Sheerien Close, Barnsley

Site Investigation Report

Yorkshire Housing

Solmek Report Number S120835/SI

October 2012

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Site Investigation Report

Contract Number: S120835/SI
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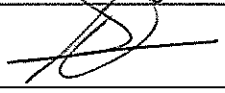
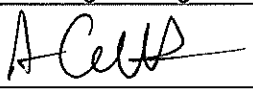
Status	Date	Prepared by	Checked by
Final	October 2012	R Woods *Geotechnical Engineer*	A Cutts *Engineering Geologist*
			

Sheerien Close, Barnsley

Site Investigation Report

1 INTRODUCTION AND SCOPE OF WORKS

At the request of Billinghurst George and Partners on behalf of Yorkshire Housing a site investigation involving geotechnical and chemical testing was carried out on land to the east of Sheerien Close, Barnsley. A plan showing the site location is included in Appendix A, Figure 1.

1.1 Scope of Works

The proposed development of the site involves the construction of thirty two residential dwellings. The final development will also include hardstanding in the form of car parking and areas of soft landscaping as garden areas.

A geotechnical and environmental investigation including a ground gas risk assessment was requested. The fieldwork and testing was generally carried out according to the recommendations of BS5930:1999 "Code of Practice for Site Investigations" and all stratum descriptions are as recommended in that publication. A Phase 1 Desk Study was carried out by Solmek (S120835, September 2012) and should be read in conjunction with this report.

The information provided in this report is based on the investigation fieldwork, and is subject to the comments and approval of the various Regulatory Authorities.

There may be other conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report. Solmek reserve the right to alter conclusions and recommendations should further information be available or provided. Any schematic representation or opinion of the possible configuration of ground conditions between exploratory boreholes is conjectural and given for guidance only and confirmation of intermediate ground conditions should be considered if deemed necessary.

2 SITE DESCRIPTION AND FIELDWORK

The preliminary site inspection, as recommended in BS 5930 and BS 10175, was undertaken on Monday 3rd September 2012. Location maps are presented in Appendix 1. The site is centred at the approximate Ordnance Survey Co-ordinates 434350E, 409980N and covers an area of approximately 0.78ha.

The site consists of a roughly rectangular parcel of land which is located within a housing estate. The northern quarter of the site has a fall in elevation of approximately 1m and the southeast corner of the site is raised by approximately 1-2m.

The majority of the site is covered with overgrown grass, small trees and bushes. A footpath crosses the eastern half of the site allowing access to the school to the south. Houses mark the northern and western boundaries.

The surrounding area consisted of mainly residential housing with a school located to the south of the site. There were no visual signs of contamination or services noted on the site during the site walkover.

2.1 Fieldwork

The fieldwork was carried out on 3rd September 2012 and comprised six small percussive boreholes (BH1 to BH6) drilled to depths of up to 2.2m below ground level (bgl). In addition to the boreholes, nine machine excavated trial pits (TP1 to TP9) were dug to a maximum depth of 2.0mbgl to supplement the borehole data and undertake insitu testing.

Insitu CBR testing using the hand held Farnell Probe was carried in TP1, TP2, TP6, TP8 and TP9. Soakaway percolation trials have been undertaken within TP1, TP2 and TP6.

Standard penetration tests (SPT) were undertaken at various depths within the boreholes. Samples were taken for both geotechnical and contamination analysis. Descriptions of the strata encountered in the boreholes and trial pits together with details of testing, sampling and groundwater are presented in Appendix B of this report. A plan showing the location of the boreholes and trial pits can be found in Appendix A (Figure 2).

Ground gas monitoring installations were placed within three of the boreholes (BH2, BH4 & BH5). The remaining boreholes and all of the trial pits were backfilled with the clean arisings and fully reinstated on completion of the works. A period of ground gas monitoring is currently underway and will be presented as an addendum to this report.

3 GROUND CONDITIONS

3.1 Made Ground

Made Ground was encountered within all of the boreholes to depths ranging between 0.5mbgl and 1.3mbgl; however the base was not proven through the centre of the site in BH3 and BH4 due to encountering concrete and brick footings at 1.2 and 1.3mbgl respectively. A surface covering of topsoil was

found in BH1, BH2 and BH5 to a maximum depth of 0.2mbgl. Below the topsoil and from surface level in BH3 and BH4 was generally sandy gravelly clay fill containing brick, concrete and sandstone proven to a maximum depth of 1.0mbgl. Concrete and brick was found to termination depths of 1.2 and 1.3mbgl in BH3 and BH4 respectively. Within BH6, a black ashy gravel fill of tarmac was found from surface level to 0.15mbgl, underlain by very gravelly clay fill of brick to 0.5mbgl.

Within the trial pits, made ground was proven to a maximum depth of 1.6mbgl (TP4) with a surface covering of topsoil proven in TP1, TP2, TP8 and TP9 to a maximum depth of 0.6mbgl (TP9). From surface level in the remaining trial pits (except TP6), clay fill containing brick rubble and concrete was found to a maximum depth of 1.6mbgl (TP4). The engineer recorded two concrete footings along the face of TP4 to 1.5mbgl. Within TP6, gravel fill of tarmac and mudstone was found from surface level to 0.2mbgl.

3.2 Natural Deposits

The natural deposits proven beneath the made ground generally comprised stiff, locally firm, slightly sandy gravelly clay. The clay was proven to a maximum depth of 2.0mbgl (TP4). The trial pits were terminated between depths of 0.9 and 2.0mbgl within the stiff clay horizon. Highly weathered mudstone was found below the clay in BH1, BH2, BH5 and BH6 to termination depths of between 2.0 and 2.2mbgl. Refusal was recorded by the SPT sampler in all four boreholes inferring solid geology comprising mudstone.

3.3 Groundwater

No groundwater was encountered within any of the six boreholes during the drilling. The engineer recorded seepage in TP2 from 1.3mbgl and that the base of TP3 (1.9mbgl) was 'wet'. It should be noted the rapid rate of advancement of the exploratory holes may mask minor seepages and it should be borne in mind that water levels fluctuate with a number of influences including season, rainfall, dewatering and pumping activities. Therefore, water levels significantly higher than those found during this investigation may be encountered.

4 GEOTECHNICAL TESTING

Samples taken from the boreholes and trial pits underwent a series of geotechnical tests (BS 1377:1990) to aid foundation design and soil description. In addition, insitu SPTs were undertaken at regular intervals during drilling. The geotechnical results are presented in Appendix C.

4.1 Strength and Density

Five disturbed samples recovered during the site works were subjected to quick, undrained triaxial testing.

The samples ranged in depth from 0.8mbgl to 1.65mbgl. The results were fairly consistent and ranged from 76kPa and 131kPa indicating stiff conditions.

4.2 Atterberg Limit Determinations

Six Atterberg Limit Determination tests were carried out on samples of cohesive material to classify the fine grained soils. The results were compared to the Casagrande Chart published in BS 5930 and showed the samples to be clay of intermediate to high plasticity.

The Plasticity Indices ranged from 24 to 33 with moisture contents recorded above and below the corresponding plastic limits. The cohesive material can be assessed as having a **medium** shrinkage potential in relation to NHBC Guidance Chapter 4.2.

4.3 Moisture Contents

Disturbed samples recovered from the boreholes and trial pits were subjected to moisture content tests to determine the moisture profile at depths of between 0.8 and 2.0mbgl. Moisture levels were fairly consistent throughout the depths of tests undertaken at levels of between 21% and 26%.

4.4 pH and Sulphate Results

Two samples of natural soil were tested for acidity and soluble sulphate content to assess whether the material may be potentially aggressive to building fabric. The results of the testing for pH were 4.4 and 5.7 indicating acidic conditions. Soluble sulphates were recorded at levels of 78mg/l and 103mg/l.

4.5 Insitu CBR Results

Insitu CBR testing was undertaken within TP1, TP2, TP6, TP8 and TP9 using the hand held Farnell Probe. The tests were carried out at depths of between 0.5 and 0.9mbgl, with the results ranging from 3.5% to 6% within natural stiff clay deposits. However, given the unpredictable nature of made ground and possibility of very loose or voided ground we would recommend adopting an equilibrium CBR of 2% for the site. This could be improved by some light compaction or removing the made ground from beneath the proposed roads and replacing it with properly compacted gravel fill.

4.6 Percolation Testing

Percolation testing was undertaken within TP1, TP2 and TP6 in order to derive an infiltration rate for the natural sub-strata and assess it's suitability as a sustainable drainage medium. The infiltration rates in all three tests were recorded as 0.0m/sec*$^{10-6}$ which would be classified as '*Not Acceptable*' based on BRE Digest 365.

5 CONTAMINATION ANALYSIS AND RESULTS

The proposed development of the site is to involve the construction of thirty-two residential dwellings. The final development will also include hardstanding in the form of access roads and car parking with areas of soft landscaping as gardens.

To provide information upon the possibility of ground contamination three samples of made ground were subject to chemical contamination analysis.

The sites proposed end use comprises residential land use, therefore the test results have been compared to a series of Solmek Generic Assessment Criteria (GAC) thresholds based on a residential land use with home grown produce. Solmek GAC were derived using the EA CLEA Software Version 1.06 (May 2011) which produce Model Output Reports to compare the contamination concentrations against. In the absence of Solmek GAC values, WS Atkins Soil Screening Values (SSV) for residential land use with home grown produce have been used (which have been derived using EA CLEA Version 1.06, May 2011).

Solmek used the following input parameters within the CLEA Model to generate the GAC values:

- **Land use:** Residential with home grown produce
- **Receptor:** Female
- **Building Type:** Semi detached house
- **Soil Type:** Clay loam
- **Soil pH:** 6.2 (Lowest Recorded Value)
- **Soil Organic Matter:** 3.2% (Lowest Recorded Value)

The samples were subjected to a range of tests to detect the levels of various metals, semi-metals, non-metals and inorganic determinants. In addition, the samples were subject to pH analysis and screened for the presence of asbestos. The results and CLEA UK Model Output Report have been provided in full in Appendix D and summarised in Table 1 below.

Determinant	Units	Number of Samples above Level of Detection	Minimum Level	Maximum Level	Threshold Value	Number of Results Exceeding Threshold Value
Metals						
Cadmium	mg/kg	3	0.3	1.4	5.17	0
Chromium	mg/kg	3	33	51	3000	0
Chromium VI	mg/kg	0	<1.0	-	4.25	0
Copper	mg/kg	3	26	110	2360	0
Lead	mg/kg	3	45	52	276*	0
Mercury	mg/kg	2	<0.05	0.1	169	0
Nickel	mg/kg	3	28	52	127	0
Zinc	mg/kg	3	42	130	2860	0
Semi metals and non metals						
Arsenic	mg/kg	3	14	16	32.4	0
Boron	mg/kg	3	1.0	1.4	10.3	0

Selenium	mg/kg	2	<0.5	1.0	350	0
Inorganic chemicals						
Cyanide	mg/kg	3	0.2	0.4	1.62	0
W.S. Sulphate	mg/l	3	49	75	500#	0
Sulphide	mg/kg	1	<10	52	250+	0
Other						
pH	pH	3	6.2	8.6	<5.5+	0
Phenols	mg/kg	3	0.7	1.0	357	0
Asbestos	-	None Detected				

TABLE 1: SUMMARY OF INORGANIC CONTAMINATION TESTING RESULTS

* SSV Residential with home grown produce
\+ EA derived thresholds
\# BRE Special Digest One, Lower Limit

5.1 Metals, Semi Metals and Inorganic Chemicals

None of the three samples tested returned concentrations which exceed the thresholds for metals, semi-metals, non metals or inorganic chemicals.

Soluble sulphates (potentially aggressive to foundation concrete) was recorded at a maximum value of 75mg/l.

5.2 Other

The results of the pH testing were between 6.2 and 8.6. These pH levels are consistent with slightly acidic to alkaline conditions. No asbestos was detected within the three samples screened for fibres.

5.3 Contamination Assessment

A qualitative approach using the statutory definition of Contaminated land, as defined within Section 78A (2) of Part 2A of the Environmental Protection Act (1990), has been adopted. This 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 or on or under the land that "Significant harm is being caused or there is a significant possibility of such harm being caused; or pollution of controlled waters is being or is likely to be, caused".*

The concept of "significant harm" is dealt with via Government guidance (DEFRA circular 01/2006 Contaminated Land). The statutory guidance uses the concept of pollutant linkages set out in the Circular. Before the local authority can make a judgment on whether "significant harm" and the significant possibility of harm is being caused they are required to identify a "significant pollution linkage". This means effectively that three elements (a source of contamination, a relevant receptor and a pathway) must be present. Without identification of all three elements together, land should not be regarded as "contaminated" in the statutory sense. See Appendix F for additional notes on contamination guidelines.

5.4 Conceptual Model and Pollution Linkages

The contamination conceptual model in Table 2 below identifies the **potential** pollution linkages present on site based on source – pathway – receptor relationships.

SOURCES	PATHWAYS	RECEPTORS
Made Ground proven to depths of up to 1.6mbgl and generally comprised occasional topsoil over clay fill with brick and concrete. The base of the made ground was not proven in BH3 and BH4. Former school on site. Site is currently disused. A former landfill site is located approx. 140m to the west No significant levels of contamination in made ground on the site. Basic radon protection measures required.	Dermal absorption Inhalation of soil/volatised compounds Ingestion of soil Contact with contaminated groundwater	**Users of site** – Adults and children receptors. Soft landscaping present in final development as garden areas.
	Dermal absorption Inhalation of soil/volatised compounds Ingestion of soil Contact with contaminated groundwater	**Construction Workers** – Users of the site during construction phase of development.
	Dermal absorption Inhalation of soil/volatised compounds Ingestion of soil	**Users of surrounding sites** – Residential housing and a school.
	Taken up through roots and foliage Direct contact	**Vegetation** – Soft landscaping as garden areas.
	Slow seepage or leaching of contaminants	**Groundwater** – Secondary A Aquifer. No significant groundwater strikes recorded during field work.
	Slow seepage or leaching of contaminants and accumulation of contaminated sediments	**Surface water** – nearest located over 500m from the site.
	Direct contact	**Construction Materials** – Concrete and underground service pipes.

TABLE 2: POTENTIAL POLLUTION LINKAGES

In general terms, the users of the site, construction workers, users of the surrounding sites, vegetation, controlled waters and construction materials are considered to be at risk from potential contamination in the soils on site as pollution linkages may be present for these receptors. The actual risks posed are considered below.

5.5 Users of the Site Once Development is Complete

The users of the site are likely to be exposed to contaminants present in the soils beneath the site, as soft landscaping is proposed in the final development. **Potential** exposure pathways include dermal absorption after contact with contaminated ground, inhalation of soil or dust, inhalation of volatised compounds, and inadvertent soil ingestion (or deliberate soil ingestion in the case of some children).

To establish if the levels of contaminants present on site may pose a risk to the health of the future users of the site the results of the contamination testing have been compared to a series of Solmek Generic GAC thresholds based on a residential land use with homegrown produce. The results indicate that the concentrations of the metals, semi-metals, non-metals and inorganics contaminants within the made ground are below the threshold values for long term risk to human health.

It is therefore considered that the levels of contamination on site are unlikely to pose a risk to the current and future users of the site, and remediation is not required beneath proposed hardstanding areas or the proposed building footprints.

If any zones of odorous, brightly coloured or suspected contaminated ground are encountered then work should cease in that area until the material has been tested. The results of the tests will determine whether or not remediation will be required.

The current legislation on waste involves the categorization of materials into inert waste, non reactive hazardous wastes and hazardous wastes. The determination of the category depends on DEFRA landfill directive waste acceptance criteria (WAC) testing. Material taken off site may be subject to WAC by the appropriate waste disposal company.

5.6 Construction Workers and Users of Surrounding Sites

Short term human exposure to contaminants present in soils can occur via several pathways during the construction and ground works phase of the development. These include dermal absorption after contact with contaminated ground, inhalation of soil or dust (including windblown dust), inhalation of volatised compounds, inadvertent soil ingestion and contact with contaminated groundwater.

Using guidance in the HSE publication *"Protection of Workers and the General Public during the Development of Contaminated Land"*, the made ground can generally be classed as slightly contaminated, locally contaminated around BH6 due to elevated nickel and sulphide concentrations. The natural ground is considered contaminated around TP4 due to the acidic ground conditions. PPE should be employed in accordance with HSE guidance and safeguards should be taken to limit dust during ground works, and limit access to the public. Gloves should be worn when handling made ground.

5.7 Vegetation

Plants can be affected by soil contamination in a number of ways resulting in growth inhibition, nutrient deficiencies and yellowing of leaves. Contaminants are taken up by plants through the roots and through foliage. Contaminants identified as being highly phytotoxic include boron, cadmium, copper, nickel, and zinc.

To establish if the levels of contaminants present on site may pose a risk to vegetation the results of the contamination testing have been compared to a series of threshold values published in *"Code of Good Agricultural Practice for the Protection of Soil"*. Following comparison no elevated concentrations of phytotoxic determinands were above the corresponding thresholds.

Residential garden areas are proposed around the site. The existing areas of thin topsoil on site should be stripped, screened and stockpiled during the initial site clearance. Within the remaining areas

deleterious materials such as brick and concrete have been proven. Therefore, we would recommend all garden areas be stripped to a depth of 500mm. The stripped ground can then be screened for deleterious materials, with retained materials crushed and used beneath areas of permanent hardcover such as roads or removed from site. Following this the screened ground may be replaced and used as subsoil. Should insufficient material be available then this will have to be imported along with any required topsoil. As a minimum all garden areas should contain 300mm subsoil over 200mm topsoil.

Solmek should be contacted either prior to or following the placement of the subsoil and topsoil in garden areas to validate that the materials are fit-for-purpose.

5.8 Surface Water and Groundwater

The principal pathway by which soil contamination may reach the water environment is through a slow seepage or leaching to groundwater or surface water. The potential for contaminants to migrate along such pathways is dependent on the chemical and physical characteristics of the contaminants and the local hydrogeology.

The site does not lie within a Source Protection Zone and the solid geology is classified as a Secondary A Aquifer. The nearest surface water feature is located over 500m from the site. No groundwater was encountered during field work, apart from some slight seepage in TP2 (1.3m) and at the base of TP3. It should be noted the rapid rate of advancement of the exploratory holes may mask minor seepages and it should be borne in mind that water levels fluctuate with a number of influences including season, rainfall, dewatering and pumping activities.

Given the low contamination profile of the ground, distance to a watercourse and lack of any significant groundwater within the natural deposits the risk to controlled waters is considered low.

5.9 Construction Materials

Materials at risk from potential soil contamination include inorganic matrices such as cement and concrete and also organic material; e.g. plastics and rubbers. Acid ground conditions and elevated levels of sulphates can accelerate the corrosion of building materials. Plastics and rubbers are generally used for piping and service ducts and are potentially attacked by a range of chemicals, most of which are organic, particularly petroleum based substances. Drinking water supplies can be tainted by substances that can penetrate piping and water companies enforce stringent threshold values.

BRE Special Digest One: *"Concrete in Aggressive Ground"*:2005 3rd Edition has been used to assess the risks posed to underground concrete and to establish the design measures required to mitigate the risks. The results of the pH and sulphate tests fall into Class DS-1, ACEC (Class AC-1s) requirements for concrete protection. This assumes static groundwater conditions.

The levels of potential contaminants detected have been compared to thresholds supplied in the Water Regulations Advisory Scheme Guidance Note 9-04-03 *"The Selection of materials for Water Supply Pipes to be laid in Contaminated Land"*. Based on the contamination test results, levels of arsenic and pH (>8) are present in levels exceeding the threshold values. Prior to laying any new services consultation with the utility providers is recommended. As a minimum services should be placed within clean service trenches.

6 GROUND GAS ASSESSMENT

Ground gas monitoring installations were placed within three of the boreholes (BH2, BH4 & BH5). A period of ground gas monitoring is currently underway and will be presented as an addendum to this report.

7 CONCEPTUAL MODEL AND RISK ASSESSMENT

The conceptual model (Table 3) collates the salient aspects of the site to form a model. This model identifies the potential pollution linkages that may influence the proposed development and the relevant geological considerations.

The risk ratings are based on the outcome **after** mitigating action has taken place.

SOURCES	PATHWAYS	RECEPTORS	MITIGATION	RISK RATING
No raised levels of inorganic contaminants from the three samples subject to testing.	Dermal absorption Inhalation of soil/volatised compounds Ingestion of soil Contact with contaminated groundwater	**Proposed residential housing. Adult and infant users.**	Levels of contamination are generally low. Remediation not required beneath buildings or hardstanding.	**LOW**
Raised values of nickel and sulphide noted within made ground sample from BH6. Acidic natural ground in TP4 classed as contaminated	Dermal absorption Inhalation of soil/volatised compounds (dust) Ingestion of soil Contact with contaminated groundwater	**Construction workers.**	Made ground on site classed as slightly contaminated, locally contaminated. Appropriate PPE should be employed as a matter of course. No asbestos fibres noted.	**LOW**

No raised levels of inorganic contaminants from the three samples subject to testing.	Dermal absorption Inhalation of soil/volatised compounds (dust) Ingestion of soil	**Surrounding areas, residential land.**	Damping down of site in dry/windy conditions and limit access to the general public.	**LOW**
No raised concentration of phytotoxic determinands.	Uptake via roots and leaf surfaces	**Vegetation.**	Existing topsoil suitable for re-use after screening. Screen out any deleterious materials to a depth of 500mm. Solmek should be contacted to validate garden areas once placed or materials screened/imported.	**LOW**
No raised levels of inorganic contaminants from the three samples subject to testing.	Seepage or leaching of contaminants. Accumulation of contaminated sediments in water body.	**Surface Water**	Site to be capped by the proposed development. The nearest surface water feature over 500m north east of site.	**LOW**
		Ground Water	Site to be capped by the proposed development. Secondary A Aquifer.	**LOW**
Raised levels of alkaline pH and arsenic.	Contact with contaminated soil/deleterious material.	**Construction Materials and service fabrics**	Class DS-1, AC-1s assuming static ground water. Services should be laid in clean trenches as a **minimum**. Consultation with utility providers is recommended.	**LOW**

TABLE 3: CONCEPTUAL MODEL AND RISK ASSESSMENT

8 CONCLUSIONS

A site investigation was required for a site to the east of Sheerien Close, Barnsley where a series of new residential homes are to be constructed.

8.1 Summary of Ground Conditions

Made Ground was encountered within all of the boreholes and trial pits to a maximum depth of 1.6mbgl; however the base was not proven in BH3 and BH4 due to encountering concrete and brick footings at 1.2 and 1.3mbgl respectively. Generally a surface covering of either topsoil or clay fill was proven, with the clay fill containing brick and concrete. A gravel fill including tarmac was found in BH6 and TP6.

The natural deposits generally comprised stiff, locally firm, slightly sandy gravelly clay proven to a maximum depth of 2.0mbgl. Highly weathered mudstone was found below the clay in BH1, BH2, BH5 and BH6 to termination depths of between 2.0 and 2.2mbgl. Refusal was recorded by the SPT sampler in all four boreholes inferring solid geology comprising mudstone.

8.2 Foundations

The proposed housing is expected to be of traditional construction, two storeys in height and will likely impart low to moderate loads onto the ground. The foundations should be placed directly onto the stiff, locally firm clay, no shallower than 0.9mbgl. The depth will require deepening around BH3 and BH4 due to the depth of made ground in the vicinity.

Using the lowest triaxial result of 76kN/m^2 at approximate foundation depth and assuming a traditional concrete strip footing of 0.60m width, a safe bearing capacity of 175kN/m^2 has been calculated. Providing the imposed loads do not exceed the safe bearing capacity then settlements should not exceed 25mm.

Prior to placing any foundation concrete all exposed formations should be well compacted and any obvious soft or loose spots should be removed and replaced with hardcore. Furthermore, all excavations should be inspected to ensure that they fully penetrate any areas of disturbed ground.

8.3 Insitu CBR Results

Insitu CBR testing carried out at depths of between 0.5 and 0.9mbgl produced results ranging from 3.5% to 6% within natural stiff clay deposits. However, given the unpredictable nature of made ground and possibility of very loose or voided ground we would recommend adopting an equilibrium CBR of 2% for the site. This could be improved by some light compaction or removing the made ground from beneath the proposed roads and replacing it with properly compacted gravel fill.

8.4 Percolation Testing

Percolation testing was undertaken within TP1, TP2 and TP6 in order to derive an infiltration rate for the natural sub-strata and assess it's suitability as a sustainable drainage medium. The infiltration rates in all three tests were recorded as 0.0m/sec^{*10-6} which would be classified as '*Not Acceptable*' based on BRE Digest 365.

8.5 Excavation

Based on the nature of the ground conditions encountered, excavations should be within the capacity of normal earthworks plant although breaking out of relict foundations and other obstructions should be anticipated and these have been proven within BH3, BH4 and TP4 through the centre of the site.

Stability of excavations will be poor in the made ground but should improve markedly in the natural clay. The stability of any excavations will deteriorate over time and with the ingress of any water. Excavation sides should be designed, constructed and supported in accordance with the recommendations given in CIRIA Report No. 97: "Trenching Practice".

8.6 Groundwater

No groundwater was encountered within any of the six boreholes during the drilling. The engineer recorded seepage in TP2 from 1.3mbgl and that the base of TP3 (1.9mbgl) was 'wet'. Therefore, it is unlikely that anything other than minimal groundwater will be encountered in shallow excavation, but as good practice some allowance for dewatering should be made. It should be noted the rapid rate of advancement of the exploratory holes may mask minor seepages and it should be borne in mind that water levels fluctuate with a number of influences including season, rainfall, dewatering and pumping activities. Therefore, water levels significantly higher than those found during this investigation may be encountered.

8.7 Chemical Contamination Results

To establish if the levels of contaminants present on site may pose a risk to the health of the future users of the site the results of the made ground contamination testing have been compared to a series of Solmek GAC thresholds based on a residential land use with home grown produce.

Following comparison, none of the inorganic determinants exceeded the derived threshold values. Remediation is not required beneath hardstanding areas or the proposed building footprints.

In terms of construction workers the made ground on site should be classified as slightly contaminated, locally contaminated, and it is recommended that gloves are always worn when handling made ground as well as wearing the correct PPE.

It is recommended that utility companies are consulted due to the arsenic and pH values (>8) within the made ground.

Following comparison against values in "*Code of Good Agricultural Practice for the Protection of Soil*", the levels of the phytotoxic determinands were below the corresponding thresholds. The existing areas of thin topsoil on site should be stripped, screened and stockpiled during the initial site clearance. Within the remaining areas deleterious materials such as brick and concrete have been proven. Therefore, all garden areas should be stripped to a depth of 500mm. The stripped ground can then be screened for deleterious materials, with retained materials crushed and used beneath areas of permanent hardcover such as roads or removed from site. Following this the screened ground may be replaced and used as subsoil. Should insufficient material be available then this will have to be imported along with any required topsoil. As a minimum all garden areas should contain 300mm subsoil over 200mm topsoil.

Solmek should be contacted either prior to or following the placement of the materials in garden areas to validate that the materials are fit-for-purpose.

8.8 Sulphate results

The results of the pH and sulphate tests on the made ground and natural ground, from the geotechnical analysis results fall into Class DS-1, ACEC (Class AC-1s) requirements for concrete protection assuming static groundwater conditions.

8.9 Radon Protection

Basic radon protection measures are required in accordance with the procedure described in BRE Publication BR211 *Radon: Guidance on Protective Measures for New Dwellings.*

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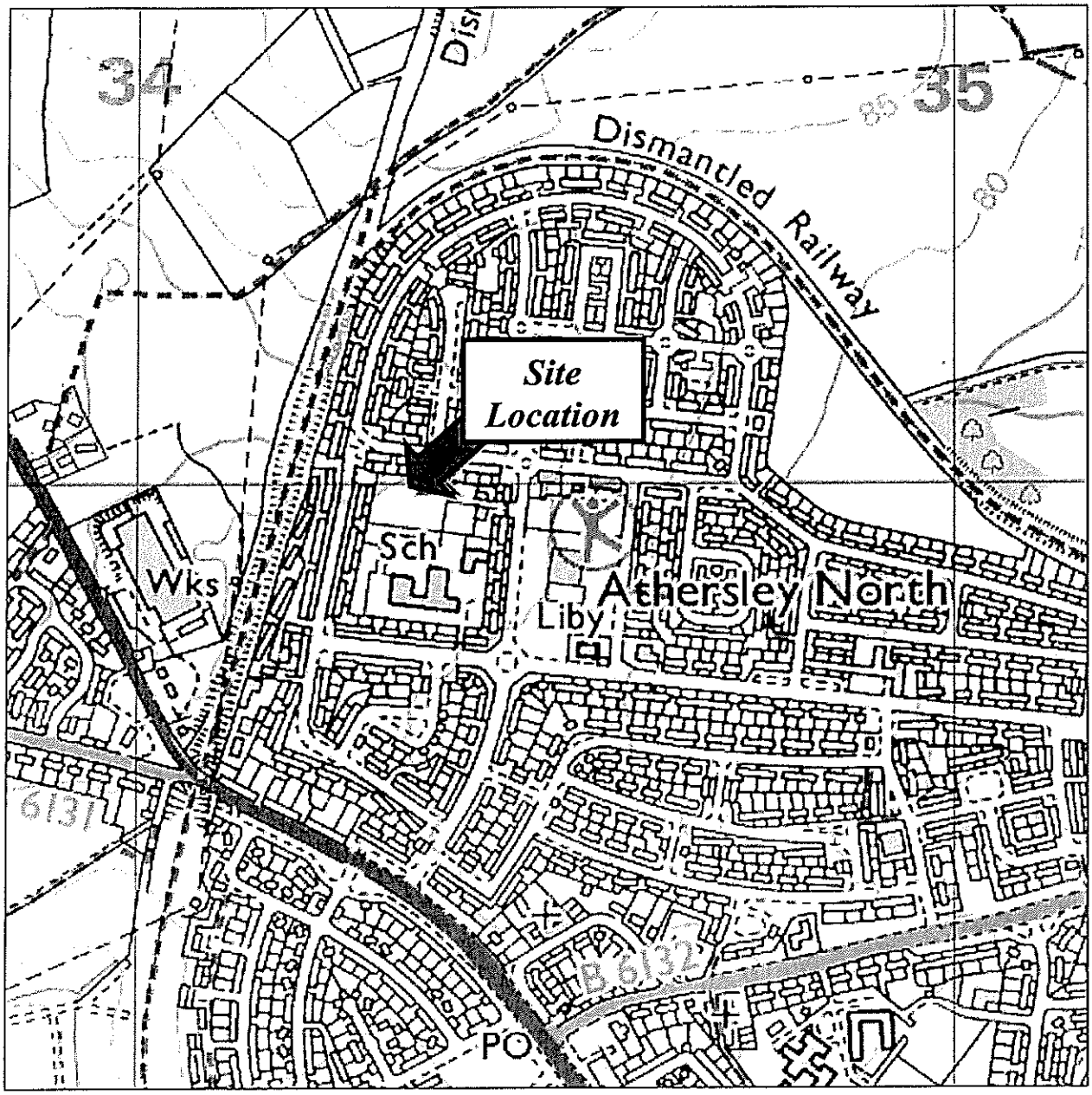
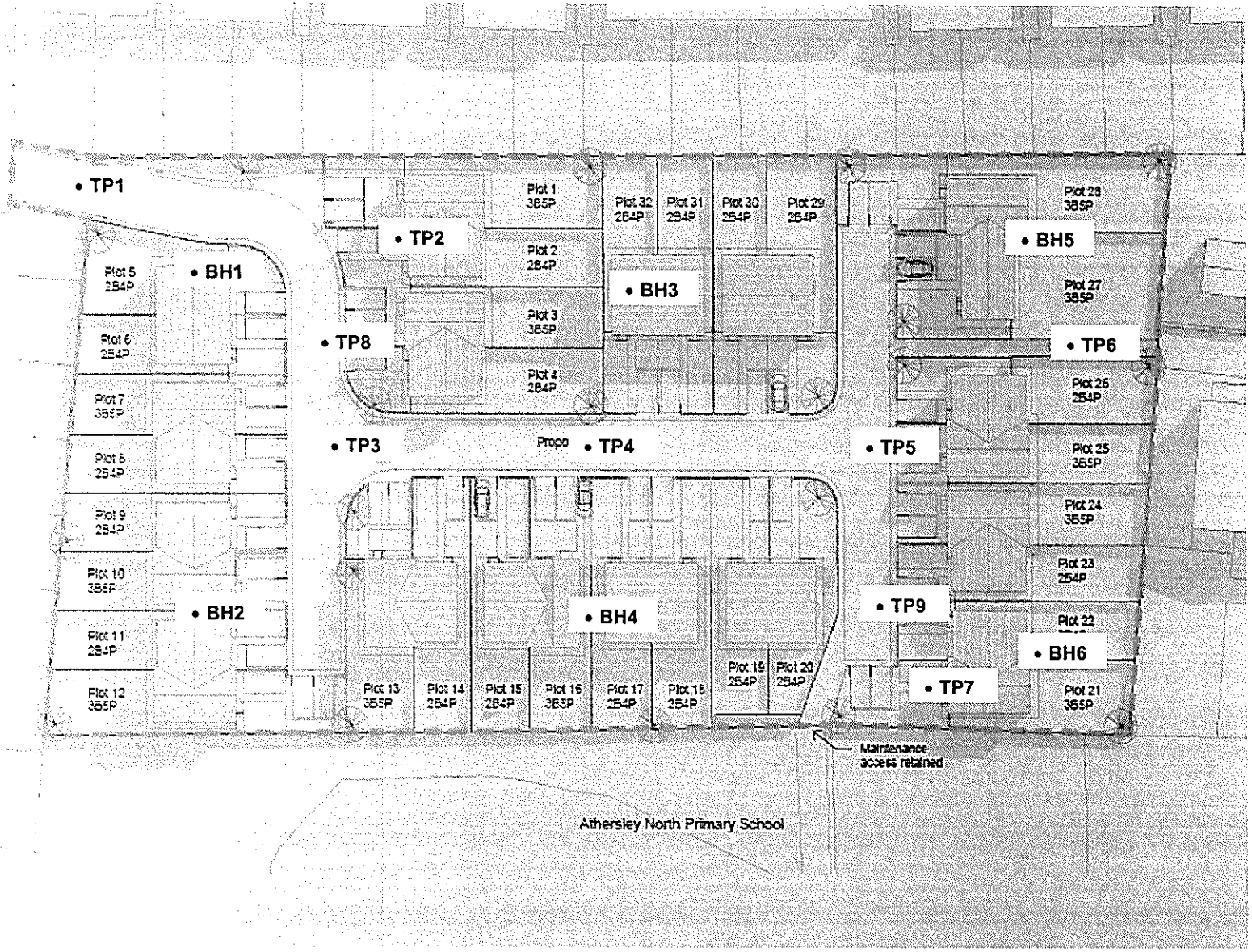
APPENDIX A:
Drawings



Client:	Yorkshire Housing	
Project:	Sheerien Close, Barnsley	
Title:	Site Location Plan	
Drawing No:	Figure 1	**Scale:** NTS
Date	October 2012	

SOLMEK



Title	Borehole & Trial Pit Location Map
Project	Sheerien Close, Barnsley
Client	Yorkshire Housing
Date	October 2012
DRG No	Figure 2
Scale	NTS

N

12 Yarm Road
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SOLMEK

APPENDIX B:
Borehole & Trial Pit Logs

Solmek/Hymas Geo
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TS 18 3NA

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BOREHOLE LOG

Project				BOREHOLE No
Sheerien Close, Barnsley				**BH1**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	04-09-12			
Contractor				Sheet
				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
						0.10	MADE GROUND: Dark brown slightly sandy slightly gravelly clay topsoil. Gravel is sub angular fine to coarse of mudstone.		
0.20-0.30	B					(0.70)	MADE GROUND: Dark grey-brown sandy gravelly clay fill. Gravel is angular to sub angular fine to coarse of brick, concrete, glass, sandstone and mudstone.		
						0.80			
1.00-1.30	B						Stiff orangey-brown-grey slightly sandy gravelly CLAY. Gravel is sub angular to sub rounded fine to coarse including cobbles of sandstone and mudstone.		
1.00	D SPT	N=33				(0.90)			
						1.70			
1.70-1.90	B					(0.40)	Very weak highly weathered grey MUDSTONE, recovered as very stiff gravelly clay.		
2.00	D SPT	N=50+				2.10	Refusal.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	No groundwater encountered.

All dimensions in metres Scale 1:18.75	Client Yorkshire Housing	Method/ Plant Used Mini-Rig	Logged By RW

GRD_BOREHOLE_LOG S120835.GPJ AGS3_ALL.GDT 08/10/12

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BOREHOLE LOG

Project				BOREHOLE No
Sheerien Close, Barnsley				**BH2**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	04-09-12			
Contractor				Sheet
				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
						(0.20) 0.20	MADE GROUND: Dark brown slightly sandy slightly gravelly clay topsoil. Gravel is sub angular fine to coarse of mudstone.		
0.30-0.50	B					(0.50) 0.70	MADE GROUND: Dark grey-brown sandy gravelly clay fill. Gravel is angular to sub angular fine to coarse of brick, concrete, glass, sandstone and mudstone.		
1.00-1.20 1.00	J SPT	N=33				(1.20) 1.90	Stiff dark orangey-brown-grey slightly sandy gravelly CLAY. Gravel is sub angular fine to coarse including cobbles of sandstone and mudstone.		
1.30-1.50	B								
1.90-2.00	B					(0.30) 2.20	Very weak highly weathered grey MUDSTONE, recovered as very stiff very gravelly clay.		
2.00-2.20 2.00	D SPT	N=50+					Refusal.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	No groundwater encountered.

All dimensions in metres Scale 1:18.75	Client Yorkshire Housing	Method/ Plant Used Mini-Rig	Logged By RW

GRD_BOREHOLE_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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BOREHOLE LOG

Project				BOREHOLE No
Sheerien Close, Barnsley				**BH3**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	04-09-12			
Contractor				Sheet
				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.30-0.50	B					(1.00)	MADE GROUND: Dark brown sandy gravelly clay fill. Gravel is angular to sub rounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.80-1.00	B					1.00			
1.00	D SPT	N=50+				(0.20) 1.20	MADE GROUND: Concrete and brick.		
							Refusal on inferred footing.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	No groundwater encountered.

All dimensions in metres Scale 1:18.75	Client Yorkshire Housing	Method/ Plant Used Mini-Rig	Logged By RW

GRD_BOREHOLE_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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BOREHOLE LOG

Project				BOREHOLE No
Sheerien Close, Barnsley				**BH4**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	04-09-12			
Contractor				Sheet
				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.30-0.50	B					(1.00)	MADE GROUND: Dark brown sandy gravelly clay fill. Gravel is angular to sub rounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.80-1.00	B					1.00			
1.00-1.30	B					(0.30)	MADE GROUND: Concrete and brick.		
1.00-1.20	D					1.30			
1.00	SPT	N=50+					Refusal on inferred buried footing.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	No groundwater encountered.

All dimensions in metres Scale 1:18.75	Client Yorkshire Housing	Method/ Plant Used Mini-Rig	Logged By RW

GRD_BOREHOLE_LOG S120835.GPJ AGS3_ALL.GDT 08/10/12

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BOREHOLE LOG

Project				BOREHOLE No
Sheerien Close, Barnsley				**BH5**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	04-09-12			
Contractor				Sheet
				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
						0.10	MADE GROUND: Dark brown clay topsoil.		
						(0.50)	MADE GROUND: Dark brown slightly sandy gravelly clay fill. Gravel is angular to sub rounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.50-0.60	B					0.60			
0.80-1.00	D						Firm becoming stiff dark orangey-brown-grey slightly sandy gravelly CLAY. Gravel is sub angular fine to coarse of sandstone, mudstone and cobbles of sandstone noted.		
0.80	SPT	N=12				(1.30)			
1.50-1.60	D					1.90			
2.00-2.10	D					(0.20)	Very weak highly weathered grey MUDSTONE, recovered as very stiff gravelly clay.		
2.00	SPT	N=50+				2.10	Refusal.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	No groundwater encountered.

All dimensions in metres Scale 1:18.75	Client Yorkshire Housing	Method/ Plant Used Mini-Rig	Logged By RW

GRD_BOREHOLE_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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BOREHOLE LOG

Project				BOREHOLE No
Sheerien Close, Barnsley				**BH6**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	05-09-12			
Contractor				Sheet
				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.10	B					(0.15) 0.15	MADE GROUND: Dark grey-black ashy gravel fill of tarmac.		
0.40	B					(0.35) 0.50	MADE GROUND: Reddish-brown very gravelly clay fill. Gravel is angular to sub angular fine to coarse of brick.		
1.20	D SPT	N=11				(0.90) 1.40	Firm becoming stiff dark orangey-brown-grey slightly sandy gravelly CLAY. Gravel is sub angular to sub rounded fine to coarse including cobbles of sandstone and mudstone.		
1.50	B					(0.60) 2.00	Very weak highly weathered grey-brown MUDSTONE, recovered as very stiff, very gravelly clay.		
2.00	D SPT	N=50+					Refusal.		

Boring Progress and Water Observations					
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:18.75	Client Yorkshire Housing	Method/ Plant Used Mini-Rig	Logged By RW

GRD_BOREHOLE_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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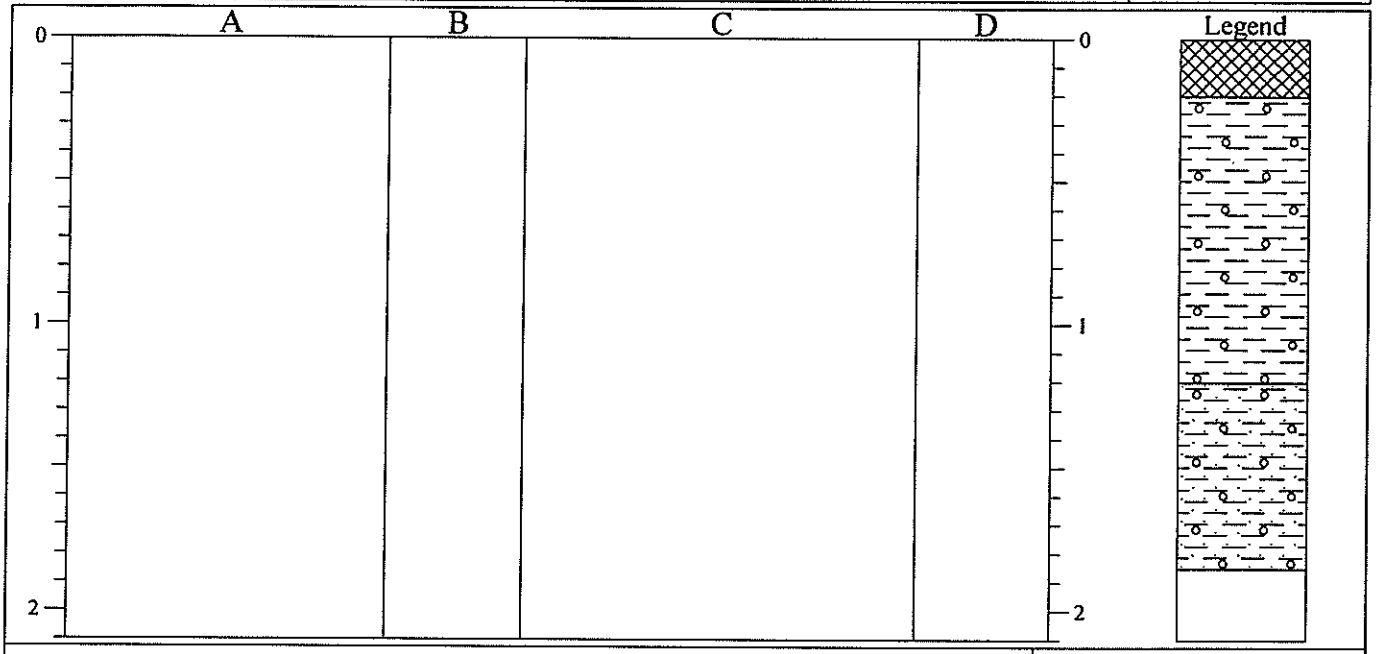
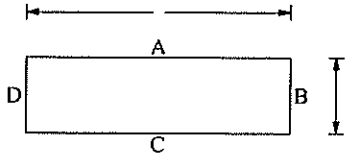
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				**TP1**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.20		MADE GROUND; Dark brown clayey topsoil.			
0.20-1.20		Stiff orangey brown to grey slightly sandy slightly gravelly to gravelly CLAY.	0.50	CBR	=4%
			0.70	CBR	=4%
1.20-1.85		Very stiff grey slightly gravelly CLAY. (completely weathered mudstone).			

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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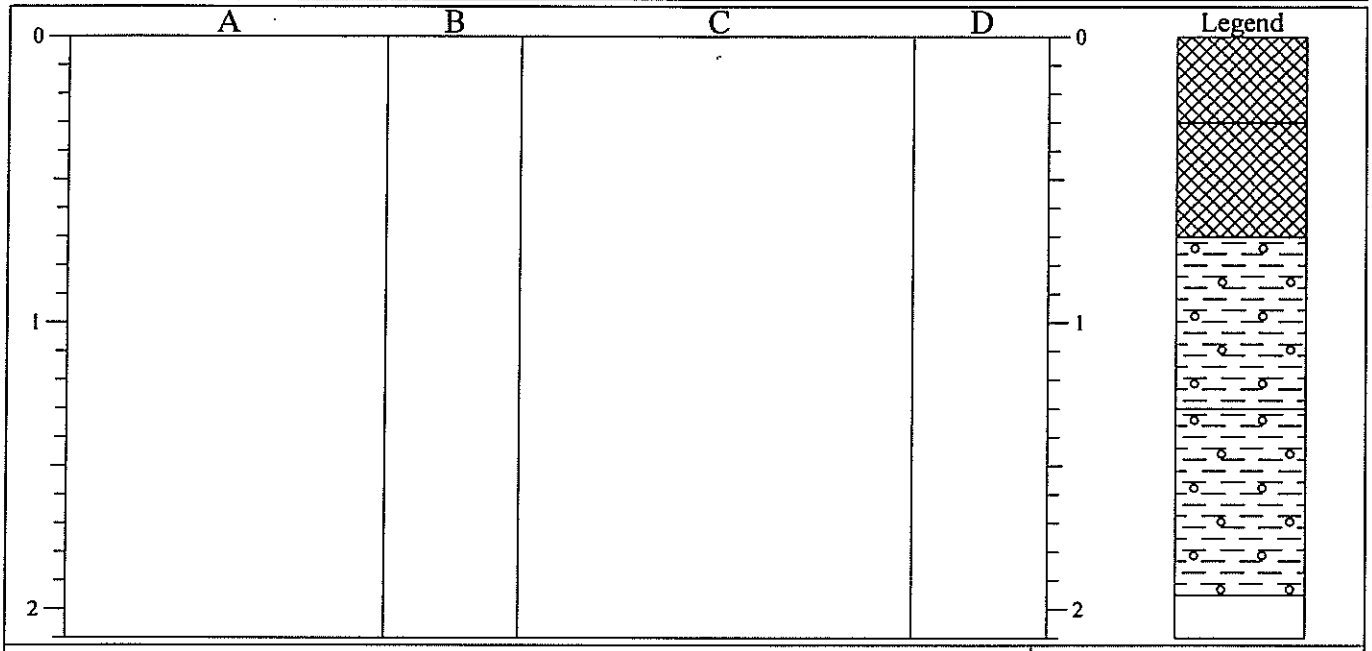
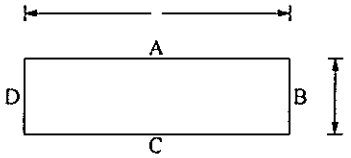
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				**TP2**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.30		MADE GROUND; Dark brown clayey topsoil.			
0.30-0.70		MADE GROUND: Light brown dolomite gravel fill.			
0.70-1.30		Stiff orangey brown to grey slightly gravelly to gravelly CLAY.	0.70	CBR	=4%
			0.90	CBR	=3.5%
1.30-1.95		Very stiff grey slightly gravelly CLAY. (Completely weathered mudstone).			

Shoring/Support:
Stability:



GENERAL REMARKS

Groundwater seepage below 1.30m.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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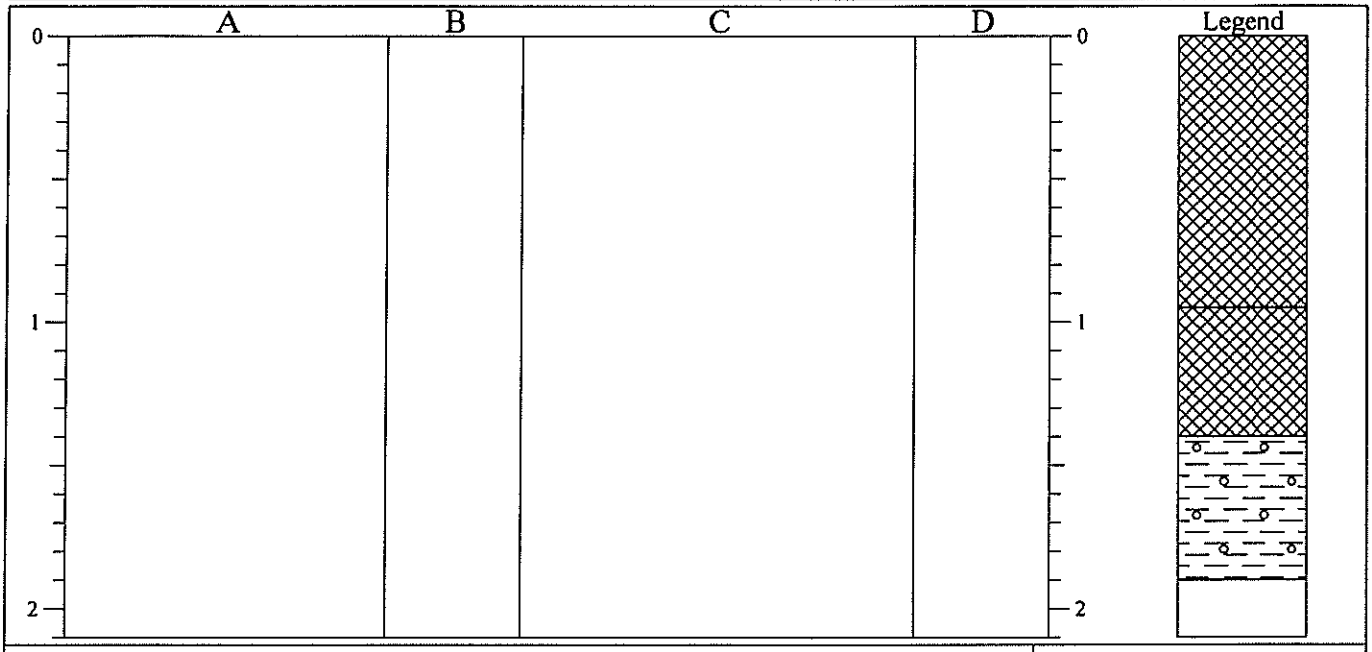
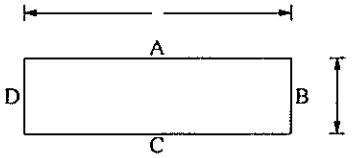
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				TP3
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.95		MADE GROUND: Brown clay fill with frequent brick and concrete.	0.50	B	
0.95-1.40		MADE GROUND: Dark brown clay fill with occasional brick fragments.			
1.40-1.90		Stiff grey to orangey brown slightly gravelly CLAY. (Completely weathered mudstone).			

Shoring/Support:
Stability:



GENERAL REMARKS

Wet at base.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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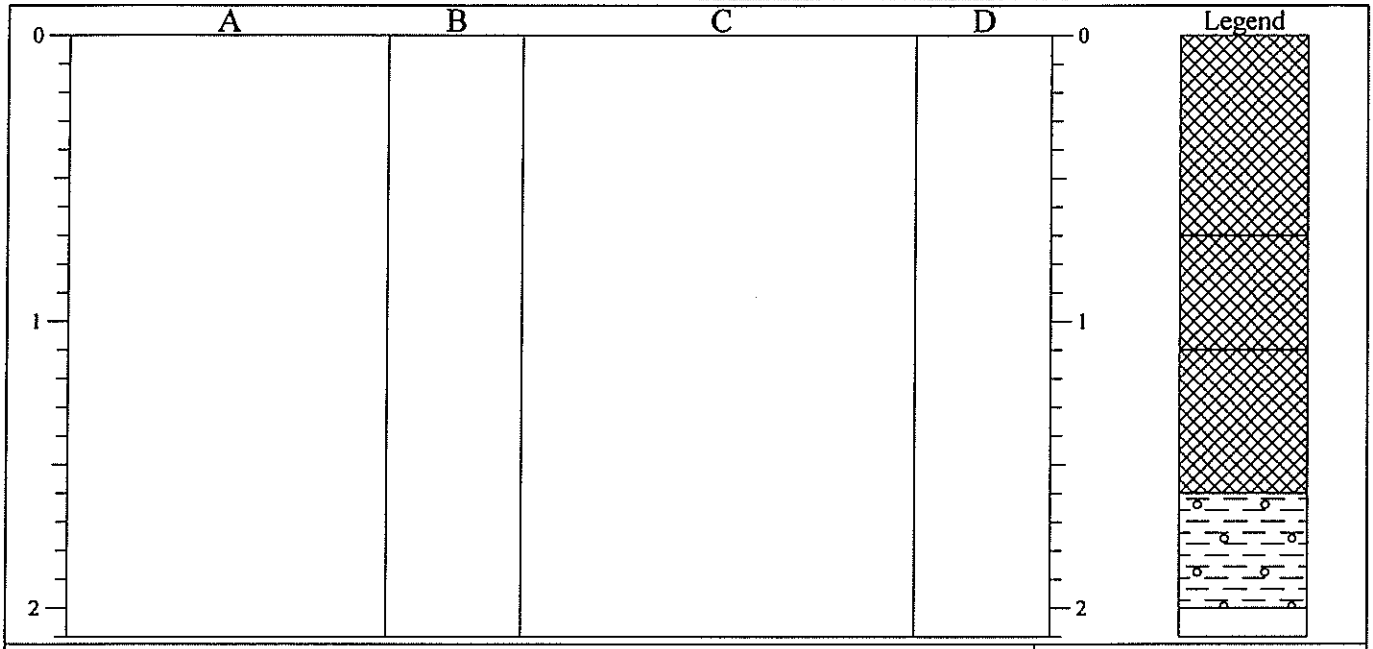
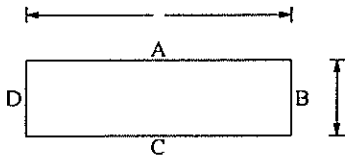
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				**TP4**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.70		MADE GROUND: Brown clay fill with concrete and brick. 2 no footings noted to 1.50m.			
0.70-1.10		MADE GROUND: Orangey brown slightly gravelly re-worked clay.			
1.10-1.60		MADE GROUND: Dark brown clay fill with glass and sinders.			
1.60-2.00		Stiff grey mottled with orangey brown slightly gravelly CLAY. (Completely weathered mudstone).	1.65	B	

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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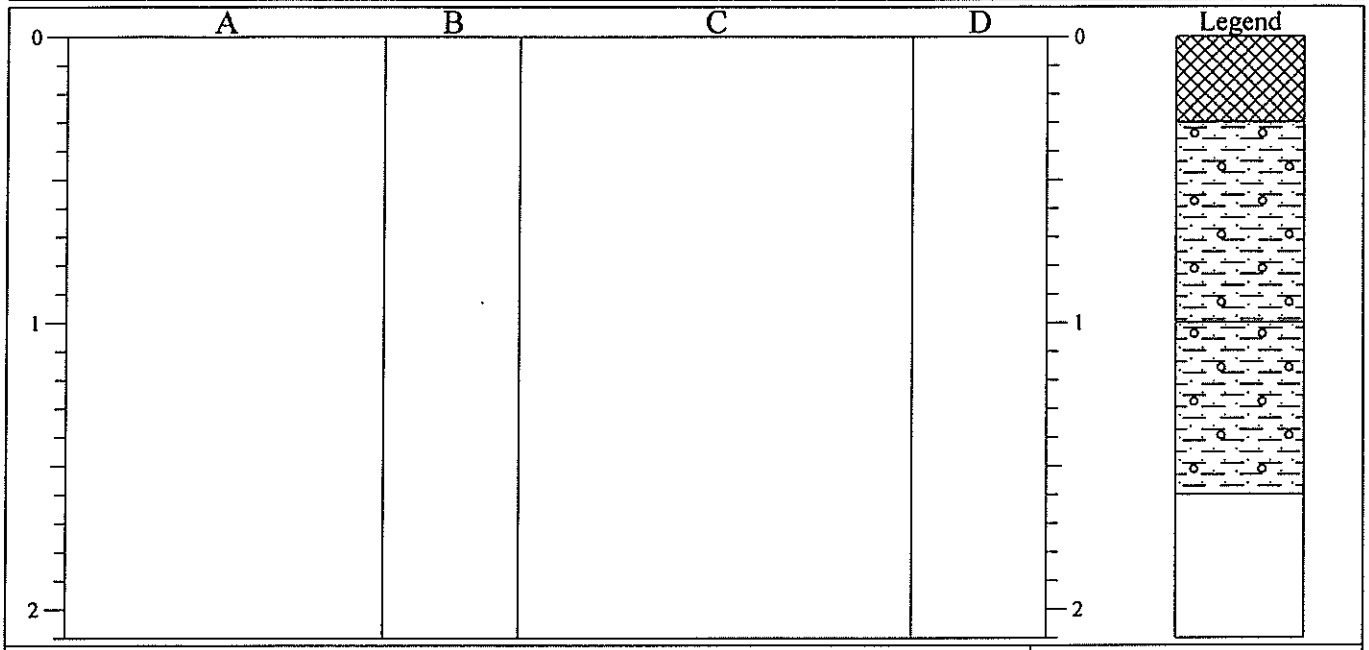
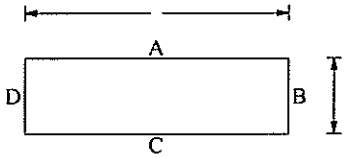
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				**TP5**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.30		MADE GROUND: Brown clay fill with brick and concrete. Gas/water pipe noted at 0.30m.			
0.30-1.00		Stiff orangey brown to grey slightly sandy gravelly CLAY.			
1.00-1.60		Stiff grey slightly gravelly CLAY. (Completely weathered mudstone).			

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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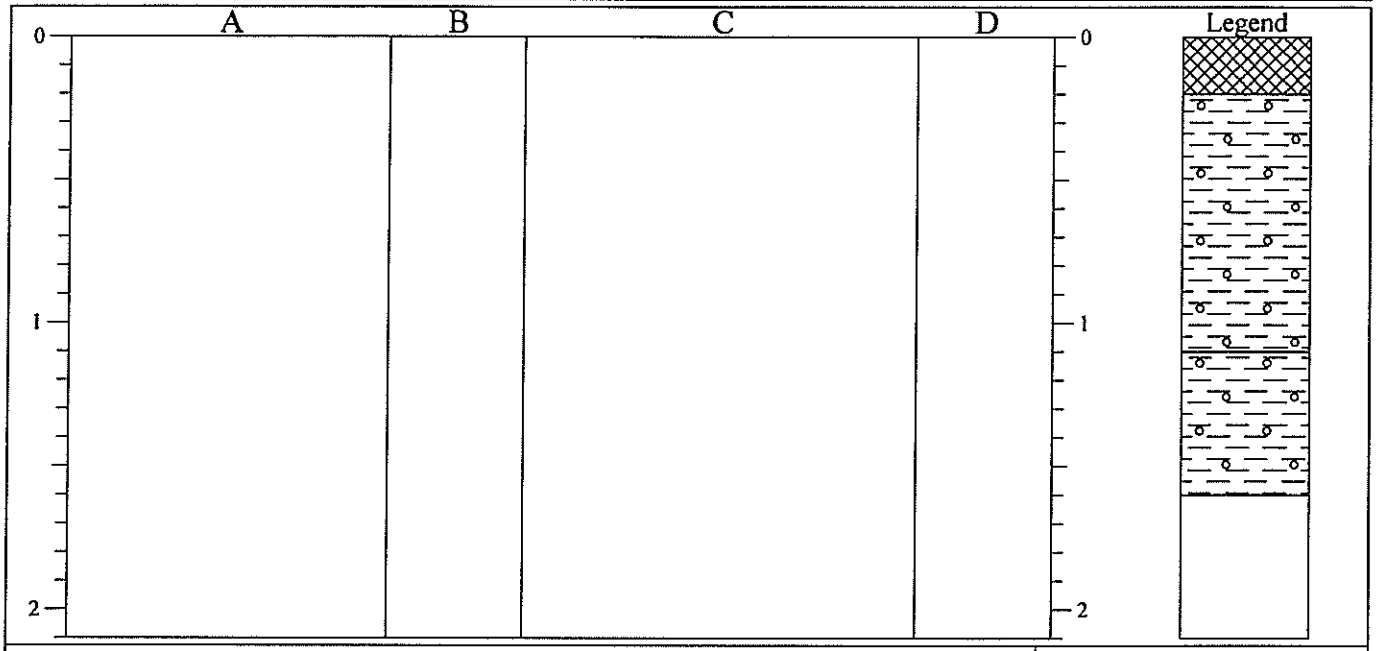
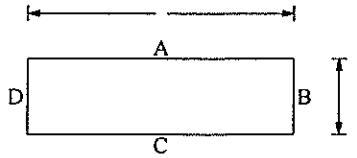
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				**TP6**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.20		MADE GROUND: Black to reddy brown gravel fill of mudstone and tarmac.	0.10	B	
0.20-1.10		Stiff orangey brown to grey slightly sandy gravelly CLAY.	0.40	CBR	=4%
			0.70	CBR	=4.5%
1.10-1.60		Stiff grey to light brown gravelly CLAY. (Completely weathered mudstone).			

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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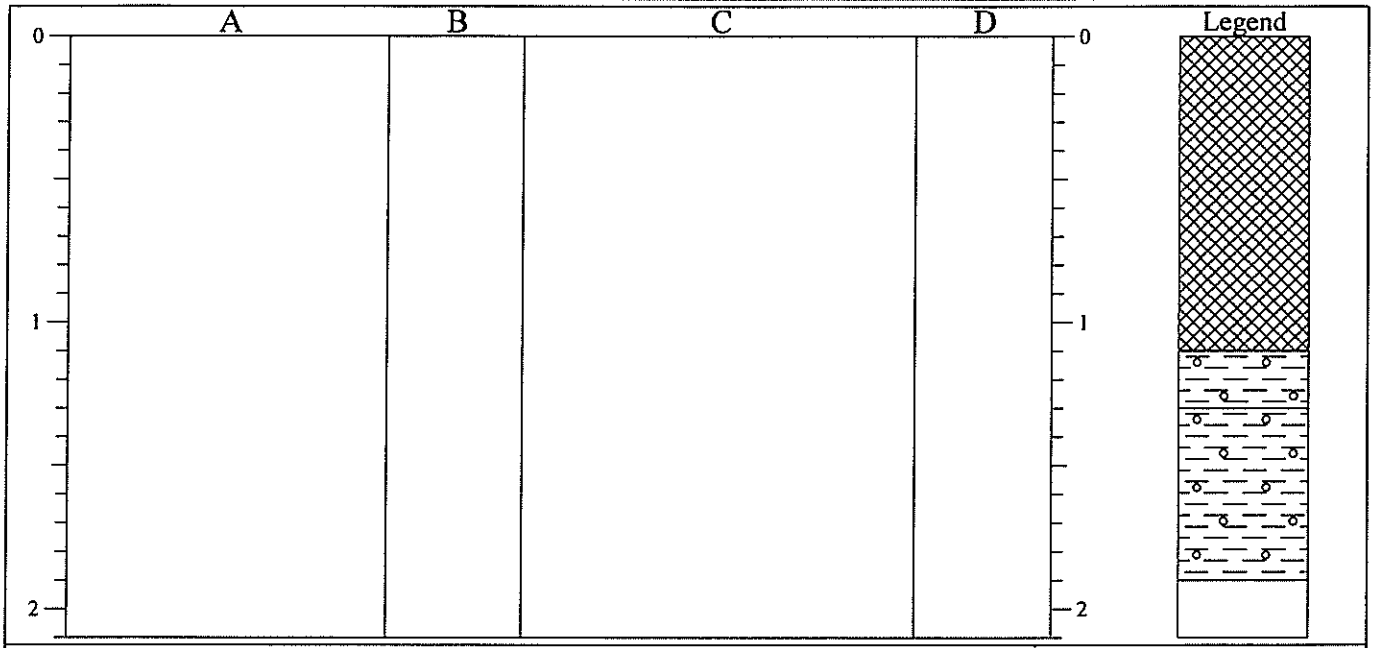
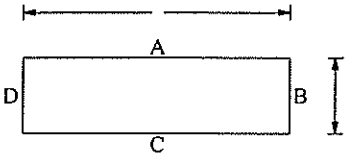
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				TP7
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-1.10		MADE GROUND: Dark brown clay fill with brick and gravel.	0.50	B	
1.10-1.30		Stiff brown gravelly CLAY.			
1.30-1.90		Stiff orangey brown to grey slightly gravelly CLAY. (Completely weathered mudstone).			

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

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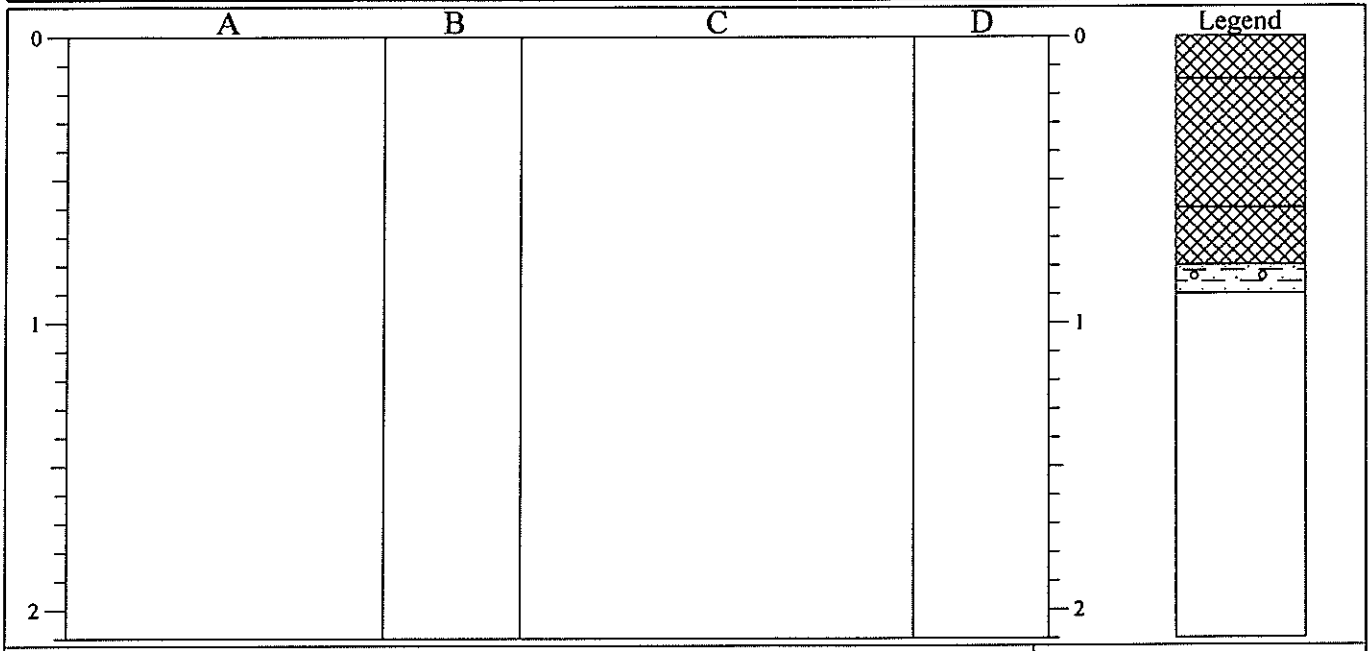
TS 18 3NA

Tel 01642 607083
Fax 01642 612355

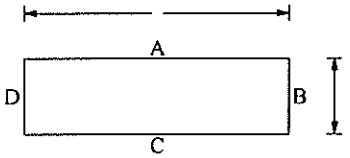
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				**TP8**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.15		MADE GROUND; Dark brown topsoil.			
0.15-0.60		MADE GROUND: Orangey brown to grey slightly gravelly re-worked clay.			
0.60-0.80		MADE GROUND: Dark brown clay fill with rare brick and glass.			
0.80-0.90		Stiff grey mottled with orangey brown slightly gravelly CLAY.	0.80	CBR	=6%

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

Solmek/Hymas Geo
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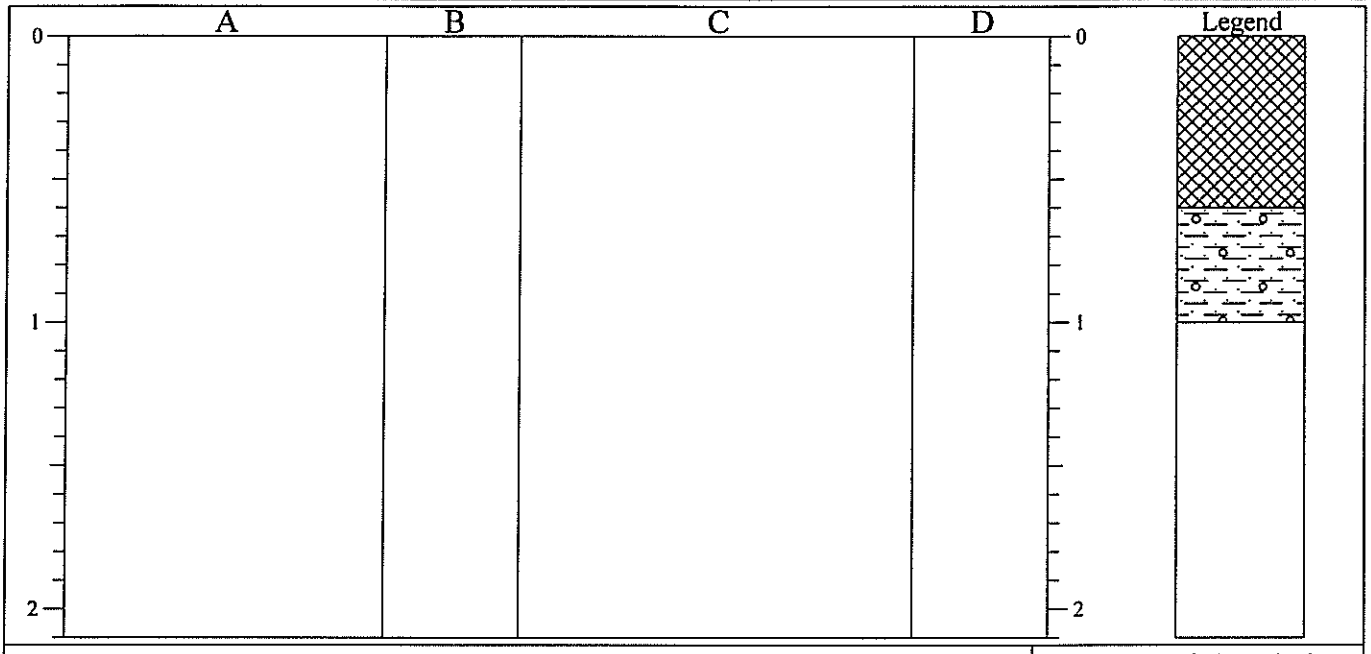
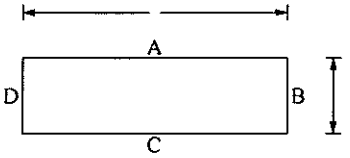
TRIAL PIT LOG

Project				TRIAL PIT No
Sheerien Close, Barnsley				TP9
Job No	Date	Ground Level (m)	Co-Ordinates ()	
S120835	03-09-12			
Contractor				Sheet
				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	Type	Remarks/Tests
0.00-0.60		MADE GROUND: Dark brown topsoil with brick.			
0.60-1.00		Stiff orangey brown to grey slightly gravelly CLAY.	0.70	CBR	=4%
			0.90	CBR	=4%

Shoring/Support:
Stability:



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres Scale 1:26.25	Client Yorkshire Housing	Method/ Plant Used	Logged By PF

GRD_TRIAL_PIT_LOG S120835.GPJ AGS3_ALL.GDT 05/10/12

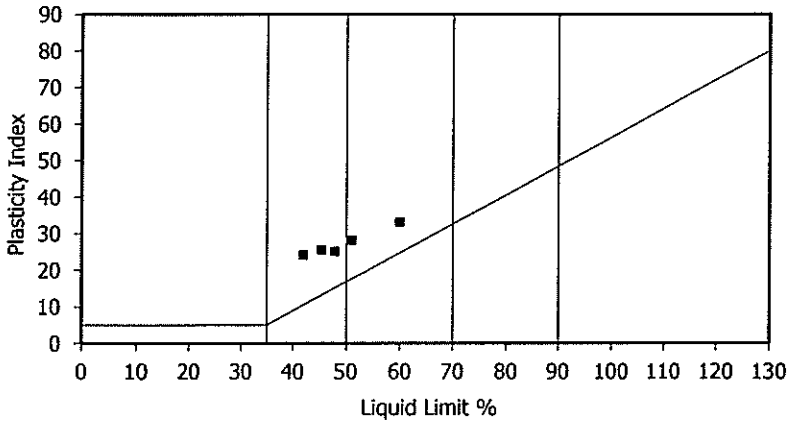
APPENDIX C:
Geotechnical Laboratory Results

SUMMARY OF SOIL CLASSIFICATION TESTS
(BS1377-2:1990+A1:1996)

SHEERIEN CLOSE, BARNSLEY
S120835

SOLMEK

Hole	Depth m	Type	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	Plasticity	% Passing 425µm	pH	SO_4 Content mg/L	Chloride Content mg/L	Lab Shear Vane (kPa)
BH1	1.0-1.3	B	22	60	27	33	CH	96.0				
BH2	1.3-1.5	B	26	51	23	28	CH	98.0				
BH2	1.9-2.0	B	26	51	23	28	CH	99.9				
BH5	0.8-1.0	B	22	45	20	25	CI	91.3				
BH6	1.50	B	21	48	23	25	CI	96.8	5.7	78		
TP4	1.65	B	22	42	18	24	CI	92.2	4.4	103		



Liquid Limit		
CE	Extremely high plasticity CLAY	>90%
ME	Extremely high plasticity SILT	
CV	Very high plasticity CLAY	70 - 90%
MV	Very high plasticity SILT	
CH	High plasticity CLAY	50 - 70%
MH	High plasticity SILT	
CI	Intermediate plasticity CLAY	35 - 50%
MI	Intermediate plasticity SILT	
CL	Low plasticity CLAY	<35%
ML	Low plasticity SILT	

Comments

Prepared: Date: 28/09/12

Checked: Date: 28/09/12

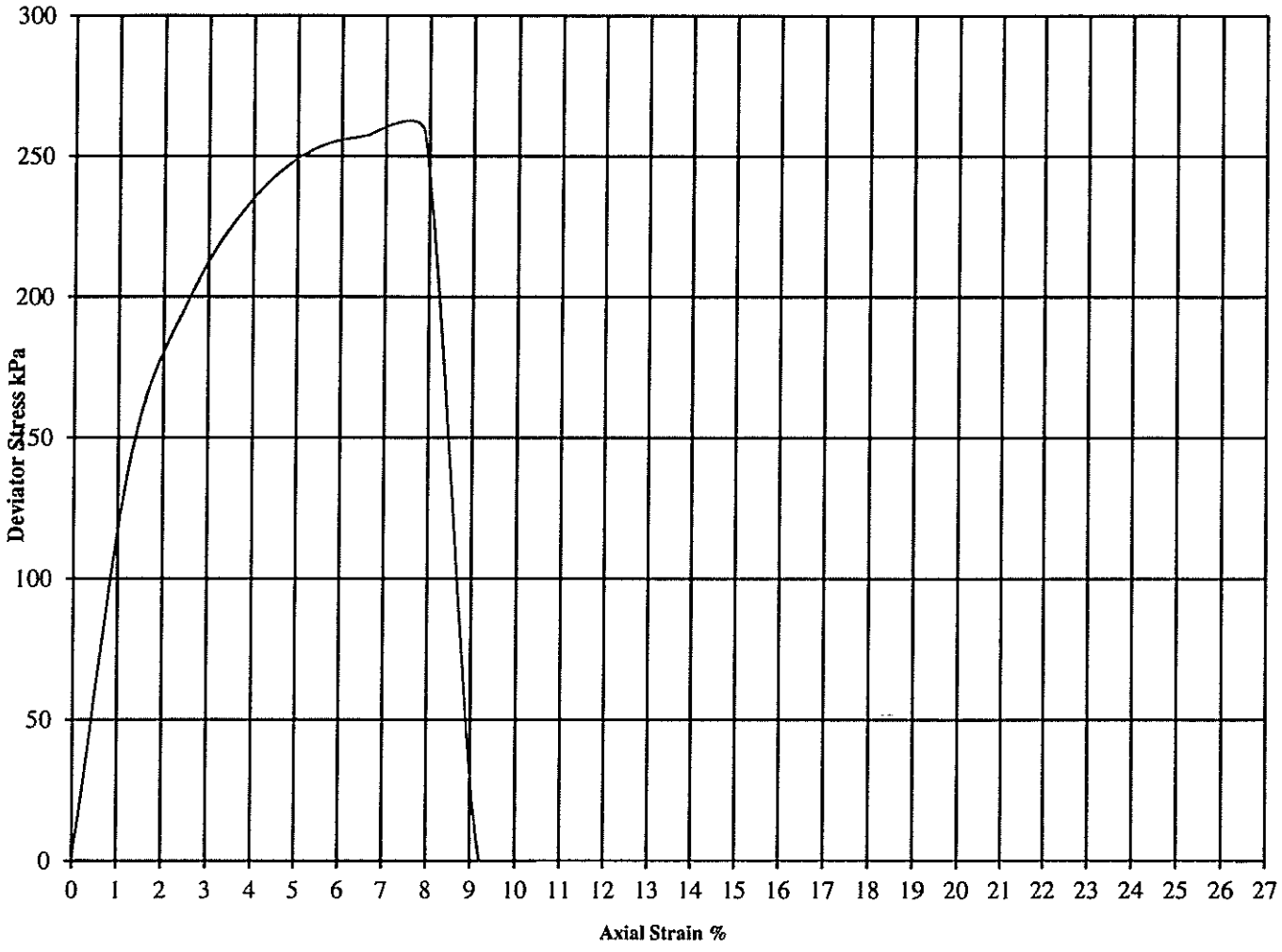
Approved: Date: 08/10/12

Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

B.S. 1377 : Part7 : Clause 8 : 1990

Hole Reference **BH 1** **Depth (m)** **1**



Diameter (mm):		38	Height (mm):		76	Test:	38 mm Single Stage.			Diagram
Stage	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Deviator Stress (kPa)	Cohesion (kPa)	Failure Strain (%)	Mode of Failure	Shear Strength (kPa)	
1	21	2.00	1.65	20	258	129	7.9	Compound	129	
Description		Stiff grey silty CLAY								

Checked and Approved	Date
	28/9/12

SOLMEK

Sheerien Close, Barnsley

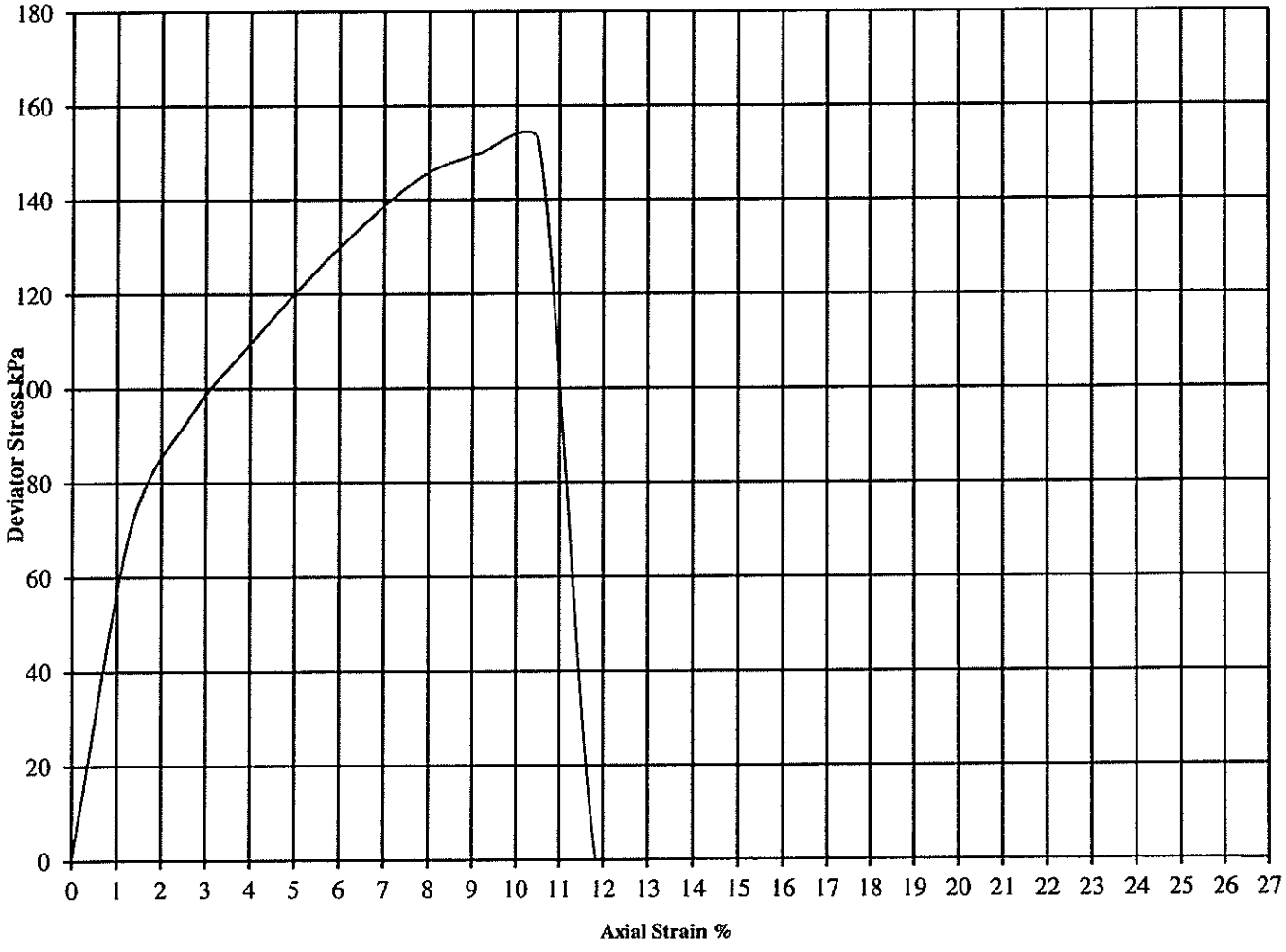
Contract No
S120835

Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

B.S. 1377 : Part7 : Clause 8 : 1990

Hole Reference BH 2 **Depth (m)** 1.3



Diameter (mm):		38	Height (mm):		76	Test:	38 mm Single Stage.			Diagram
Stage	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Deviator Stress (kPa)	Cohesion (kPa)	Failure Strain (%)	Mode of Failure	Shear Strength (kPa)	
1	26	1.97	1.56	26	152	76	10.5	Compound	76	
Description		Firm light brown slightly gravelly sandy CLAY								

Checked and Approved	Date
	28/09/12

SOLMEK

Sheerien Close, Barnsley

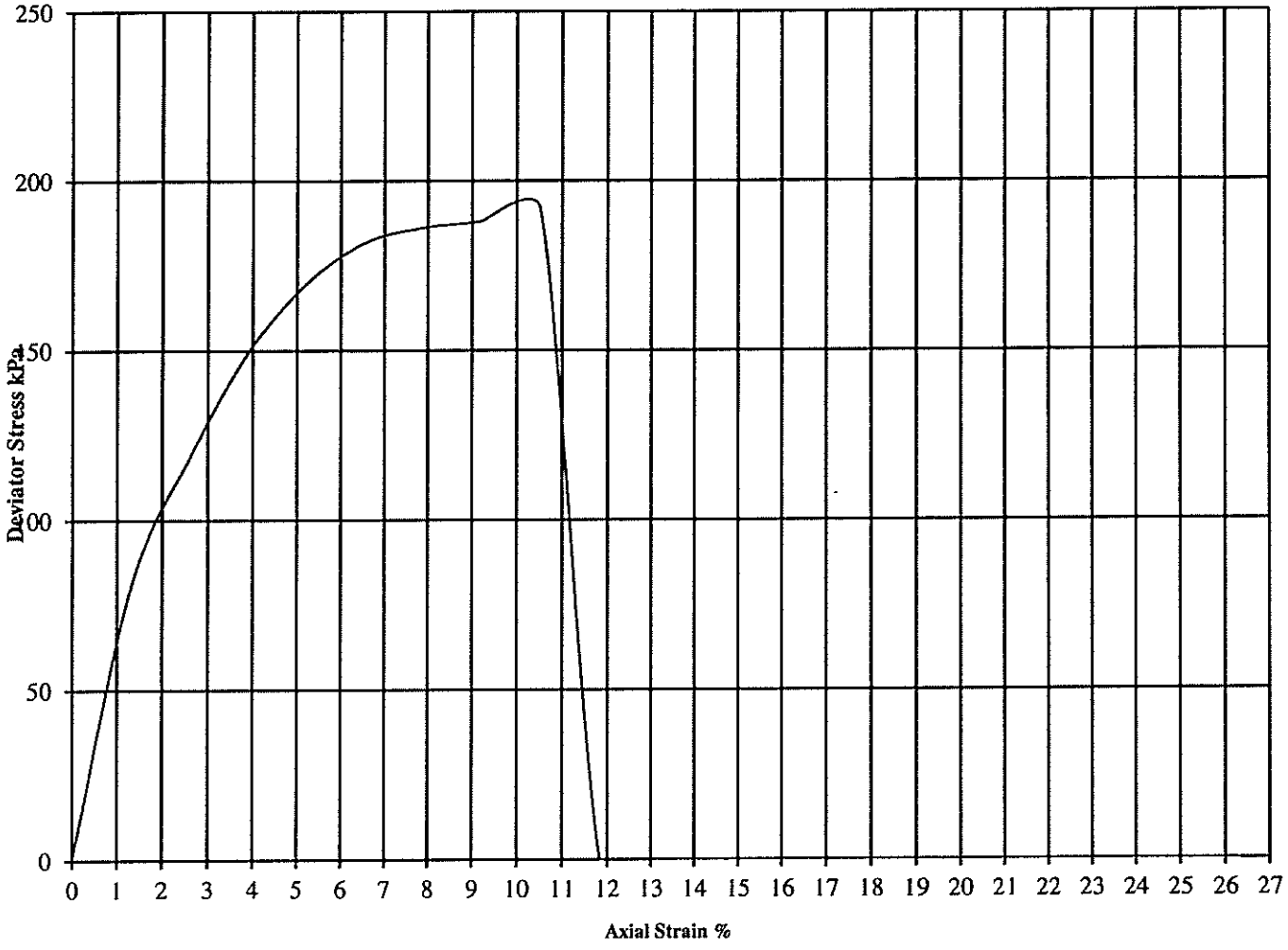
Contract No
S120835

Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

B.S. 1377 : Part7 : Clause 8 : 1990

Hole Reference **BH 5** **Depth (m)** **0.80-1.00**



Diameter (mm):		38	Height (mm):		76	Test:	38 mm Single Stage.			Diagram
Stage	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Deviator Stress (kPa)	Cohesion (kPa)	Failure Strain (%)	Mode of Failure	Shear Strength (kPa)	
1	22	2.03	1.67	20	191	96	10.5	Compound	96	
Description		Firm light brown sandy CLAY								

Checked and Approved	Date
	28/9/12

SOLMEK

Sheerien Close, Barnsley

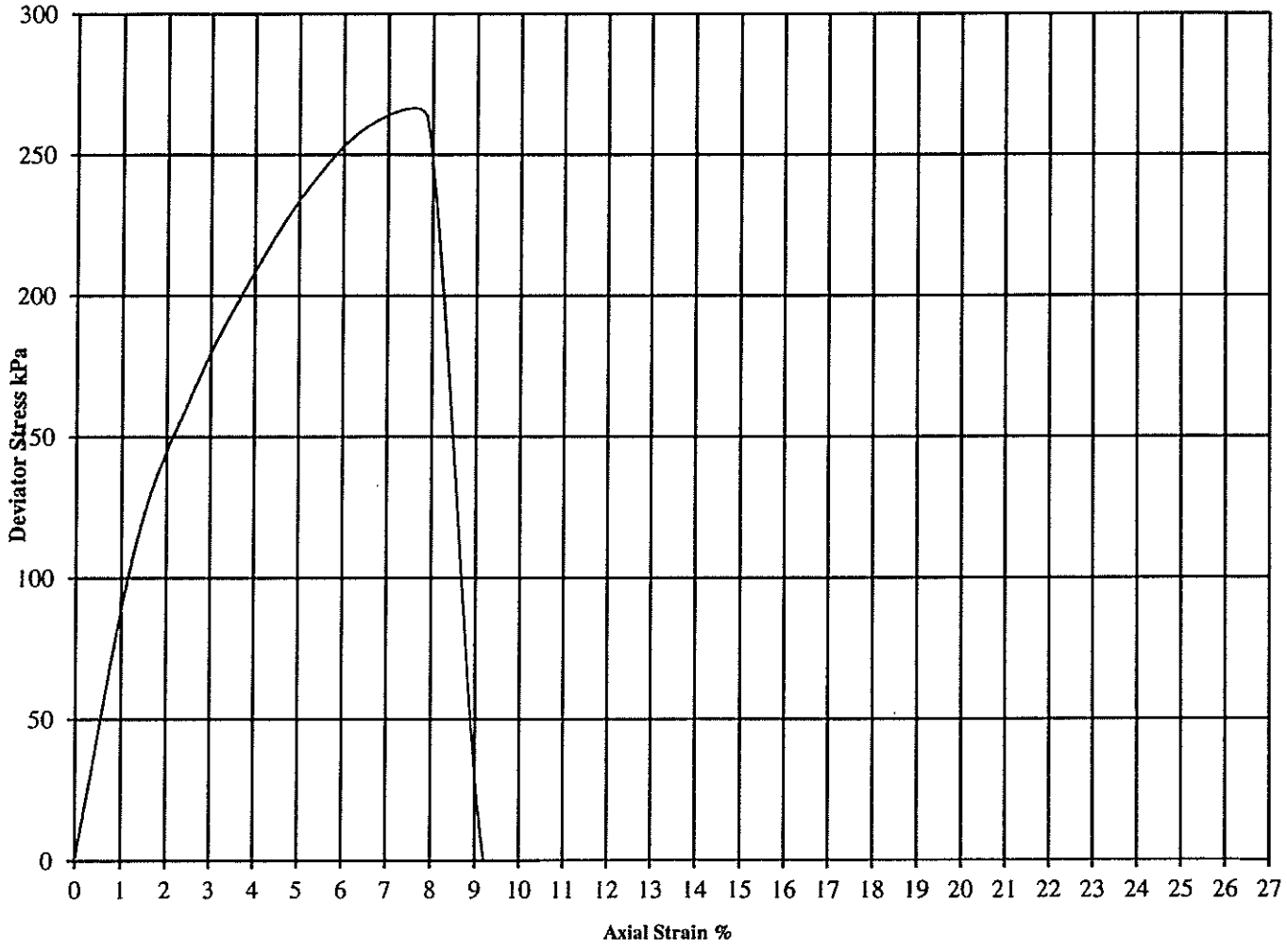
Contract No
S120835

Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

B.S. 1377 : Part7 : Clause 8 : 1990

Hole Reference BH 6 **Depth (m)** 1.5



Diameter (mm):		38	Height (mm):		76	Test:	38 mm Single Stage.			Diagram
Stage	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Deviator Stress (kPa)	Cohesion (kPa)	Failure Strain (%)	Mode of Failure	Shear Strength (kPa)	
1	21	2.09	1.73	30	262	131	7.9	Compound	131	
Description		Stiff mid brown silty CLAY								

Checked and Approved	Date
	28/9/12

SOLMEK

Sheerien Close, Barnsley

Contract No
S120835

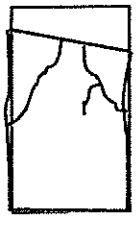
Undrained Shear Strength in Triaxial Compression

without measurement of Pore Pressure

B.S. 1377 : Part7 : Clause 8 : 1990

Hole Reference TP 4 **Depth (m)** 1.65

Diameter (mm):		38	Height (mm):		76	Test:	38 mm Single Stage.			Diagram
Stage	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Deviator Stress (kPa)	Cohesion (kPa)	Failure Strain (%)	Mode of Failure	Shear Strength (kPa)	
1	22	2.05	1.68	32	227	113	21.1	Compound	113	
Description		Firm grey mottle orange sandy CLAY								



Checked and Approved	Date
	28/7/12

SOLMEK

Sheerien Close, Barnsley

Contract No
S120835

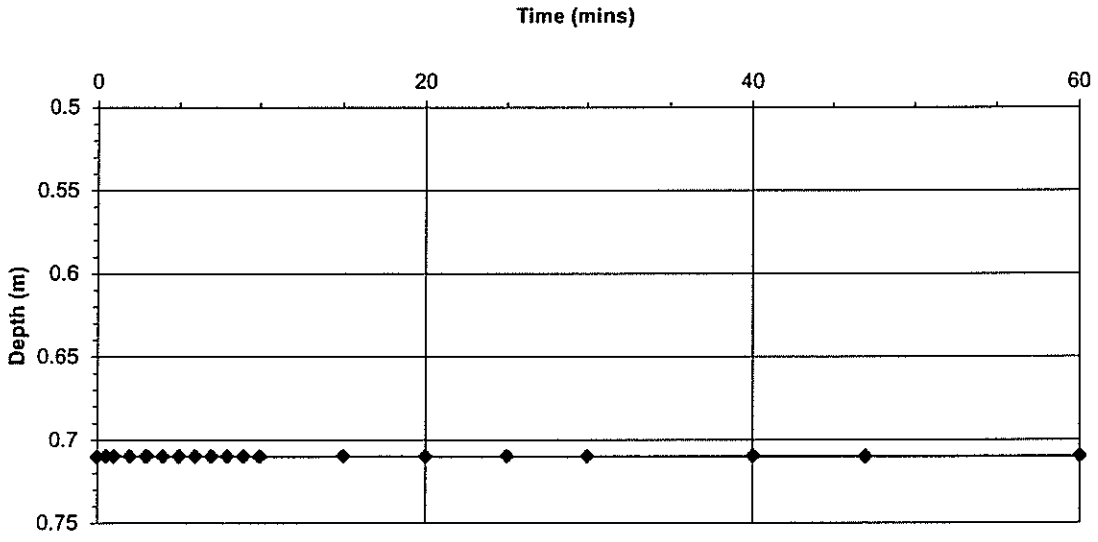
SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 1991
BRE Digest 365, Figure 2, Page 5

Client:	Yorkshire Housing				
Site:	Sheerien Close, Barnsley				
Job No:	S120835				
Pit No:	TP1		Test No:	1	

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (m)
0	0.71
0.5	0.71
1	0.71
2	0.71
3	0.71
4	0.71
5	0.71
6	0.71
7	0.71
8	0.71
9	0.71
10	0.71
15	0.71
20	0.71
25	0.71
30	0.71
40	0.71
47	0.71
60	0.71
90	0.71
120	0.71
180	0.71

Pit Dimensions	Length (m) =	1.20	
	Width (m) =	0.50	
	Depth (m) =	1.85	
Depth at start of test (m) =		0.710	
Depth at end of test (m)=		0.710	
75% level (m)=		0.710	
50% Effective Depth		0.000	
25% level (m)=		0.710	
Base area of pit (m^2) =		0.600	
Vp_{75-25} (m^3) =		0.000	
a_{p50} (m^2) =		0.600	
From the graph:			
tp 75 (min) =	1		
tp 25 (min) =	1		
Soil infiltration rate, f, (m/s) =	#DIV/0!	normal test	
Input by:	RW	Date:	08/10/2012
Checked by:		Date:	



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 1991
BRE Digest 365, Figure 2, Page 5

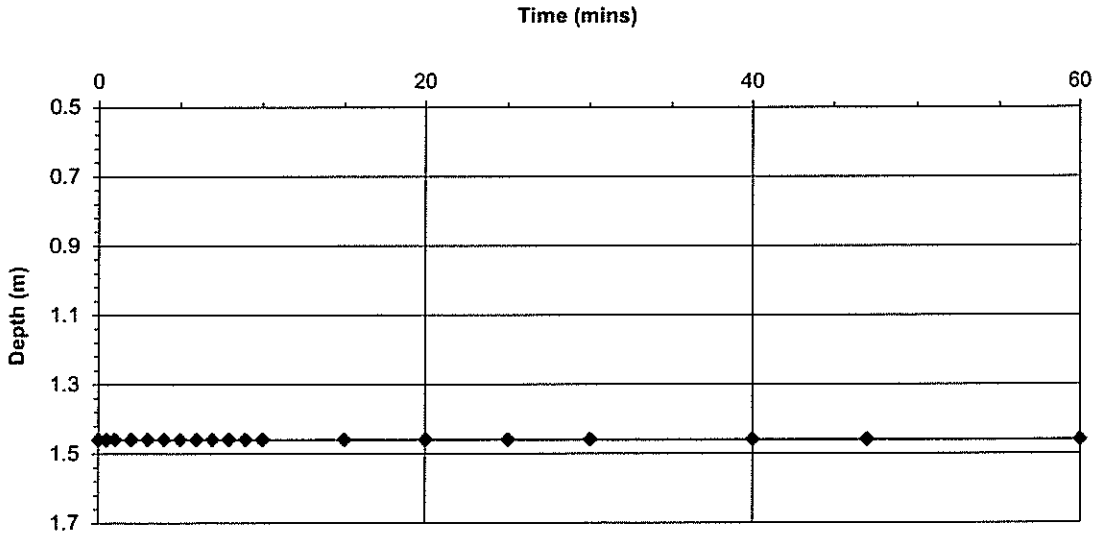
Client:	Yorkshire Housing				
Site:	Sheerien Close, Barnsley				
Job No:	S120835				
Pit No:	TP2		Test No:	1	

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (m)
0	1.46
0.5	1.46
1	1.46
2	1.46
3	1.46
4	1.46
5	1.46
6	1.46
7	1.46
8	1.46
9	1.46
10	1.46
15	1.46
20	1.46
25	1.46
30	1.46
40	1.46
47	1.46
60	1.46
90	1.46
120	1.46
180	1.46

Pit Dimensions	
Length (m) =	1.30
Width (m) =	0.50
Depth (m) =	1.95
Depth at start of test (m) =	1.460
Depth at end of test (m)=	1.460
75% level (m)=	1.460
50% Effective Depth	0.000
25% level (m)=	1.460
Base area of pit (m^2) =	0.650
Vp_{75-25} (m^3) =	0.000
a_{p50} (m^2) =	0.650
From the graph:	
tp 75 (min) =	2
tp 25 (min) =	3
Soil infiltration rate, f, (m/s) =	0.00E+00 normal test

Input by:	RW	Date:	08/10/2012
Checked by:		Date:	



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 1991
BRE Digest 365, Figure 2, Page 5

Client:	Yorkshire Housing				
Site:	Sheerien Close, Barnsley				
Job No:	S120835				
Pit No:	TP6		Test No:	1	

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (m)
0	0.73
0.5	0.73
1	0.73
2	0.73
3	0.73
4	0.73
5	0.73
6	0.73
7	0.73
8	0.73
9	0.73
10	0.73
15	0.73
20	0.73
25	0.73
30	0.73
40	0.73
47	0.73
60	0.73
90	0.73
120	0.73
180	0.73

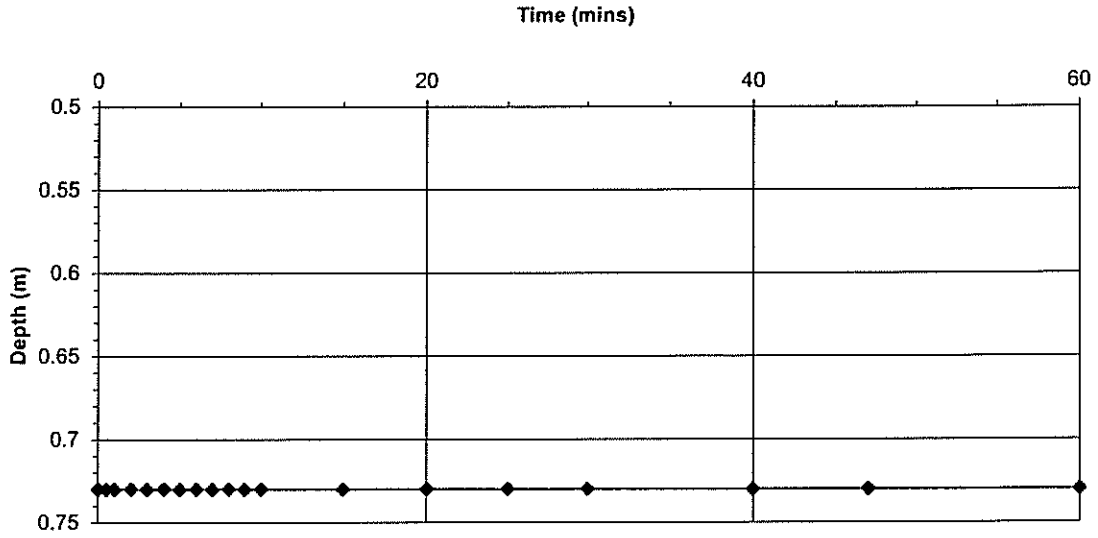
Pit Dimensions	
Length (m) =	1.15
Width (m) =	0.50
Depth (m) =	1.60

Depth at start of test (m) =	0.730
Depth at end of test (m)=	0.730
75% level (m)=	0.730
50% Effective Depth	0.000
25% level (m)=	0.730
Base area of pit (m^2) =	0.575
Vp_{75-25} (m^3) =	0.000
a_{p50} (m^2) =	0.575

From the graph:	
tp 75 (min) =	2
tp 25 (min) =	3

Soil infiltration rate, f, (m/s) =	0.00E+00	normal test

Input by:	RW	Date:	08/10/2012
Checked by:		Date:	



APPENDIX D:
Contamination Laboratory Results and CLEA Model Output Reports

dets
Derwentside Environmental Testing Services

UKAS TESTING
2139

Certificate of Analysis

Date: 27/09/2012

Certificate Number: 12-68982

Client:	SOLMEK 12 Yarm Road Stockton On Tees Cleveland TS18 3NA
Our Reference:	12-68982
Client Reference:	S120835
Contract Title:	Sheerien Close, Barnsley
Description:	3 soil samples
Date Received:	19 September 2012
Date Started:	20 September 2012
Date Completed:	27 September 2012
Test Procedures:	Identified by prefix DETSn (details on request), Asbestos Analysis (DETS 082).
Notes:	Observations and interpretations are outside the scope of UKAS accreditation
Approved By:	

Rob Brown Business Manager

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 except in full, without the prior written approval of the laboratory.

Derwentside Environmental Testing Services Limited
Unit 2, Park Road Industrial Estate South, Consett, Co Durham, DH8 5PY
Tel: 01207 582333 • Fax 01207 582444 • email: info@dets.co.uk • www.dets.co.uk

Information in Support of the Analytical Results

Analysis

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425um sieve, in accordance with BS1377.
Organic soil analysis was carried out on an 'as received' sample.

Key

*	Denotes test not included in laboratory scope of accreditation
#	Denotes test that holds MCERTS accreditation, however, MCERTS accreditation is only implied if the report carries the MCERTS logo
$	Denotes tests completed by an approved subcontractor
I/S	Denotes insufficient sample to carry out test
U/S	Denotes that the sample is not suitable for testing

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month
Liquids - 2 weeks
Asbestos (test portion) - 6 months

Summary of Chemical Analysis
Soil Samples

Our Ref: 12-68982
Client Ref: S120835
Contract Title: Sheerien Close, Barnsley

			Lab No.	445907	445908	445909
			Sample ID	BH1	BH3	BH6
			Depth	0.2-03	0.30-0.50	0.10
			Sample Ref			
			Sample Type			
			Sampling Date	/ /	/ /	03/08/2012
			Sampling Time			
Test	**Units**	**DETSxx**	**LOD**			
Arsenic	mg/kg	DETS 042#	0.2	14	16	15
Cadmium	mg/kg	DETS 042#	0.1	0.3	1.2	1.4
Chromium	mg/kg	DETS 042#	0.15	38	33	51
Hexavalent Chromium	mg/kg	DETSC 2204*	1	< 1.0	< 1.0	< 1.0
Copper	mg/kg	DETS 042#	0.2	110	26	62
Lead	mg/kg	DETS 042#	0.3	48	52	45
Mercury	mg/kg	DETSC 2325#	0.05	0.10	0.07	< 0.05
Nickel	mg/kg	DETS 042#	1	28	32	52
Selenium	mg/kg	DETS 042#	0.5	0.8	1.0	< 0.5
Zinc	mg/kg	DETS 042#	1	42	120	130
Boron (water soluble)	mg/kg	DETS 020#	0.2	1.0	1.4	1.2
Cyanide total	mg/kg	DETSC 2130#	0.1	0.2	0.4	0.2
Organic matter	%	DETSC 2002#	0.1	3.2	4.0	4.1
Sulphide	mg/kg	DETSC 2024#	10	< 10.0	< 10.0	52
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	49	63	75
pH		DETSC 2008#		6.2	6.7	8.6
Phenol - Monohydric	mg/kg	DETSC 2130#	0.3	1.0	0.7	0.7

Summary of Asbestos Analysis
Soil Samples

Our Ref: 12-68982
Client Ref: S120835
Contract Title: Sheerien Close, Barnsley

Lab No	Sample Ref	Material Type*	Result	Comment	Analyst
445907	BH1 0.2-0.3	Soil	NAD	None	Colin Patrick
445908	BH3 0.30-0.50	Soil	NAD	None	Colin Patrick
445909	BH6 0.10	Soil	NAD	None	Colin Patrick

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. NAD = No Asbestos Detected. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETS 082 using polarised light microscopy in accordance with HSG248 and documented in-house methods. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'.

CLEA Software Version 1.06

Report generated 04-Oct-12

Report title Sheerien Close, Barnsley

Created by RW at Solmek Ltd

RESULTS

Environment Agency

Environment Agency

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?	
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal
1	Cadmium	5.45E+00	2.97E+01	5.17E+00	0.91	0.10	1.00	NR	Yes	Yes
2	Chromium III	1.95E+04	3.55E+03	3.00E+03	0.15	0.85	1.00	NR	No	No
3	Chromium VI	NR	4.25E+00	NR	0.00	1.00	NR	NR	Yes	No
4	Copper	2.70E+03	1.04E+04	2.36E+03	0.77	0.23	1.00	NR	Yes	No
5	Mercury, inorganic	1.81E+02	2.55E+03	1.69E+02	0.93	0.07	1.00	NR	No	No
6	Nickel	5.31E+02	1.27E+02	NR	0.14	1.00	NR	NR	Yes	Yes
7	Zinc	3.74E+03	7.49E+03	2.86E+03	0.62	0.38	1.00	NR	Yes	No
8	Arsenic	3.24E+01	8.50E+01	NR	1.00	0.38	NR	NR	No	No
9	Boron	2.91E+02	1.05E+01	1.03E+01	0.02	0.98	1.00	NR	Yes	No
10	Selenium	3.50E+02	NR	NR	1.00	NR	NR	NR	Yes	No
11	Cyanide	1.17E+01	1.75E+00	1.62E+00	0.07	0.93	1.00	NR	Yes	No
12	Phenol	1.21E+03	5.07E+02	3.57E+02	0.30	0.70	1.00	1.05E+05 (vap)	No	No
13										
14										
15										
16										
17										
18										
19										
20										

Environment Agency

	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?	
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

		Soil Distribution				Media Concentrations													
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	Cadmium	99.6	0.4	0.0	100.0	5.17E+00	NR	2.59E+00	2.20E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-01	1.50E-01	1.60E-01	8.28E-02	1.60E-02	7.24E-03
2	Chromium III	100.0	0.0	0.0	100.0	3.00E+03	NR	1.50E+03	1.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.01E-02	9.01E-02	9.01E-02	9.01E-02	9.01E-02	9.01E-02
3	Chromium VI	98.0	2.0	0.0	100.0	4.25E+00	NR	2.12E+00	1.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.50E-04	4.25E-04	4.25E-04	3.82E-01	1.27E-03	3.82E-01
4	Copper	99.6	0.4	0.0	100.0	2.36E+03	NR	1.18E+03	1.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.85E+01	4.85E+01	4.85E+01	4.85E+01	4.85E+01	4.85E+01
5	Mercury, inorganic	99.9	0.1	0.0	100.0	1.69E+02	NR	8.43E+01	7.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.41E-01	1.16E+00	7.25E-01	1.69E-01	1.86E-01	1.69E-01
6	Nickel	99.9	0.1	0.0	100.0	1.27E+02	NR	6.37E+01	5.42E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.84E-01	5.48E-01	2.42E-01	3.19E-01	3.19E-01	4.33E-01
7	Zinc	99.0	1.0	0.0	100.0	2.86E+03	NR	1.43E+03	1.22E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E+02	1.54E+02	1.54E+02	4.09E+02	1.54E+02	1.54E+02
8	Arsenic	99.9	0.1	0.0	100.0	3.24E+01	NR	1.62E+01	1.38E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-02	1.30E-02	7.45E-03	1.07E-02	6.48E-03	3.56E-02
9	Boron	96.3	3.7	0.0	100.0	1.03E+01	NR	5.14E+00	4.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E+00	2.06E+00	2.06E+00	2.06E+00	2.06E+00	2.06E+00
10	Selenium	99.3	0.7	0.0	100.0	3.50E+02	NR	1.75E+02	1.49E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.78E+00	1.27E+00	2.91E-01	9.49E-01	1.05E+00	1.05E+00
11	Cyanide	-268.4	368.4	0.0	100.0	1.62E+00	NR	8.08E-01	6.88E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.57E-01	7.57E-01	7.57E-01	7.57E-01	7.57E-01	7.57E-01
12	Phenol	80.7	19.3	0.0	100.0	3.57E+02	1.56E+00	1.79E+02	1.52E-07	0.00E+00	1.34E-03	1.00E-04	0.00E+00	1.48E+02	2.68E+02	1.60E+02	0.00E+00	0.00E+00	3.02E+02
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	Soil Distribution				Media Concentrations													
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
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Environment Agency

		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	Cadmium	3.84E-05	1.32E-04	1.97E-07	1.22E-07	0.00E+00	7.54E-04	1.21E-06	11.21	38.70	0.06	0.04	0.00	0.00	49.96	0.04
2	Chromium III	2.23E-02	3.53E-04	0.00E+00	7.07E-05	0.00E+00	3.39E-03	1.64E-05	85.34	1.35	0.00	0.27	0.00	0.00	12.97	0.06
3	Chromium VI	3.15E-05	1.82E-04	0.00E+00	1.00E-07	0.00E+00	3.77E-04	0.00E+00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
4	Copper	1.75E-02	5.23E-02	0.00E+00	5.55E-05	0.00E+00	3.94E-01	4.12E-05	12.52	37.44	0.00	0.04	0.00	0.00	49.97	0.03
5	Mercury, inorganic	1.25E-03	5.64E-04	0.00E+00	3.97E-06	0.00E+00	5.63E-05	0.00E+00	66.71	30.08	0.00	0.21	0.00	0.00	3.00	0.00
6	Nickel	9.45E-04	4.66E-04	2.43E-05	3.00E-06	0.00E+00	7.31E-03	3.64E-06	32.77	16.18	0.84	0.10	0.00	0.00	49.90	0.10
7	Zinc	2.12E-02	2.08E-01	0.00E+00	6.73E-05	0.00E+00	1.52E+00	1.45E-04	3.09	30.23	0.00	0.01	0.00	0.00	33.33	0.02
8	Arsenic	2.40E-04	2.27E-05	3.70E-05	7.62E-07	0.00E+00	0.00E+00	0.00E+00	79.89	7.54	12.31	0.25	0.00	0.00	0.00	0.00
9	Boron	7.63E-05	2.75E-03	0.00E+00	2.42E-07	0.00E+00	2.08E-01	2.41E-05	0.90	32.34	0.00	0.00	0.00	0.00	33.24	0.28
10	Selenium	2.60E-03	1.82E-03	0.00E+00	8.24E-06	0.00E+00	1.97E-03	3.64E-06	40.59	28.46	0.00	0.13	0.00	0.00	30.82	0.00
11	Cyanide	1.20E-05	8.12E-04	6.16E-06	3.80E-08	0.00E+00	1.69E-02	3.64E-06	0.48	32.56	0.25	0.00	0.00	0.00	33.28	0.15
12	Phenol	2.65E-03	1.99E-01	4.08E-03	8.41E-06	1.24E-03	1.97E-02	2.42E-03	1.16	86.84	1.78	0.00	0.54	0.00	8.61	1.06
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	Average Daily Exposure (mg kg^{-1} bw day^{-1})							ibution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produc	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
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			Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})	Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailabi inhalation (unitless)
1	Cadmium	TDI	0.36	TDI	0.0014	13.4	0.02	NR	NR	NR	NR	NR	0.001	0.5	1	1	1
2	Chromium III	TDI	150	TDI	0.1	60.2	0.27	NR	NR	NR	NR	NR	0	0.5	1	1	1
3	Chromium VI	TDI	1	ID	0.0001	6.7	NR	NR	NR	NR	NR	NR	0	0.5	1	1	1
4	Copper	TDI	160	TDI	0.286	7000	0.68	NR	NR	NR	NR	NR	0	0.5	1	1	1
5	Mercury, inorganic	TDI	2	TDI	0.06	1	0	NR	NR	NR	NR	NR	0	0.5	1	1	1
6	Nickel	TDI	12	TDI	0.006	130	0.06	NR	NR	NR	NR	NR	0.005	0.5	1	1	1
7	Zinc	TDI	600	TDI	600	27000	2.4	NR	NR	NR	NR	NR	0	0.5	1	1	1
8	Arsenic	ID	0.3	ID	0.002	NR	NR	NR	NR	NR	NR	NR	0.03	0.5	1	1	1
9	Boron	TDI	160	TDI	2.9	3700	0.398	NR	NR	NR	NR	NR	0	0.5	1	1	1
10	Selenium	TDI	6.4	NR	0	35	0.06	NR	NR	NR	NR	NR	0	0.5	1	1	1
11	Cyanide	TDI	12	TDI	0.9	300	0.06	NR	NR	NR	NR	NR	0.1	0.5	1	1	1
12	Phenol	TDI	700	TDI	10	350	40	8.35E-06	7.90E-06	6.36E-10	1.92	1.48	0.3	0.5	1	1	1
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Environment Agency

	Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})		Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
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		Soil-to-water partitic --- ($cm^3\ g^{-1}$)	Vapour pressure (P	Water solubility (mg	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
1	Cadmium	1.00E+02	NR	1.62E+06	0.052 fw	0.029 fw	0.031 fw	0.016 fw	0.0031 fw	0.0014 fw
2	Chromium III	4.80E+03	NR	5.85E+05	0.00003 fw	0.00003 fw	0.00003 fw	0.00003 fw	0.00003 fw	0.00003 fw
3	Chromium VI	1.80E+01	NR	2.30E+06	0.0002 fw	0.0001 fw	0.0001 fw	0.09 fw	0.0003 fw	0.09 fw
4	Copper	1.00E+02	NR	1.38E+06	0.0206 fw	0.0206 fw	0.0206 fw	0.0206 fw	0.0206 fw	0.0206 fw
5	Mercury, inorganic	5.00E+02	NR	7.40E+04	0.0038 fw	0.0069 fw	0.0043 fw	0.001 fw	0.0011 fw	0.001 fw
6	Nickel	5.00E+02	NR	2.50E+06	0.0038 fw	0.0043 fw	0.0019 fw	0.0025 fw	0.0025 fw	0.0034 fw
7	Zinc	3.80E+01	NR	4.32E+06	0.054 fw	0.054 fw	0.054 fw	0.143 fw	0.054 fw	0.054 fw
8	Arsenic	5.00E+02	NR	1.25E+06	0.00043 fw	0.0004 fw	0.00023 fw	0.00033 fw	0.0002 fw	0.0011 fw
9	Boron	1.00E+01	NR	6.35E+04	0.4 fw	0.2 fw	0.2 fw	0.2 fw	0.2 fw	0.2 fw
10	Selenium	5.00E+01	NR	2.17E+06	0.0108 fw	0.00364 fw	0.00083 fw	0.00271 fw	0.003 fw	0.003 fw
11	Cyanide	1.00E-01	NR	1.00E+05	model	model	model	model	model	model
12	Phenol	1.54E+00	1.15E+01	8.41E+04	model	model	model	0.00E+00	0.00E+00	model
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	Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concer factor for green veg g^{-1} plant DW or FW mg g^{-1} DW soil)	Soil-to-plant concer factor for root veget g^{-1} plant DW or FW mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
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APPENDIX E:
Notes on Limitations & Contamination Guidance

SOLMEK NOTES ON CONTAMINATION GUIDANCE(REF: VERSION 1/2012)

UK BACKGROUND

A qualitative approach using the statutory definition of Contaminated land as defined with Section 78A (2) of Part 2A of the Environmental Protection Act has been adopted. This defines contaminated land (DEFRA 'Guidance on the Legal Definition of Contaminated Land', July 2008b) as:

"any land which appears to the local authority in whose area the land is situated to be in such a condition, by reason of substances in, on or under the land, that (a) significant harm is being caused or there is a significant possibility of such harm being caused; or (b) pollution of controlled waters is being, or is likely to be, caused"

"Harm" is defined as *harm to the health of living organisms or other interference within the ecological systems of which they form part, and in the case of man, includes harm to his property.*

The concept of "significant harm" is dealt with via the Government guidance DEFRA Circular 02/2000 Contaminated Land: *"Implementation of Part IIA of the Environmental Protection Act 1990"*. The statutory guidance uses the concept of pollutant linkages set out in Section 2.4 of the circular. Before the Local Authority can make a judgement on whether *"significant harm"* and the significant possibility of harm is being caused they are required to identify a *"significant pollution linkage"*. This means effectively that three elements (a **source** of contamination, a relavent **receptor** and a **pathway**) must be present. In statutory terms:

- A **source** is a substance that is in, on or under the land and has the potential to cause harm.
- A **receptor** is in general terms, is something that could be adversely affected by a contaminant, such as people.
- A **pathway** is a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Without identification of all three elements together, land should not be regarded as *"Contaminated"* in the statutory sense. Solmek adopts the above measures in accordance with CLR 11 (2004) 'Model Procedures for the management of Land Contamination'.

HUMAN RECEPTORS

Human exposure to contaminants present in soils can occur via several pathways. Direct exposure pathways include dermal absorption after contact with contaminated ground, inhalation of soil or dust, inhalation of volatised compounds, and inadvertent soil ingestion (or deliberate soil ingestion in the case of some children). Other indirect pathways include human ingestion of plants grown in contaminated soil or contaminated ground or surface water. Contaminants associated with wind blown dust can affect humans on surrounding sites.

DEFRA published the discussion paper 'Soil Guideline Values: the way forward' (2006). Following consultation, DEFRA released 'Improvements to Contaminated Land Guidance and Outcome of the Way Forward exercise on Soil Guideline Values' (2008b). From this review DEFRA and the Environment Agency had withdrawn documents CLR 7 to 10 since these no longer fully reflect the new UK approach, along with the associated Soil Guidelines Values (SGV). The Environment Agency have revised and updated information presented in CLR 7 to 10 within two recently published CLEA Framework Reports: Human health toxicological assessment of contaminants in soil (Science Report Final SC050021/SR2) and updated technical background to the CLEA model (Science Report Final SC050021/SR3).

The Environment Agency released the updated CLEA Software Version 1.06 in May 2011 which accompanies the two CLEA Framework Reports and reflects the updated approach. Solmek uses the CLEA Software Version 1.06 to derive a series of Generic Assessment Criteria (GAC) threshold values based on a number of site and soil parameters. Solmek GAC values represent a level at which a risk to human health may exist and are primarily intended as a guide to site redevelopment. Various factors used within the CLEA software by Solmek are summarised below:

<table>
<tr><th>Land Use</th><th>Receptor</th><th>Building</th><th>Soil Type</th><th>pH and SOM</th></tr>
<tr><td>Residential with Homegrown Produce</td><td>Female (Age Class 1-6: Young Child)</td><td rowspan="2">Bungalow
Small Terraced House
Medium/large Terraced House
Semi-detached House
Detached House</td><td rowspan="6">Clay
Silty Clay
Silty Clay Loam
Clay Loam
Sandy Lam
Loam
Silty Loam
Sandy Loam
Sandy Loam
Sand</td><td rowspan="6">pH and SOM content values as presented from testing.</td></tr>
<tr><td>Residential without Homegrown Produce</td><td>Female (Age Class 1-6: Young Child)</td></tr>
<tr><td>Allotments</td><td rowspan="3">Female (Age class 1-6: Young Child)</td><td rowspan="3">Assumes None</td></tr>
<tr><td>Parks</td></tr>
<tr><td>Open spaces</td></tr>
<tr><td>Playing fields</td><td>Female (Age class 4-11: Child)</td></tr>
<tr><td>Commercial</td><td>Female (Age Class 17-17: Working Adult)</td><td>Warehouse (pre 1970)
Warehouse (post 1970)
Office (pre 1970)
Office (post 1970)</td></tr>
<tr><td colspan="5">DERIVATION OF SOLMEK GAC THRESHOLD VALUES</td></tr>
</table>

A number of specific exposure pathways are considered in addition to the above table when considering the generated GAC values. In some instances, the GAC generated value may be presented at the soil saturation limit if this has been exceeded. The choice of receptor may differ from the table above based on professional judgment (with justification).

Solmek adopts a pH value of 7, Soil Organic Matter (SOM) content of 1% and a sandy loam soil where this information is not available. These figures accord with the generic units presented within the CLEA Software. Where Solmek cannot generate specific GAC values, the Environment Agency's SGVs (where available), released from March 2009, and Atkins SSV's (derived using CLEA Software Version 1.04, May 2011) are adopted for comparison.

VEGETATION

Plants can be affected by soil contamination in a number of ways resulting in growth inhibition, nutrient deficiencies and yellowing of leaves. Contaminants are taken up by plants through the roots and through foliage. Contaminants identified as being highly phytotoxic include boron, cadmium, copper, lead, nickel, and zinc.

To establish if the levels of contaminants present on a site may pose a risk to vegetation the results of the contamination testing are compared to a series of threshold values published in 'Code of Good Agricultural Practice for the Protection of Soil'.

GROUNDWATER AND SURFACE WATER RECEPTORS

The principal pathway by which soil contamination may reach the water environment is through a slow seepage or leaching to groundwater or surface water. The potential for contaminants to migrate along such pathways is dependent on the chemical and physical characteristics of the contaminants and the local hydrogeology. Surface watercourses may also accumulate contamination as contaminated sediments are deposited within the water body.

Where the site investigated overlies major/principal aquifers (and in some cases minor/secondary aquifers depending on certain conditions), groundwater Source Protection Zones and areas in close proximity to groundwater abstractions, contamination test results have been compared with the Water Supply (Water Quality) Regulations 1989 and The Water Supply (Water Quality) Regulations 2000.

Should a surface water receptor, such as a fresh water environment (river, canal, stream, lake etc), or marine environment be considered sensitive in relation to a site, then test results are compared with DEFRA & SEPA Environmental Quality Standards (2004). Many of the Environmental Quality Standards are hardness ($CaCO_3$) depended. Where no hardness values are available, Solmek assume conservative values (of between 0 and 50mg/l).

In the absence of vulnerable ground and surface water environments, Solmek may compare any test results with the Environment Agency Leachate Quality Threshold Values.

DETAILED QUANTITATIVE RISK ASSESSMENT (DQRA)

In line with CLR 11- Model Procedures, a DQRA for groundwater/human health may be required following a Phase 2 investigation and before the preparation of a Phase 3 Remediation Strategy. For human health DQRA, a site specific assessment criteria is undertaken using CLEA Software Version 1.06. For groundwater DQRA, the Environment Agency Remedial Targets Worksheet Version 3.1 is used.

WASTE ACCEPTANCE CRITERIA

Waste Acceptance Criteria (WAC) testing accords with the Landfill (England and Wales) 2002 Regulations and the subsequent amendments set out in Schedule 1 of the Landfill (England and Wales)(Amendment) Regulations 2004. WAC testing was introduced into UK Practise to supplement the revised changes to the Hazardous Waste and Landfill regulations outlined in 2005. The WAC testing relates to materials that are to be exported from a site/development to landfill, and do not directly relate to human health specifically. The WAC test categorises materials as either inert waste, non-reactive hazardous waste, and hazardous waste. The testing results are generally presented as certificates which can be used by site owners/contractors etc, which should be presented to the accepting waste facility or waste contractor.

CONSTRUCTION MATERIALS

Materials at risk from possible soil contaminants include inorganic matrices such as cement and concrete and also organic material such as plastics and rubbers. Acid ground conditions and high levels of sulphates can accelerate the corrosion of building materials. Where pH and soluble sulphate analysis has been undertaken, Solmek compare the test results with the guidelines presented within BRE Special Digest 1, 2005 (3rd Edition) 'Concrete in Aggressive Ground'. Plastics and rubbers are generally used for piping and service ducts and are potentially attacked by a range of chemicals, most of which are organic, particularly petroleum based substances. Drinking water supplies can be tainted by substances that can penetrate piping and water companies enforce stringent threshold values.

REQUIREMENTS OF PARTIES WITHIN THE DEVELOPMENT PROCESS

Interested parties involved in the development process may use the data in different ways and there may be varying views and interpretation of the factual data. Local Authority staff may have a view on contamination and human health and the wider environment. The Environment Agency are concerned principally with the protection of Controlled waters. Building insurers, funders and purchasers may be primarily concerned with issues of potential commercial blight. Purchasers are also not always fully informed, and perceptions on issues associated with risk can affect the decision to purchase. Developers and construction organisations will focus on financial aspects of dealing with the contamination in the context of the development and construction programme.

RISKS & LIABILITIES FROM CONTAMINATION

In simple terms, risks associated with contamination may be considered in terms of 1) statutory risks and 2) development related risks. If contamination is severe or forms a potential hazard based on its potential to affect groundwater, surface water or human health, a statutory risk may be present, and as such, if the risk is not reduced, criminal proceedings may be instigated by a government body or local authority.

If the contamination is less severe or not considered to be mobile, it may be considered a commercial liability which could, in theory remain untreated, but which may at a later date affect the value of the property, or, with changing legislation, become a statutory risk. Commercial liabilities could give rise to civil proceedings by third parties if there are grounds for action.

♣Solmek conditions of offer, notes on limitations & basis for contract (ref: version1/2012)

These conditions accompany our tender and supercede any previous conditions issued. Solmek will prepare a report solely for the use of the Client (the party invoiced) and its agent(s). No reliance should be placed on the contents of this report, in whole or in part by 3rd parties. The report, its content and format and associated data are copyright, and the property of Solmek. Photocopying of part or all of the contents, transfer or reproduction of any kind is forbidden without written permission from Solmek. A charge may be levied against such approval, the same to be made at the discretion of Solmek. Solmek was a trading name of Hymas Geoenvironmental Ltd.

Solmek cannot be held liable and do not warrant, or otherwise guarantee the validity of information provided by third parties and subsequently used in our reports. Solmek are not responsible for the action negligent of otherwise of subcontractors or third parties.

Site investigation is a process of sampling. The scope and size of an investigation may be considered proportional to levels of confidence regarding the ground and groundwater conditions. The exploratory holes undertaken investigate only a small volume of the ground in relation to the overall size of the site, and can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions as encountered within each of the exploratory holes. There may be different ground conditions elsewhere on the site which have not been identified by this investigation and which therefore have not been taken into account in this report. Reports are generally subject to the comments of the local authority and Environment Agency. The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that mobile contamination, ground gas levels and groundwater levels may vary owing to seasonal, tidal and/or weather related effects. Solmek cannot be held liable for any unrecorded or unforeseen obstructions between exploratory boreholes and trial pits. This includes instances where previous structures on the site (buried man made structures) or the presence of boulder clay (cobbles and/or boulder obstructions) have been anticipated. All types of piling operations should make allowance for obstructions within the construction budget to accommodate this. Unrecorded ancient mining may occur anywhere where seams that have been worked and influence the rock and soil above. Dissolution cavities can occur where gypsum or chalk is present. Rotary drilling is the recommended technique to prove the integrity of the rock.

Where the scope of the investigation is limited via access to information, time constraints, equipment limitations, testing, interpretation or by the client or his agents budgetary constraints, elements not set out in the proposal and excluded from the report are deemed to be omitted from the scope of the investigation.

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2001 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

Where the type, number or/and depth of exploratory hole is specified by others, Solmek cannot and will not be responsible for any subsequent shortfall or inadequacy in data, and any consequent shortfall in interpretation of environmental and geotechnical aspects which may be required at a later date in order to facilitate the design of permanent or temporary works.

All information acquired by Solmek in the course of investigation is the property of Solmek, and, only also becomes the joint property of the Client only on the complete settlement of all invoices relating to the project. Solmek reserve the right to use the information in commercial tendering and marketing, unless the Client expressly wishes otherwise in writing. The quoted rates do not include VAT, and payment terms are 30 days from dispatch of invoice from our offices. Quotes are subject to a site visit.

We have allowed for 1 mobilisation and normal working hours unless otherwise stated. The scope of the investigation may be reviewed following the desk study and/or fieldwork. The presence or otherwise of Japanese Knotweed or other invasive plants can be difficult to identify especially during winter months. If Japanese Knotweed or other invasive species are suspect, it should be confirmed by an ecologist. We have not allowed for acquiring services information, and cannot be responsible for damage to underground services or pipes not shown to us or not clearly shown on plans. Costs incurred will be passed on to you, and in commissioning Solmek you understand and accept that you/your agent have a contractual relationship with Solmek & you accept this. Our rates assume unobstructed, reasonably level and firm access to the exploratory positions and adequate clear working areas and headroom. We have priced on the basis that you or your client have the necessary permissions, wayleaves and approvals to access land. All boreholes and pits are backfilled with arisings except where gas monitoring pipes are installed with stopcock covers. Solmek are not responsible for any uneven surfaces as a result of siteworks and rutting and backfilled excavations may require re-levelling and/or making good by others after fieldwork is complete, and Solmek has not allowed for this. No price has been provided or requested for a return visit to remove pipework and covers. Hourly rates apply to consultancy only and do not include expenses unless otherwise shown. If warranties are required, legal costs incurred will be passed on to you assuming Solmek agree to complete such warranties, modified or otherwise and you understand and agree to pay all costs.

We reserve the right to pursue full payment of the invoice prior to release of any information including reports. We advise you/your client that we may elect to pursue our statutory rights under late payment legislation, and will apply 8% to the base rate for unreasonably late payments. Solmek are exempt from the CIS Scheme. Solmek offer to undertake work only in strict accordance with conditions covered by our current insurances, which are available for inspection. Solmek are not responsible for acts, negligent or otherwise of subcontractors and as a matter of policy cannot indemnify any other parties. Professional indemnity insurance is limited to ten times the invoice net total except where stated otherwise by Solmek. Solmek give notice that consequential loss as a direct or indirect result of Solmek's activities or omission of the same are excluded.