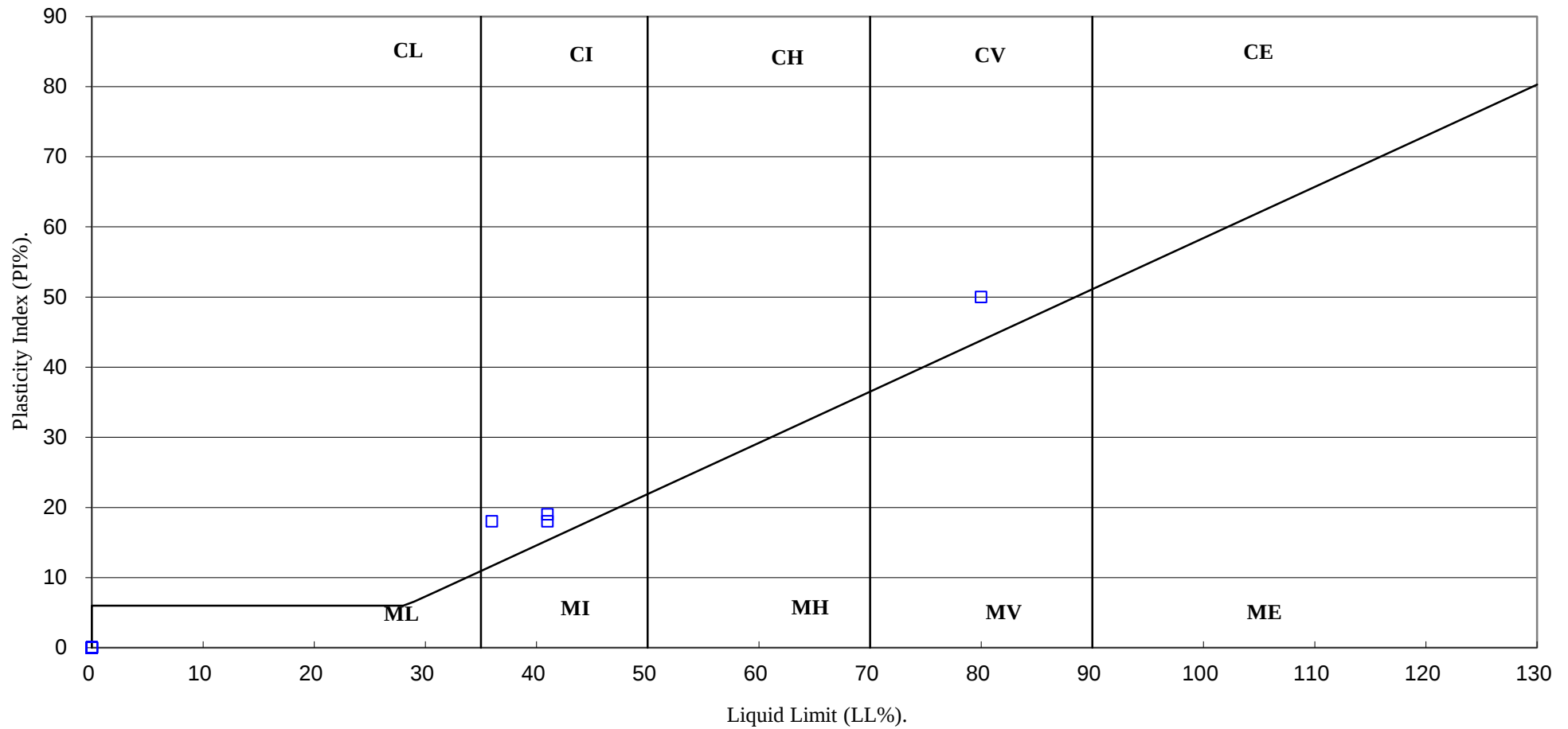
PSL17/3199

Client Ref:

41333

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



4043

PSL

Professional Soils Laboratory

Birkenshaw

Contract No:

PSL17/3199

Client Ref:

41333

Appendix 4

Chemical Test Results (Chemtest Report No. 17/16774)
Residential with Home-grown Produce Assessment Values



Amended Report

Report No.: 17-16774-2

Initial Date of Issue: 11-Jul-2017 **Date of Re-Issue:** 19-Jul-2017

Client: Eastwood & Partners

Client Address: St. Andrews House
23 Kingfield Road
Sheffield
South Yorkshire
S11 9AS

Contact(s): Geo
Stefani Ellis

Project: 41333 Birkenshaw

Quotation No.: **Date Received:** 30-Jun-2017

Order No.: 41333/KE/SAE **Date Instructed:** 30-Jun-2017

No. of Samples: 19

Turnaround (Wkdays): 14 **Results Due:** 19-Jul-2017

Date Approved: 19-Jul-2017

Approved By:



Details: Martin Dyer, Laboratory Manager

Results - Soil

Project: 41333 Birkenshaw

Client: Eastwood & Partners	Chemtest Job No.:				17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774
Quotation No.:	Chemtest Sample ID.:				477234	477235	477236	477237	477238	477239	477240	477241
Order No.: 41333/KE/SAE	Client Sample Ref.:				TP1	TP3	TP3	TP3	TP4	TP4	TP5	TP5
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.10	0.30	0.10	0.80	0.10	1.10	0.10	0.60
	Date Sampled:				26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017
	Asbestos Lab:				COVENTRY	COVENTRY	COVENTRY		COVENTRY		COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD								
ACM Type	U	2192		N/A	-	-	-		-		-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		No Asbestos Detected		No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	18	19	22	25	1.7	10	7.7	14
Soil Colour	N	2040		N/A	Brown	Brown	Brown	Brown	Grey	Brown	Brown	Brown
Other Material	N	2040		N/A	Stones, Roots	Stones, Roots	Stones, Roots	NONE	Stones	Stones	Stones	NONE
Soil Texture	N	2040		N/A	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay
pH	M	2010		N/A	6.6	7.2	5.5	6.7	8.9	7.1	9.1	7.6
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010		< 0.010		< 0.010		0.015	0.031	0.020
Total Sulphur	M	2175	%	0.010		0.039		0.014		0.011	0.14	0.018
Sulphate (Acid Soluble)	M	2430	%	0.010		0.050		0.047		0.017	0.14	0.12
Arsenic	M	2450	mg/kg	1.0	32	9.2	45	5.5	43	4.9	28	5.5
Cadmium	M	2450	mg/kg	0.10	0.32	0.13	0.37	< 0.10	0.93	< 0.10	0.31	< 0.10
Chromium	M	2450	mg/kg	1.0	25	23	37	34	1.7	19	16	17
Copper	M	2450	mg/kg	0.50	43	18	55	20	3.9	20	16	20
Mercury	M	2450	mg/kg	0.10	0.45	0.11	0.33	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	26	20	34	28	4.6	32	22	27
Lead	M	2450	mg/kg	0.50	92	31	110	16	11	5.4	21	12
Selenium	M	2450	mg/kg	0.20	0.34	< 0.20	0.40	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Zinc	M	2450	mg/kg	0.50	120	86	120	68	86	56	56	110
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Total Organic Carbon	M	2625	%	0.20							1.0	
As Stomach Bioaccessibility	N	2630	mg/kg	0.20								
As Intestinal Bioaccessibility 1	N	2630	mg/kg	0.20								
As Intestinal Bioaccessibility 2	N	2630	mg/kg	0.20								
As Bioaccessible Fraction	N	2630	%	0.10								
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0							< 1.0	
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0							< 1.0	
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0							< 1.0	
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0							< 1.0	
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0							2.3	
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0							13	
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0							70	
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0							< 1.0	
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0							85	
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0							< 1.0	
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0							< 1.0	
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0							< 1.0	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0							< 1.0	

Results - Soil

Project: 41333 Birkenshaw

Client: Eastwood & Partners	Chemtest Job No.:				17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774
Quotation No.:	Chemtest Sample ID.:				477234	477235	477236	477237	477238	477239	477240	477241
Order No.: 41333/KE/SAE	Client Sample Ref.:				TP1	TP3	TP3	TP3	TP4	TP4	TP5	TP5
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.10	0.30	0.10	0.80	0.10	1.10	0.10	0.60
	Date Sampled:				26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017
	Asbestos Lab:				COVENTRY	COVENTRY	COVENTRY		COVENTRY		COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD								
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0							1.7	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0							76	
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0							350	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0							< 1.0	
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0							430	
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0							520	
Naphthalene	M	2800	mg/kg	0.10	0.14	< 0.10	0.30	< 0.10	< 0.10	< 0.10	0.18	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.59	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10	< 0.10	0.17	< 0.10	< 0.10	< 0.10	0.32	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10	< 0.10	0.14	< 0.10	< 0.10	< 0.10	0.17	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	0.44	< 0.10	1.5	< 0.10	< 0.10	< 0.10	3.2	0.33
Anthracene	M	2800	mg/kg	0.10	< 0.10	< 0.10	0.12	< 0.10	< 0.10	< 0.10	2.3	< 0.10
Fluoranthene	M	2800	mg/kg	0.10	0.84	< 0.10	1.8	< 0.10	< 0.10	< 0.10	22	0.49
Pyrene	M	2800	mg/kg	0.10	0.56	< 0.10	1.5	< 0.10	< 0.10	< 0.10	21	0.42
Benzo[a]anthracene	M	2800	mg/kg	0.10	0.22	< 0.10	0.49	< 0.10	< 0.10	< 0.10	10	0.12
Chrysene	M	2800	mg/kg	0.10	0.28	< 0.10	0.66	< 0.10	< 0.10	< 0.10	11	0.15
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10	< 0.10	0.53	< 0.10	< 0.10	< 0.10	23	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10	< 0.10	0.16	< 0.10	< 0.10	< 0.10	8.3	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10	< 0.10	0.22	< 0.10	< 0.10	< 0.10	21	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	19	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	2.7	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	16	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	2.5	< 2.0	7.6	< 2.0	< 2.0	< 2.0	160	< 2.0

Results - Soil

Project: 41333 Birkenshaw

Client: Eastwood & Partners	Chemtest Job No.:				17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774
Quotation No.:	Chemtest Sample ID.:				477242	477243	477244	477245	477246	477247	477248	477249	477250
Order No.: 41333/KE/SAE	Client Sample Ref.:				TP5	TP6	TP7	TP8	TP9	TP9	TP9	TP10	TP10
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				1.30	0.10	0.60	0.10	0.20	0.50	0.90	0.20	0.90
	Date Sampled:				26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017
	Asbestos Lab:					COVENTRY		COVENTRY	COVENTRY	COVENTRY		COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD									
ACM Type	U	2192		N/A		-		-	-	-		-	-
Asbestos Identification	U	2192	%	0.001		No Asbestos Detected		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	10	19	25	26	9.4	23	17	6.5	11
Soil Colour	N	2040		N/A	Brown	Brown	Brown	Brown	Beige	Black	Brown	Beige	Black
Other Material	N	2040		N/A	Stones	Stones, Roots	NONE	Stones, Roots	Stones	Stones	Stones	Stones	Stones
Soil Texture	N	2040		N/A	Clay	Sand	Clay	Sand	Sand	Sand	Clay	Sand	Sand
pH	M	2010		N/A	7.4	5.4	6.2	6.1	9.3	8.3	7.8	9.2	10.5
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010		< 0.010		< 0.010	0.032	0.019	< 0.010	0.46
Total Sulphur	M	2175	%	0.010	0.016		0.015		0.024	0.14	0.032	0.033	0.60
Sulphate (Acid Soluble)	M	2430	%	0.010	0.17		0.10		0.13	0.14	0.060	0.095	0.62
Arsenic	M	2450	mg/kg	1.0	3.6	52	7.4	49	30	43	13	29	48
Cadmium	M	2450	mg/kg	0.10	< 0.10	0.46	< 0.10	0.41	5.2	0.45	0.12	0.27	0.15
Chromium	M	2450	mg/kg	1.0	18	27	29	29	3.4	26	18	7.8	57
Copper	M	2450	mg/kg	0.50	22	64	18	53	6.9	53	24	6.1	140
Mercury	M	2450	mg/kg	0.10	< 0.10	0.28	< 0.10	0.39	< 0.10	0.21	< 0.10	< 0.10	0.25
Nickel	M	2450	mg/kg	0.50	30	33	27	30	3.1	34	26	7.3	67
Lead	M	2450	mg/kg	0.50	9.7	110	18	120	130	85	28	9.8	130
Selenium	M	2450	mg/kg	0.20	< 0.20	0.71	< 0.20	0.45	< 0.20	0.86	< 0.20	< 0.20	< 0.20
Zinc	M	2450	mg/kg	0.50	90	150	75	110	270	130	100	25	100
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Total Organic Carbon	M	2625	%	0.20								1.4	
As Stomach Bioaccessibility	N	2630	mg/kg	0.20		< 0.20							
As Intestinal Bioaccessibility 1	N	2630	mg/kg	0.20		0.72							
As Intestinal Bioaccessibility 2	N	2630	mg/kg	0.20		0.60							
As Bioaccessible Fraction	N	2630	%	0.10		1.4							
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0								< 1.0	
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0								< 1.0	
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0								< 5.0	
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0								< 1.0	
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0								< 1.0	
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0								< 1.0	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0								< 1.0	

Results - Soil

Project: 41333 Birkenshaw

Client: Eastwood & Partners	Chemtest Job No.:				17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774	17-16774
Quotation No.:	Chemtest Sample ID.:				477242	477243	477244	477245	477246	477247	477248	477249	477250
Order No.: 41333/KE/SAE	Client Sample Ref.:				TP5	TP6	TP7	TP8	TP9	TP9	TP9	TP10	TP10
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				1.30	0.10	0.60	0.10	0.20	0.50	0.90	0.20	0.90
	Date Sampled:				26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017	26-Jun-2017
	Asbestos Lab:					COVENTRY		COVENTRY	COVENTRY	COVENTRY		COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD									
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0								< 1.0	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0								< 1.0	
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0								< 1.0	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0								< 1.0	
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0								< 5.0	
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0								< 10	
Naphthalene	M	2800	mg/kg	0.10	< 0.10	0.26	< 0.10	0.30	< 0.10	0.47	< 0.10	< 0.10	2.0
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.29	< 0.10	< 0.10	0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10	0.14	< 0.10	0.35	< 0.10	0.29	< 0.10	< 0.10	0.23
Fluorene	M	2800	mg/kg	0.10	< 0.10	0.11	< 0.10	0.28	< 0.10	0.38	< 0.10	< 0.10	0.18
Phenanthrene	M	2800	mg/kg	0.10	0.12	1.3	< 0.10	2.4	< 0.10	3.2	< 0.10	< 0.10	2.6
Anthracene	M	2800	mg/kg	0.10	< 0.10	0.17	< 0.10	0.45	< 0.10	0.85	< 0.10	< 0.10	0.88
Fluoranthene	M	2800	mg/kg	0.10	0.41	1.6	< 0.10	3.0	< 0.10	5.9	< 0.10	< 0.10	4.2
Pyrene	M	2800	mg/kg	0.10	0.43	1.4	< 0.10	2.7	< 0.10	4.9	< 0.10	< 0.10	3.6
Benzo[a]anthracene	M	2800	mg/kg	0.10	0.12	0.55	< 0.10	1.1	< 0.10	2.5	< 0.10	< 0.10	2.2
Chrysene	M	2800	mg/kg	0.10	0.16	0.61	< 0.10	1.5	< 0.10	2.6	< 0.10	< 0.10	2.4
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10	0.62	< 0.10	1.3	< 0.10	3.5	< 0.10	< 0.10	3.2
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	0.40	< 0.10	1.4	< 0.10	< 0.10	1.1
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10	0.31	< 0.10	0.77	< 0.10	2.4	< 0.10	< 0.10	2.3
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10	0.11	< 0.10	0.30	< 0.10	1.7	< 0.10	< 0.10	1.4
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.14	< 0.10	< 0.10	0.19
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10	0.15	< 0.10	0.51	< 0.10	1.8	< 0.10	< 0.10	1.5
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0	7.3	< 2.0	15	< 2.0	32	< 2.0	< 2.0	28

Project: 41333 Birkenshaw

Client: Eastwood & Partners	Chemtest Job No.:				17-16774	17-16774
Quotation No.:	Chemtest Sample ID.:				477251	477252
Order No.: 41333/KE/SAE	Client Sample Ref.:				TP11	TP11
	Sample Type:				SOIL	SOIL
	Top Depth (m):				0.10	1.90
	Date Sampled:				26-Jun-2017	26-Jun-2017
	Asbestos Lab:				COVENTRY	
Determinand	Accred.	SOP	Units	LOD		
ACM Type	U	2192		N/A	-	
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	
Moisture	N	2030	%	0.020	13	20
Soil Colour	N	2040		N/A	Brown	Brown
Other Material	N	2040		N/A	Stones, Roots	NONE
Soil Texture	N	2040		N/A	Sand	Clay
pH	M	2010		N/A	8.5	6.5
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010		< 0.010
Total Sulphur	M	2175	%	0.010		0.022
Sulphate (Acid Soluble)	M	2430	%	0.010		0.035
Arsenic	M	2450	mg/kg	1.0	19	5.3
Cadmium	M	2450	mg/kg	0.10	0.25	< 0.10
Chromium	M	2450	mg/kg	1.0	28	21
Copper	M	2450	mg/kg	0.50	39	15
Mercury	M	2450	mg/kg	0.10	0.25	< 0.10
Nickel	M	2450	mg/kg	0.50	30	19
Lead	M	2450	mg/kg	0.50	49	17
Selenium	M	2450	mg/kg	0.20	< 0.20	< 0.20
Zinc	M	2450	mg/kg	0.50	110	61
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50
Total Organic Carbon	M	2625	%	0.20		
As Stomach Bioaccessibility	N	2630	mg/kg	0.20		
As Intestinal Bioaccessibility 1	N	2630	mg/kg	0.20		
As Intestinal Bioaccessibility 2	N	2630	mg/kg	0.20		
As Bioaccessible Fraction	N	2630	%	0.10		
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0		
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0		
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0		
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0		
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0		
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0		
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0		
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0		
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0		
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0		
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0		
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0		
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0		

Project: 41333 Birkenshaw

Client: Eastwood & Partners	Chemtest Job No.:				17-16774	17-16774
Quotation No.:	Chemtest Sample ID.:				477251	477252
Order No.: 41333/KE/SAE	Client Sample Ref.:				TP11	TP11
	Sample Type:				SOIL	SOIL
	Top Depth (m):				0.10	1.90
	Date Sampled:				26-Jun-2017	26-Jun-2017
	Asbestos Lab:				COVENTRY	
Determinand	Accred.	SOP	Units	LOD		
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0		
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0		
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0		
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0		
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0		
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0		
Naphthalene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	0.30	< 0.10
Anthracene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10	0.33	< 0.10
Pyrene	M	2800	mg/kg	0.10	0.36	< 0.10
Benzo[a]anthracene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Chrysene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2630	PBET	PBET	Extraction at 37C / ICP-MS
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenzo[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

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

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

All Asbestos testing is performed at the indicated laboratory

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

Sample Deviation Codes

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

Sample Retention and Disposal

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

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

Charges may apply to extended sample storage

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

customerservices@chemtest.co.uk

Inorganic Compounds	Human Health - Residential with Homegrown Produce (mg/kg)
Arsenic	37
Cadmium	11
Chromium (III)	910
Chromium (VI)	6
Lead	200
Mercury	1.2
Nickel	180
Selenium	250
Copper	2400
Zinc	3700

Organic Compounds	Human Health - Residential with Homegrown Produce (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Naphthalene	2.3	5.6	13
Acenaphthene	210	510	1100
Acenaphthylene	170	420	920
Fluorene	170	400	860
Phenanthrene	95	220	440
Anthracene	2400	5400	11000
Fluoranthene	280	560	890
Pyrene	620	1200	2000
Benzo(a)anthracene	7.2	11	13
Chrysene	15	22	27
Benzo(b)fluoranthene	2.6	3.3	3.7
Benzo(k)fluoranthene	77	93	100
Benzo(a)pyrene	2.2	2.7	3.0
Dibenz(a,h)anthracene	0.24	0.28	0.3
Indeno(1,2,3-cd)pyrene	27	36	41
Benzo(g,h,i)perylene	320	340	350
Benzene	0.087	0.17	0.37
Toluene	130	290	660
Ethylbenzene	47	110	260
o-Xylene	60	140	330
m-Xylene	59	140	320
p-Xylene	56	130	310

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Prepared	ET	Checked	CAT	Date	08.08.17	Job No	41333
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 Eastwood & Partners CONSULTING ENGINEERS St Andrew's House 23 Kingfield Road Sheffield S11 9AS Tel: (0114) 255 4554 Fax: (0114) 255 4330	ROUSE HOMES BRADFORD ROAD, BIRKENSRAW ASSESSMENT CRITERIA – RESIDENTIAL WITH HOMEGROWN PRODUCE
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Contaminant	Phytotoxicity			
	pH 5.0 to 5.5	pH 5.5 to 6.0	pH 6.0 to 6.5	pH >7.0
Arsenic	50			
Cadmium	3			
Chromium	400			
Lead	300			
Mercury	1			
Nickel	50	60	75	110
Copper	80	100	135	200
Zinc	200	200	200	300

The assessment concentration for lead is the Category 4 Screening Level produced by Contaminated Land: Applications in Real Environments (CL:AIRE) and outlined in Appendix H of their report SP1010. The others have been taken from Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R., and Nathanail, J., 2015, *'The LQM/CIEH S4ULs for Human Health Risk Assessment'*, Land Quality Press, Nottingham. The metals/metalloids are based on a sandy loam soil and 6% soil organic matter. The assessment values are not intended to be applied to individual sample results where materials are similar, as the levels of contaminants will have a natural variability across the site. Instead, the modified mean value should be compared with the assessment concentration.

The assessment values for phytotoxicity are the levels at which plant growth is thought to be affected. They are taken from the maximum permissible and advisable concentrations in soil after application of soil sludge given in the *'The Code of Good Agricultural Practice for the Protection of Soil'*, MAFF, 1998.

The assessment of sulphate, water soluble sulphate, elemental sulphur and sulphide is to determine the aggressive nature of the ground with respect to concrete and consequently the results are compared with BRE Special Digest 1:2005 *'Concrete in Aggressive Ground'*.

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