STRATA SURVEYS LIMITED

GROUND INVESTIGATION REPORT

REPORT NO. 13855

Plymouth Grove,

Birch Lane,

Manchester



Issue : Final Report

Issue Date : 6th March 2007

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REPORT NO. 13855

Plymouth Grove, Birch Lane, Manchester

for

The Trustees of Linson Construction Pension Fund

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1. INTRODUCTION

This report sets out the results of the field work and laboratory testing for a ground investigation carried out by Strata Surveys Limited for Linson Construction Pension Fund.

The investigation was required in connection with the proposed redevelopment of the site for three storey multi-occupancy properties.

A preliminary risk assessment has been prepared prior to this intrusive investigation dated December 2006.

The object of the investigation was to obtain information on the ground conditions and soil properties for use in the design and construction of foundations on the site and for the initial assessment of the potentially contaminated soil risk.

2. SITE DESCRIPTION

The proposed development site fronts Plymouth Grove just to the east of the junction of Stockport Road, Birch Lane and Plymouth Grove.

The site is raised above pavement level, by some 600-750mm and is partially covered with a concrete slab and partially covered with rough vegetation over compact brick hardcore.

3. SITE GEOLOGY

The published British Geological Survey (BGS) map for Manchester Sheet Number 85 shows the site lies in an area with Glacial Till (Boulder Clay) over Triassic Sherwood Sandstone with the Manchester Marls on the east. The East Manchester Fault (trending north west south east) is present to the north of the site.

4. FIELDWORK

The fieldwork was carried out during the period from 16th January 2003 to 20th January 2002 and consisted of five dynamically driven, continuously sampled boreholes ranging from 3.60m to 3.90m below the existing ground surface level using an AEC 150 self propelled, tracked dynamic sounding and sampling machine. Samples were recovered in eighty-four mm diameter, 1.00m long plastic liners, which were returned to the laboratory for description, sub-sampling and testing.

A dynamic sounding was carried out alongside each of the continuously sampled boreholes to 5.00m in depth using an AEC 150 self propelled, tracked dynamic sounding and sampling machine. Sounding was carried using the DPSH probe in accordance with BS 1377:1990 and as described in Appendix 1.

Detailed results of the strata met, depths and levels of changes, thickness of strata, samples taken and groundwater observations are given on the borehole record sheets in Appendix 2.1

Detailed results of standard penetration tests are given in Appendix 2.2.

Appendix 1 contains statements of the Terminology used in Soil Descriptions, Continuous Dynamic Sounding Concrete in Aggressive Conditions and the Classification of Chemical Contamination.

The positions of the boreholes are given on the Borehole Location Plan in Appendix 4.

A Site Location Plan is given in Appendix 5.

5. LABORATORY TESTING

A testing programme was agreed with the project engineer and the tests were carried out as specified by B.S. 1377:1990 Methods of Test for Soils for Civil Engineering Purposes.

The following tests were undertaken:-

Moisture Content	Sulphate Content of Water	pH Value
Plasticity Index	Undrained Unconsolidated Triaxial Test 100mm Multi Stage	

(The Sulphate Contents are reported as SO_4 for ease of use with BRE Digest 363 and BRE Special Digest 1.

Scientific Analysis Laboratories (SAL) carried out chemical contamination tests on three selected samples as a Maxi Package.

Comprehensive - Maxi	SOIL	WATER
	LOD	LOD
	mg/kg	mg/l
Total Metals : As, Cd, Cr, Pb,Hg,Se,Cu,Ni,Zn	1	0.05
Water Soluble Boron (1)	1	0.05
Hexavalent Chromium	0.1	0.03
Total Cyanide	2.5	0.05
Free Cyanide	2.5	0.05
Thiocyanate	1	0.2
Total Sulphate2	50	3
Sulphide	5	0 01
Total Sulphur	0.01%	0 1
pH	2dp	2dp
PAHs - 16 USEPA Priority Pollutants by GC	0.05	0.01 ug/l
Phenols	0.01	0 01

The results of all the geotechnical and the chemical contamination tests are presented in Appendix 3.

6. SUMMARY OF GROUND CONDITIONS

The CDSa boreholes show the following sequence of strata.

MADE GROUND — Ranging in thickness from 1.1m to 2.2m below the existing ground level. Generally consisting of grass over topsoil (A/B) or reinforced concrete (C-E) overlying brown sand fill with some brick fragments and occasional clay, cinder and fabric.

CLAY — Generally firm orange brown grey mottled slightly sandy clay with occasional gravel from 1.5-2m and 1.1-1.4m (BHA&E) (C_u 65kPa). Stiff to very stiff brown grey fissured slightly laminated slightly

sandy clay with occasional gravel and coal flecks proven to 4m. (C_u -240-259kPa).

The observations of groundwater conditions are given in the following tables.

Static Water Conditions

BH Number	Date	Depth of Hole (m)	Depth to water
BHA	30/01/2007	3.60	Dry on completion
BHB	30/01/2007	3.70	Dry on completion
BHC	30/01/2007	4.00	Dry on completion
BHD	29/01/2006	3.70	Dry on completion
BHE	29/01/2006	3.65	Dry on completion

7. GEOTECHNICAL ASSESSMENT

Foundation Assessment

The boreholes show that at depth of around 2.0m there is stiff Clay, which would be a suitable the founding depth for a conventional trench fill foundation.

The allowable bearing capacity at 2.0m or150mm into the stiff Clay (2.35m BHB) will be 225kN/m².

The excavation to the top of the stiff Clay will entail a significant volume of construction spoil that would go to land fill. Thus, it may prove better to adopt either a piled foundation of a ground improvement system.

Piles would need to be capable of penetrating the infilled cellar/basement to derive the necessary load carrying capacity in the stiff Clay at depth.

Ground improvement systems could comprise dynamic compaction or vibro-stone columns. Using ground improvement methods a limited volume of deleterious material (timber etc) from the infilled cellars would need to go off site.

Confirmation from the specialist ground improvement contractors should be sought as to the relative cost and efficacy of the method.

Concrete in Aggressive Ground

With reference to BRE Special Digest 1 the site should be considered as brownfield with static groundwater.

The testing for sulphates shows low concentration of soluble sulfate in the Made Ground and low sulfate content in the ground water.

Therefore the Site Design Sulphate Class is DS1 and the Aggressive Chemical Environment for Concrete (ACEC) is AC1s.

8. CONTAMINATION ASSESSMENT

CONTAMINATED SOIL

The current legislation for the assessment of Contaminated Land is Part IIA of the Environmental Protection Act (1990) Contaminated Land Regime and the development controls of the relevant Town and Country Planning acts. EA/DEFRA has produced four reports and assessment software to assist in the assessment of the potential harmful effects of contaminated land to the users of the land and the risk to the general environment. The reports are CLR 7-11 and the software is CLEA 2000 (Clea UK Beta). EA/DEFRA has also published SGV (Soil Guidance Value) for certain target compounds and contaminants and these are used for a Generic Risk Assessment.

The disposal of construction spoil that is considered waste will need to be assessed in line with current Land Fill regulations. The Lancfill (England and Wales) (Amendment) Regulations 2004 have introduced a set of analysis requirements for the classification of waste into

- Inert Waste
- Non-reactive hazardous Waste
- Hazardous Waste.

If excavation spoil is to be taken off site for disposal additional testing for the Waste Acceptance Criteria will be required.

This investigation of contaminated soil must only be considered as the preliminary phase of works where there is an identified contamination hazard. The results of the analyses of a sample can only be relied on as evidence as to what is in the sample and not what may be in the surrounding or adjacent area. Additional works may be necessary to assess the hazard of any contamination on site and the local environmental impact. Additional investigation may be necessary to evaluate the extent and hence volume of any contaminated soil. The assessment of the contaminated soil must take account of the limited access as part of the of the contamination investigation.

The site was originally a church, probably of brick construction, that in its later life was used as a depot. It is likely that the concrete slab on site at the present time is concrete placed inside the old church to as a durable working surface.

There appears that the church had a basement and during demolition the void was filled with demolition debris. The void was infilled with poorly consolidated fill generally consisting of sand and brick material.

Proposals for the re-development of the site have not been provided. However it is understood the development will consist of commercial properties on the ground floor underneath residential flats.

Three samples were selected for contamination testing. A summary of the results are below.

Contaminants	13855 Results (mg/kg)	CLEA Residential with no plant uptake Soil Guidance Values (SGV) and Atrisk- Soil Screening Value (SSV)
Arsenic	12-22	20mg/kg (SGV1)
Cadmium	<1	30mg/kg (SGV3)
Chromium	17-32	200mg/kg (SGV4)
Chromium VI	<1	200mg/kg (SGV4)
Copper	33-100	25000mg/kg (SSV - Atrisk Soil)
Lead	38-5800	450mg/kg (SGV10)
Mercury	< 1 0-3	15mg/kg (SGV5)
Nickel	13-36	100mg/kg (SGV7)
Selenium	<2	260mg/kg (SGV9)
Zinc	72-370	19000mg/kg (SSV - Atrisk Soil)
pH	6.6-10.0	6-9
Benzo(a)Pyrene	<0.1-0.3	0.85mg/kg (SSV -ATRISK^{soil})
Asbestos Screen		

SGVs represent 'intervention values'; and provide indication that soil concentrations above this level might represent an unacceptable potential risk to the health of site-users, depending on land-use (copper and zinc are known to be phytotoxic in nature and not covered under CLEA).

Atkins have developed Soil Screening Values (SSVs) applicable to the UK for common contaminants not currently covered by SGVs issued by Defra and the Environment Agency. Full justification is provided to support their use.

The analytical results generally show no elevated heavy metal levels above the current SGV levels for residential after-use with no plant uptake. However BHD at 0.95m contains 22mg/kg for Arsenic, which is above the SGV (Soil Guidance Value) of 20mg/kg. No other contaminants exceed the relevant SGV (Soil Guidance Value)/Soil Screening Values (SSV).

The MAXI package contamination analysis also included a suite of 16 speciated Poly Aromatic hydrocarbons (PAH). The results of the Poly Aromatic Hydrocarbons (PAH) are generally very low. Benzo(a)Pyrene (BaP) is regarded as a significantly carcinogenic PAH. Concentrations for BaP range from 0.1-0.3mg/kg. The Soil Screening Values (SSV) for residential developments with no plant uptake is 0.85mg/kg.

The contamination testing generally shows low level impact within the made ground encountered during fieldwork.

It is assumed that the development will consist of no gardens or soft landscaped areas. Any areas that are not covered by the new development will be hardstanding. This will reduce/eliminate the risk to the end users from any impacted material on site. If any communal soft landscaped areas are proposed, a significant thickness of 'clean' material will have to be imported to site and validated after installation.

SOIL GASES

The Desk Study indicated that the site is not situated within 250m of a registered landfill. The site has had basements, which have been infilled with generally inert material. However it is advised that CO_2 (carbon dioxide) gas protection measures are installed.

As indicated in the Desk Study report, the site is in an area where less than 1% of homes are above the action level for radon, therefore no radon protection measures are necessary in the construction of new dwellings.

APPENDIX 1 STANDARD STATEMENTS

Terminology used in Soil Descriptions

Continuous Dynamic Sounding

Concrete in Aggressive Conditions

Classification of Chemical Contamination

Terminology Used in Soil Descriptions

The procedure and principles given in BS 5930 (1992)Revision Section 8 have been adopted in producing the soils description contained in this report.
The classification is therefore based on the following.
In a soil description the main characteristics should be preferably given in a standard word order, the word order can be adjusted where appropriate for
clarity

a) Mass characteristics

1) Field Strength, density or compactness

2)Discontinuities

3)Bedding

b) Material characteristics

1) Colour

2)Particle shape, particle grading and composition.

3)Soil name(capital e.g. SAND),based on grading and plasticity.

c)Geological formations, age and type of deposit

d)Classification/soil group (optional.)

Mass Characteristics

For clay the strength scale is used as follows

Term	Field Identification	Undrained Shear Strength (kN/m²)
Very soft	Fingers easily pushed in up to 25mm	20
Soft	Fingers pushed in up to 10mm	20-40
Firm	Thumb makes impression easily	40-75
Stiff	Indented slightly by thumb.	75-150
Very Stiff	Can be indented by thumb nail	150-300
Hard Weak Mudstone	Can be scratched by thumb nail	greater than 300

Clays with undrained strength greater than 300 kN/m2 can be described as very weak mudstone or as hard clay (Spink and Norbury 1993)

Relative density of sands and gravel only may be determined by the standard penetration test scale in terms of N- Values(see BS 1377 1990) is as follows -

Term	Field Identification	SPT N Values blows/300mm
Very loose	Can be excavated with a spade	0 to 4
Loose	50mm wooden peg easily	4 to 10
Medium dense	driven(Loose)	10 to 30
Dense	requires pick for excavation	30 to 50
Very Dense	50mm wooden peg hard to drive wooden peg	over 50

Silts are described as fine soils(see 41.3) but depending on their grading may behave as a granular rather than cohesive material..
The terms uncompacted -easily moulded or crush in fingers or Compacted -can be moulded or crush by strong pressure in the fingers can be used.
Relative densities for use in field where N-values are not available are given in brackets, these terms are unquantified and should be used with caution.

Description of Discontinuities.

When describing discontinuities the type should be stated e.g fissures, faults, shear planes and the spacing detailed as below. Their openness and surface texture e.g. rough, smooth, polished,striated should be described and where possible orientation and trend should be stated.

Discontinuities		Other qualifying terms for Discontinuities.	Bedding		Other qualifying terms for Bedding	
Scale of spacing	Mean Spacing mm		Scale of bedding	Mean Thickness mm		
Term		**Fissured.**- breaks in blocks along unpolished Discontinuities.	Term		**Inter bedded**	Alternating layers of different types
Very Widely	Over 2000		Very thickly Bedded	Over 2000	**Interlaminated**	Prequalified by thickness term if in equal proportions Otherwise thickness of and spacing between subordinate layers defined.
Widely	2000 to 600	**Sheared.**- breaks in Blocks along polished	Thickly Bedded	2000 to600		
Medium	600 to 200	Discontinuities.	Medium Bedded	600 to 200		
Closely	200 to 60	Spacing terms also used for distance between	Thinly Bedded	200 to 60		
Very Closely	60 to 20	Partings, isolated Beds or laminae, Desiccation cracks roots	Very thinly Bedded	60 to 20		
Extremely Closely	under 20	etc.	Thickly laminated	20 to 6		
			Thinly Laminated	under 6		

Material Characteristics of Soils.

Material characteristics refer to those characteristics that can be described from visual and manual examination of disturbed or undisturbed samples.
Characteristics include colour, particle shape, particle grading and particle composition.

Colour
Colour given should be an overall impression. Strata with more than one colour can be described as mottled or multicoloured. Details of colours are given below -
Red, orange, yellow, brown, green, blue, white cream, grey, black etc. and supplemented as necessary with. light dark mottled and reddish orangish brownish etc. (Changes due to oxidization, desiccation for example should be noted.)

Particle Shape:- Where appropriate, particle shape may be described. Some recommended terms are as follows.

Angularity	Form	Surface texture.
Angular	flat	rough
Sub-angular	elongated	smooth
Sub-rounded		
Rounded		

The distribution of particle sizes within sands and gravels should be described stating predominant size fraction present e.g. fine to coarse SAND. Subangular elongated smooth

Principal Soil Type and Secondary Constituents.
The soil name is based on particle size of the coarse fraction and/or the plasticity of the fine fraction
Fines soils - contain 35% or more of fine material (omitting boulder and cobbles)is described as CLAY or SILT dependent on plasticity.
With less than 35% fine material it is described as a coarse material SAND or GRAVEL.
For mixtures involving very coarse soils see 41.3.2.4.
The basic soil types and their subdivisions are defined by the range of their particle sizes as shown below.BS5930 Section 8 recommends that the secondary constituents can be used before or after the principal soil type to avoid ambiguity with the qualifying adjectives.

Soil Group.	Particle Size	Principal Soil	Term Before	Principal Term	Term After	Approx. % Secondary Constituent
Very Coarse	200 60	BOULDERS COBBLES	Slightly (sandy*) or gravelly	SAND	with a little (sand*) or occasional (cobbles+)	5
Coarse Soils (over about 65% sand and Gravel)	Coarse 20 Medium 6 Fine 2	GRAVEL	(Sandy*) or gravelly (Very Sandy*) or gravelly	Or GRAVEL	with some(sand*) or some (Cobbles+) with much(sand*) or many (cobbles+)	5-20 ** >20 **
	Coarse 0.6 Medium 0.2 Fine 0.06	SAND		SAND and GRAVEL	and(sand*) or and (Cobbles*)	about equal proportions
			* Fine soil type as appropriate clayey/or silty. + Very coarse soil type as appropriate. ** or describe as a fine soil depending on assessed engineering behaviour			
			Term Before	**Principal Term**	**Term After**	**Approx. % Secondary Constituent**
			Slightly (sandy*)		with a little (sand*)	<35
Fine Soil Over 35% silt And clay size)	Coarse 0.02 Medium 0.006 Fine 0.002	SILT CLAY/SILT CLAY	or gravelly (Sandy*) or gravelly (Very Sandy*) or gravelly	CLAY Or SILT	or occasional (cobbles+) with some(sand*) or some (cobbles+) with much(sand*) /many (cobbles+)	35-65 >65 **
			** describe as coarse soil depending on assessed engineering behaviour. * coarse soil as appropriate.			

BS5930 Section 6 indicates fine soils shall be described as either SILT or CLAY depending on plastic properties,these terms are mutually exclusive terms such as silty CLAY are not to be used..Where hand test are genuinely indecisive or ambiguous the hybrid term CLAY/SILT may be used
This is also true for deposits containing mixtures of fine and coarse soil(see 41.3.2.6)
Minor constituents.Where soil contain minor quantities <10% in fine soil and 1% coarse,which are relevant to geology can be included using slightly or very slightly

Organic Soils and Peats:-(see41.3.6)

Term	Field Test			Transported Mixtures	
Firm	Fibres compressed	Fibrous	Plant remains	Slightly organic clay/silt or sand	Divided or discrete
Spongy	Very compressed and open Structure	pseudo-fibrous Fibrous	Plant remains Recognisable	Organic clay or silt organic sand Very organic clay or silt very	Organic,smell ,describe as for Inorganics
Plastic	Can be moulded in hand And smears along fingers	amorphous	Recognisable plant Remains absent	Organic sand	
				PEAT Predominantly plant remains usually dark brown black in colour distinctive smell,low bulk density	

References
BS 5930 1999 Revision 'Code of Practice for Site Investigation.'
Norbury D.R., G.H Child And T.W Spink 1986 'A critical Review of Section 8(BS 5930)Soil and Rock Descriptions'. Proc 20th Regional meeting of the Engineering Group of the Geological Society. Site Investigation Practice. Assessing BS5930. Univ of Surrey pp353-369(original proceedings).

Standard Penetration Tests

The full procedure of carrying out the Standard Penetration Tests (SPT) is given in BS 1377 1990 Methods of Tests for Soils and Civil Engineering Purposes Test 9.3

Essentially the tests consists of driving a 50mm external diameter split barrel sampler into the soil using a 65kg hammer dropping 760mm. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration (test drive) below a seating drive of 150mm through any disturbed ground at the bottom of the borehole

The number of blows for the 300mm test drive penetration is recorded on the borehole logs as the N - value.
A full record of the number of blows required to drive the sample at 75mm intervals throughout the total 450mm drive is also tabulated along with the groundwater levels at the time of test

The test is normally performed on sands, but may also be used in gravels, weak rocks and glacial tills in which case the driving shoe may be replaced by a cone When attempting the standard penetration tests in very dense materials or weathered bedrock it may be necessary to terminate the test before completion to prevent damage to the equipment

In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler
This may be achieved in the following manner.

a)	Seating Drive - using standard blows the seating drive is a penetration of 150mm or 25 blows whichever is first reached
b)	Test Drive - the number of blows required for a further penetration of 300mm If 300mm cannot be achieved in 50 blows the test can be terminated Record the number of blows per 75mm for both seating and test drives If either the seating drive or the test drive is terminated before full penetration record the depth of penetration for the 25 blows or 50 blows respectively
c)	In soft rock the test drive should be terminated after 100 blows if a penetration of 300mm has not been achieved

The N - value obtained from the Standard Penetration Tests may be used to assess the relative density of sands and gravels in accordance with Clause 41.3.2 of BS 5930.1999 Code of Practice for Site Investigation as follows

Term	SPT N - values : blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

In soft strata when the sampler assembly is lowered to the bottom of the borehole on the drive rods with the drive assembly on top the sampler may penetrate under self-weight This initial penetration should be measured and recorded If the initial penetration exceeds 450mm omit the seating and test drives and report the N value as zero.

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Continuous Dynamic Sounding

Dynamic Probe Resistance Using a 90° Cone BS1377 Part 9 Test 3.2

Table 1, Page 22 gives details of the equipment used for the two test methods, i e DPH (dynamic probing heavy) and DPSH (dynamic probing super heavy) The DPSH method equates to the Standard Penetration Test (SPT) and the DPH is the conventional dynamic probe test (DPT)

The test method requires the recording of the blows required to drive the 90° cones and driving rods into the soil over an interval of 100 mm. At the end of each 1 0m rod the torque resistance of the rod shall be measured and recorded

DPSH Equipment Details

	DPSH	DPH
Driving Mass	63 5 ± 0 5 kg	50 ± 0.5 kg
Standard Drop	750 ± 20 mm	500 ± 10 mm
Anvil diameter	100 < d < 0.5 d mm	100 < d < 0.5 d mm
Maximum Mass of Anvil and Guide Rod	30 kg	18 kg
90° Cone		
Nominal Area	20 cm²	15 cm²
Cone Base Diameter (New)	50 5 ± 0 5 mm	43.7 ± 0 3 mm
Cone Mantle Length	50 5 ± 2 mm	43.7 ± 1 mm
Cone Taper	11 degrees	11 degrees
Cone Tip Length	25 3 ± 0 4 mm	21.9 ± 0 1 mm
Extension Rods		
Mass of Rod kg/m	8 kg (maximum)	6 kg (maximum)
Diameter	35 mm (maximum)	35 mm (maximum)
Length mm	Up to 2.0 + 0.1%	Up to 2.0 ± 0 1%

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Correlation of DPSH against SPT for Sand and Gravel

The correlation's have been taken from a number of papers suggesting a correlation between Dynamic Probe Super Heavy (DPSH) and Standard Penetration Test (SPT) for sand and gravel

Cearns PJ and McKenzie.A used a DCP test using the Borros automatic 'SPT' configuration (viz hammer – 63-kg mass x 760 mm drop; cone 50.5 mm diameter, 90°, torque measurement frequency 1m). The data used was collected from approximately 100 locations.

From the results, the generalised equation gained was $DCP_{100} = 0.25 \times SPT\ 'N'$ value. The DCP_{100} is equivalent to $DPSH_{100}$

Therefore, the $DPSH_{300}$ (sum of three consecutive $DPSH_{100}$) x 1.33 is equivalent to the SPT 'N' value

Correlation's from Card GB and Roche DP, Tonks DM and Whyte IL, and the German Standard Institute Specifications DIN 4094 Part II show typical correlation's for DPH_{300} against SPT to be in the range of

$$DPH_{300} = 1.5 - 2.1 \times SPT\ 'N'\ value \quad (DPH_{300} \times 0.7 - 0.5 = SPT\ 'N'\ value)$$

The latter three publications used a Dynamic Probe Heavy, with a 50 Kg drop weight over a 500mm length, and relate a $DPH_{300} \times 0.5 - 0.7$ equal to an equivalent SPT 'N' value

From initial work carried out by Strata Surveys Limited (see below) the equivalent SPT 'N' value is at least about $0.7 \times DPSH_{300}$, which is the upper bound value for the Dynamic Probe Heavy Test

For correlation of sand and gravel the PJ Cearns and A McKenzie comparison is considered to give an overestimation of the equivalent SPT 'N' value, and for sites with sand and gravel the equivalent SPT 'N' value will be taken as the upper bound value suggested by Card and Roche, Tonks and Whyte, and DIN 4094 Part II for the DPH_{300} of 0.7

During the DPSH probing the torque required to turn the rods in the ground is measured at every 1.0m interval in accordance with BS1377, and a correction placed on the $DPSH_{100}$ value in accordance with DIN4094, where the torque is > 0

From DIN 4094 the N_{SKIN} (the number of blows required to overcome skin friction resistance is given by the formula)

$$N_{SKIN} = \frac{2M_v e}{DM_0 gh}$$

Where e = standard depth increment, D = rod diameter, M_0 = hammer mass, and h = hammer drop height, M_v = torque measurement on rods, g = gravity

For the AEC 150 equipment used, $N_{SKIN} = M_v \times 0.039$

Where N_{SKIN} is blows per 300mm-depth increment and M_v is torque measurement on the rods in Newton metres

The Strata Surveys Limited DPSH system uses a lost point with narrow rods, and the torque in stable holes will usually be low, not requiring adjustment. However, a measurement of torque is taken at 1.0m intervals in all soils, and a correction applied where the torque > 0

Correlation of DPSH against Cu value for Clays

Correlations derived by Butcher, McElmeel and Powell, 1996, showed using equations for r_d (assessment of work done by the machine) and q_d (uses r_d along with the size and number of rods), give close comparisons between different equipment

$$r_d = \frac{Mgh}{Ae} \qquad q_d = \frac{M}{(M+M')} r_d$$

were M = mass of hammer (kg)
M' = total mass of extension rods, the anvil and guiding rods (kg)
g = gravity (m/sec^2)
h = height of fall of the hammer (m)
A = area of the cone base (m^2)
e = average penetration in m per blow ($0.3/DPSH_{300}$)

The use of the two equations and bentonite slurry to reduce skin friction on the rods showed good repeatability for London Clay (stiff over consolidated clay), Glacial Till (stiff clay) and alluvial/marine sediments (soft silty clay).

The paper produced correlations between q_d and Cu value for both stiff and soft clay and q_d and SPT N value for stiff clay. The following correlations were given

Stiff clay (sensitivity about 1)	$Cu = (q_d / 22)$ (kN/m²)
Soft Clay (sensitivity > 4)	$Cu = (q_d / 170) + 20$ (kN/m²)
All clay soils	$Cu = 0.043 (q_d / S_t) + 10$ (kN/m²) Where S_t = sensitivity
Stiff Clay (sensitivity about 1)	$SPT\ N = 8 \times DPH_{100} - 6$

The Strata Surveys Limited DPSH system uses a lost point with narrow rods, and the torque in stable holes will usually be low, not requiring adjustment, and therefore the use of bentonite slurry should not be required. However, a measurement of torque is taken at 1.0m intervals in all soils, and a correction factor carried out where torque > 0

The shear strength parameters for cohesive soils are determined with 84mm diameter samples for clays up to firm and 100mm diameter samples in clays of firm and greater strength. These samples are tested by the Quick Undrained Triaxial Method, to determine a Cu value.

The correlations given by Butcher, McElmeel and Powell (1996) are used to report q_d and Cu and are carried out in unison with the methodology of Quick Undrained Triaxial Tests, until a high level of confidence with the correlations has been established

Glossary of Terms

DCP - a test using the Borros automatic 'SPT' configuration (63kg mass, 760mm drop, 50.5mm cone at 90°), equivalent to a Dynamic Probe Super Heavy (DPSH)

DPH - a Dynamic Probe Heavy (50kg mass, 500mm drop, 50mm cone)

DPSH - Dynamic Probe Super Heavy (same as DCP)

N_{100} - number of blows to drive the probe 100mm

$DPSH_{100}$ - number of blows using the DPSH to drive the probe 100mm

$DPSH_{300}$ - number of blows using the DPSH to drive the probe 300mm (sum of three consecutive $DPSH_{100}$ blow counts)

References

Butcher AP, McElmeel K, Powell JJM, Building Research Establishment, Watford, Herts, UK 1996 "Dynamic Probing and its use in clay soils" Advances in site investigation practice Thomas Telford, London

Card GB and Roche DP. (1988) "The use of continuous dynamic probing in ground investigation", Paper 11 Proc. Conf Penetration testing in the UK ICE. Thomas Telford, London

Cearns PJ and McKenzie A (1988) "Applications of Dynamic Cone Penetrometer testing in East Anglia" Paper 12 Proc Conf. Penetration testing in the UK. ICE. Thomas Telford, London.

DIN 4094 Dynamic and Static Penetrometers Part I 1974 Part II, 1982 Deutsche Normen

Tonks DM and Whyte IL (1988) "Dynamic Soundings in site investigations some observations and correlations", Paper 10 Proc. Conf. Penetration testing in the UK ICE Thomas Telford, London

Durability of Concrete in Aggressive Ground and Groundwater Conditions

Reference should be made to BRE Special Digest 1: 2005 for the detailed assessment of the potential for Sulfate and Acid attack on concrete.
Figures C4 C5 and C6 give the procedure for assessing the Aggressive Chemical Environment (ACEC) based on the nature of the site and the potential hazards on the site.
Sites are "greenfield without pyritic soil", "greenfield with pyritic soil", "brownfield without pyritic soil" and "brownfield with pyritic soil". Thus suitable samples of soil and groundwater should be selected for analyses of Soluble Sulfate (2:1 water soil extract) and pH (1:2.5 water soil extract).
The table extracts below give the relevant information from the document.

Box C7 Technical notes on limits for sulfate cases

- The division between Classes 2 and 3 for groundwater is related to the maximum solubility of calcium sulfate (1440 mg/l SO_4). Higher sulfate concentrations in groundwater confirm the presence of more soluble sulfates, usually magnesium or sodium. Other divisions between sulfate classes are drawn somewhat arbitrarily.
- The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered from those in previous Digests. The correlation between old and new limits in terms of mg/l SO_4 being as follows.

Sulfate class	New limits (mg/l SO_4)	Old limits (mg/l SO_4)
DS-1	< 500	< 1200
DS 2	500 -1500	1200 -2300
DS 3	1600-3000	2400-3700
DS-4	3100-6000	3800-6700
DS-5	> 6000	> 6700

The consequence of this adjustment is to make the ground classification based on soil tests more conservative: for example, some soils that were previously classified as DS-2 would now be considered as being DS 3.

The change stems from findings of numerous groundwater-related studies carried out by BRE and others following discoveries of the thaumasite form of sulfate attack (TSA) in the concrete foundations of highway structures[3], in the large majority of cases, the sulfate classes based on 2:1 water/soil extract tests on soil have been found to be substantially lower than sulfate classes based on sulfate in groundwater. Not surprisingly, therefore, they were inconsistently low compared to the actual occurrence of TSA. The new limits bring sulfate classification based on 2:1 water/soil extract tests into parity with the groundwater based tests.

Table C1 Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations [a]

Sulfate Design Sulfate Class for location	2:1 water/soil extract [b]	Groundwater	Total potential sulfate [c]	Groundwater Static water	Mobile water	ACEC Class for location
1	2 (SO_4 mg/l)	3 (SO_4 mg/l)	4 (SO_4 %)	5 (pH)	6 (pH)	7
DS-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DS-5	3130-6000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DS [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Notes

a [illegible]
b [illegible]
c [illegible]
d [illegible]

Explanation of suffix symbols to ACEC Class

- [illegible]
- [illegible]

Table C2 Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations[a]

Sulfate and magnesium						Groundwater		ACEC
Design Sulfate Class for location	2:1 water/soil extract[b]		Groundwater		Total potential sulfate[c]	Static water	Mobile water	Class for location
1	2 (SO_4 mg/l)	3 (Mg mg/l)	4 (SO_4 mg/l)	5 (Mg mg/l)	6 (SO_4 %)	7 (pH)[d]	8 (pH)[d]	9
DS 1	500		< 400		< 0.24	> 2.5		AC-1s
							> 6.5[e]	AC-1
							5.5–6.5	AC-2z
							4.5–5.5	AC-3z
							2.5–4.5	AC-4z
DS-2	500–1500		400–1400		0.24–0.5	< 3.5		AC-2s
							6.5	AC-2
						2.5–3.5		AC-3s
							5.5–6.5	AC-3z
							4.5–5.5	AC-4z
							2.5–4.5	AC-5z
DS-3	1500–3000		1500–3000		0.7–1.2	< 3.5		AC-3s
							< 6.5	AC-3
						3.5–5.5		AC-4s
							5.5–6.5	AC-4
							3.5–5.5	AC-5
DS-4	3000–6000	< 1200	3100–6000	< 1000	1.3–2.4	< 3.5		AC-4s
							6.5	AC-4
						2.5–3.5		AC-4x
							5.5–6.5	AC-5x
DS-4m	3000–6000	> 1200	3100–6000	> 1000	1.3–2.4	< 3.5		AC-4x
							6.5	AC-4m
						2.5–3.5		AC-4mx
							5.5–6.5	AC-5m
DS 5	> 6000	< 1200	> 6000	< 1000	> 2.4	< 3.5		AC-4z
						2.5–3.5	> 6.5	AC-5
DS 5m	> 6000	> 1200[f]	> 6000	> 1000[f]	> 2.4	< 3.5		AC-4mz
						2.5–3.5	> 6.5	AC-5m

Notes

a Brownfield locations are those sites, or parts of sites, that might contain chemical residues resulting from previous industrial uses. (Section D1.1)

b The sector Design Sulfate classes based on 2:1 water/soil extracts have been inherited from previous Digest (Box C3)

c Applies only to the strata where concrete will be exposed to sulfate ions (SO_4), whether naturally occurring or derived from the oxidation of iron sulfide minerals. Information on sulfate and sulfide sources is given in Appendix A3 and Section C5.

d An additional arrow is taken off by purchaser and mix design by adjustment to sulfate content (Section D 1.3)

e The limit for water soluble magnesium does not apply to brackish groundwater (chloride content between 12 000 mg/l and 17 000 mg/l). These waters should be considered from the relevant ACEC classification. Seawater (chloride content about 18 000 mg/l) and stronger brines are not covered by this table.

Explanation of suffix symbols to ACEC Class

- s The 's' indicates that the water has been classified as static.
- x Where placed in ACEC Classes that include the suffix 'x' have potential to reject and contains ability to react with steel in accordance with Table C5 on page 41.
- m The 'm' relates to the higher levels of magnesium in Design Sulfate Classes 4 and 5.

Durability of Concrete in Aggressive Ground and Groundwater Conditions - cont

A series of precautions required against acid attack by organic acids in peaty soils are given by Tomlinson (1980). Where mineral acids are present special precautions will be required to protect concrete against attack. Harrison briefly describes certain of the techniques available and refers to detailed references as appropriate. Alkaline groundwater is not generally aggressive to concrete unless in relatively high concentrations (pH's above 14) or if the aggregate is of a reactive type. The pH value of soil or groundwater may also be linked to sulphate concentrations in particular in borderline cases.

If the pH value is below six it is considered that acids present will tend to break down the concrete making it more susceptible to sulphate attack.

References

BRE Special Digest 1 — Concrete in Aggressive Ground. BRE 2005

Bartholomew R.F. 1979 — The protection of concrete piles in aggressive ground conditions' Proc. Conf on Recent Developments in the Design and Construction of Piles ICE London pp99 - 109

BS 1377 1990 — Methods of Tests for Soils and Civil Engineering Purposes' British Standards Institution

BRE Digest 363 . 1996 — Sulfate and Acid Resistance of Concrete in the Ground' Building Research Establishment

Harrison W.H . 1987 Feb — Durability of Concrete in Acidic Soils and Waters'. Concrete 1987 pp18 - 24

Tomlinson M.J . 1980 — Foundation Design and Construction

CONTAMINATION ASSESSMENT OF SOILS

The assessment of the potential risk from contamination is the soil and groundwater must be assessed based on the site history an
d future land use. The following tables can be used for the initial classification of the site
CLEA is the current standard for the assessment of harm. DEFRA has produced an assessment method based on the toxicology of target compound and thus a site specific assessment of risk can be assessed. The table below gives relevant guidance values for the preliminary assessment of a site.

The Environment Interim Guidance Values are used to assess the risk for the off site disposal to land fill of potentially contaminated soil. Reference may be made to previous classification systems used historically for the classification of waste disposal (Kelly Table) and the ICRCL tables.

CLEA

Contaminant	Threshold Residential (Plant Uptake)	Threshold Residential (No Plant Uptake)	Threshold Commercial Industrial	Reference
Arsenic	20	20	500	SGV1
Boron	3		3	EA Interim Guidence
Cadmium	1 pH 6 2 pH7 8 pH*	30	1400	SGV3
Total Chromium	130	200	5000	SGV4
Copper	130		130	EA Interim Guidance
Cyanide Total	250		250	EA Interim Guidance
Cyanide (Free)	25		25	EA Interim Guidance
Lead	450	450	750	SGV10
Mercury	8	15	480	SGV5
Nickel	54	100	100	SGV7
PAH	A CLEA Assessment shall be Made			
pH	6-8 Threshold 5-9 Action			EA Interim Guidance
Phenols	5		5	EA Interim Guidance
Selenium	35	280	8000	SGV9
Sulphate	2000		2000	EA Interim Guidance
Sulphide	250		250	EA Interim Guidance
Thiocyanate	50		50	ICRCL
TEM/SEM	5000		10000	EA Interim Guidance
Zinc	300		300	EA Interim Guidance
Total Sulphur	5000		5000	ICRCL
Total Sulphur Action	20000		20000	ICRCL

TABLE OF CHEMICAL CONTAMINATION CONCENTRATIONS
AFTER ICRCL, GLC(Kelly) and GMWRA

	Class A	GMWRA CLASS					ICRCL VALUES			
							HIGH RISK		LOW RISK	
		A	B	C	D	E	THRESHOLD	ACTION	THRESHOLD	ACTION
DETERMINAND	µg/dw	Max	Max	Max	Max	Max				
ph Acid	5.5	6	5	4	2	2	5	3	NL	NL
Ph Alkaline	8.5	8	9	10	12	14	***	***	***	***
Antimony	100	30	50	100	500	2500	***	***	***	***
Arsenic	500	30	50	100	500	2500	10	NL	40	NL
Barium	10000	500	1000	2000	10000	50000	***	***	***	***
Beryllium	250	5	10	20	50	250	***	***	***	***
Boron (Available)	20000	2	5	50	250	1250	3	NL	***	***
Cadmium	50	1	3	10	50	100	3	NL	15	NL
Chromium	500	100	200	500	2500	12500	600	NI	1000	NI
Copper (available)	30000	0-100	200	500	2500	12500	130	NL	***	***
Lead	500	200	1000	2000	10000	50000	500	NL	2000	NI
Lead (Available)	500	500	500	1000	10000	50000	***	***	***	***
Magnesium	500000	500	1000	2000	10000	50000	***	***	***	***
Manganese	500	500	1000	2000	1%	50000	***	***	***	***
Mercury	10	1	3	10	50	100	1	NL	20	nil
Nickel (Available)	500	20	50	200	1000	5000	70	NI	***	***
Selenium	100	1	3	10	50	250	3	NL	6	NL
Sulphate	2500000	2000	5000	1%	5%	250000	2000 (1)	10000	2000(1)	50000 (2)
Sulphide	see sulphate	10	20	100	500	2500	250	1000	250	1000
Sulphur (Free)	see sulphate	100	500	1000	5000	25000	5000	20000	5000	20000
Vanadium	10000	100	200	500	2500	12500	***	***	***	***
Zinc	50000	250	500	2000	10000	50000	***	***	***	***
Zinc (Available)	50000	250	500	1000	5000	25000	300	NL	***	***
Cyanide (Free)	See total Cn	1	5	50	100	500	25	500	100	500
Cyanide (Total)	500	5	25	250	500	2500	250	1000	250	NL
Ferricyanide	500	100	500	1000	5000	25000	***	***	***	***
Thiocyanate	500	10	50	100	500	2500	50	NL	50	NL
Coal Tar	100	500	1000	2000	10000	50000	***	***	***	***
Phenol	5	1	5	50	250	1250	5	200	5	1000
Toluene Extract	100	5000	10000	50000	250000	500000	***	***	***	***
Cyclohexane Extract	100	2000	5000	20000	100000	500000	***	***	***	***
PAH (Polyaromatic Hydrocarbons)	2	50	500	1000	5000	25000	50	500	1000	10000
PCB	1	1	3	10	50	250	***	***	***	***
Chlorinated Solvents	30	1	3	10	50	250	***	***	***	***

ALL VALUES GIVEN IN mg/kg AIR DRIED SOIL UNLESS STATED OTHERWISE

SOURCES:
GREATER MANCHESTER WASTE REGULATION AUTHORITY (GMWRA)
Inner Departmental Committe on the Redevelopment of Contaminated Land (ICRCL) GLC (Kelly) Greater London Council
Guidance Note 59/83 : Guidance on the assessment and redevelopment of contaminated land", 1987, DOE
NOTES:
Leach Test to DIN 38 414. Classes B-E may be re classified to Class A if leach test values are less than shown
ICRCL : High risk are domestic gardens, allotments, play areas
ICRCL: Low risk is Parks, playing fields, landscaped areas, open space, buildings and hard cover
NL: No limit advised *** No comparative value given
EADE

GMWRA VALUES	
Class A	Uncontaminated
B	Slightly Contaminated
C	Contaminated
D	Heavily Contaminated
E	Unusually Contaminated

ALcontrol Laboratories - Land Division

INFORMATION SHEET

WASTE ACCEPTANCE CRITERIA (WAC)

The current Landfill (England and Wales) (Amendment) Regulations 2004 came into force on 15th June 2004 (regs 4(2), 7, 8(1) and 9 only). This is listed as Stanitory Instrument (SI) 2004 No 1375 on the HMSO website. This replaced all other consultation documents that have been in circulation for many months

The Enviroment Agency Guidance on Sampling and Testing of Wastes to meet landfill Waste Acceptance Procedures – Version 4.3a- December 2003 should also be consulted, although the June Regs supercede this. The main difference being that the PAHs mentioned in the EA doenment are no longer required.

From the laboratory perspective, it is the BS EN 12457 – 3 that is being asked for on a regular basis for the classification of waste.

This is a two stage leaching test. The sample is leached at a liquid/solid ratio of 2/1 and analysed. The sample is then leached again at a ratio of 8/1 and analysed. The sum of the two leachate values gives a cumulative 10/1 result, which is then reported in mg/kg for direct comparison with the WAC limits outlined in the Landfill Regs (SI 1375). A summary is attached.

The note about the Sulphate exceeding guideline values has caused some confusion, so a "simpler" interpretation follows:

For example:
For Inert Waste Landfill, if sulphate is >1000mg/kg, then a percolation test (pr EN 14405) has to be performed, and if the first value (C_0) is < 1,500mg/l, then values up to 6000mg/kg are acceptable.
Unfortunately, the percolation test is very costly (about £350) and time consuming (about 28 days), and currently only available in Alcontrol in Holland.
Alternatively, TDS can be used as an optional replacement for chloride and sulphate values, if a waste is unable to comply with chloride and sulphate but is able to meet the TDS values (4000mg/kg for Inert waste).

Landfill Waste Acceptance Criteria

Parameter	Inert Waste Landfill	Stable non-reactive hazardous waste in non hazardous landfill¶	Hazardous waste landfill
Parameters determined on the waste			
Total Organic Carbon (w/w%)	3%	5%	6%*
Loss on ignition			10%*
BTEX (mg/kg)	6		
PCBs (7 congners) (mg/kg)	1		
Mineral Oil C_{10}-C_{40} (mg/kg)	500		
pH		>6	
Acid neutralisation capacity		To be Evaluated	To be Evaluated
Limit Values (mg/kg) for compliance leachate test using BS EN 12457-3 at L/S 10:1kg-1	**Inert Waste Landfill CRITERIA L/S 10:1mg/kg**	**Stable non-reactive hazardous waste in non hazardous landfill¶ CRITERIA L/S 10:1mg/kg**	**Hazardous waste landfill CRITERIA L/S 10:1mg/kg**
As	0.5	2	25
Ba	20	100	300
Cd	0.04	1 (UK 0.1) §	5 (UK 0.1) §
Cr	0.5	10	70
Cu	2	50	100
Hg	0.01	0.2 (UK 0.02) §	2 (UK 0.4) §
Mo	0.5	10	30
Ni	0.4	10	40
Pb	0.5	10	50
Sb	0.06	0.7	5
Se	0.1	0.5	7
Zn	4	50	200
Cl	800	15,000	25,000
F	10	150	500
SO_4	1000 #	20,000	50,000
Total dissolved Solids (TDS) +	4000	60,000	100,000
Phenol Index	1		
Dissolved organic Carbon at own pH or pH7.5-8.0 @	500	800	1,000

¶ And non-hazardous wastes deposited in the same cell

* Either TOC or LOI must be used or hazardous wastes

§ The lower limit values for Cd and Hg may apply within the UK (see above)

This limit value for sulphate may be increased to 6,000mg/kg, provided that the value of C_0 (the first eluate of a percolation test at L/S = 0.1 l/kg) does not exceed 1,500 mg/l. It will be necessary to use a percolation test to determine the limit value at L/S = 0.1 l/kg under initial equilibrium conditions

If SO4 does not meet the L/S 10 limit a percolation test (prEN 14405) has to be done. this costs £350 and takes 28 days and is only done in our Dutch laboratory.

\+ the values for TDS can be used instead of the values for Cl and SO4

@ DOC at pH 7.5-8.0 and L/S 10 can be determined on eluate derived from a modified version of the pH dependence test, prEN 14429, if the limit value at own pH (BS EN 12457 eluate) is not met

Requires 2kg of sample and takes a minimum of 10 working days

APPENDIX 2 RECORDS OF FIELDWORK

APPENDIX 2.1 Boreholes

STRATA SURVEYS LIMITED

RECORD SHEET SYMBOL KEY

SAMPLES/TESTS

U	Undisturbed 100mm open tube driven sample (depth records recovered length from start of test). * Indicates a sample with Nil Recovery
D	Small disturbed sample (depth records the interval of sample).
B	Large disturbed sample (Bulk) depth records recorded interval.
S	Standard penetration test (SPT; BS1377 Part 9) recovered as a small disturbed sample. * Indicates a sample with Nil Recovery.
C	Cone penetration test.
W	Water sample.
L	Continuous Dynamic Sample 84mm 1.0m long *Note for special sampling the container type shall be noted* *e.g. J = glass jar, V = 40ml vial and septa*

FIELD RECORD COLUMN

This column is used to present depth related information of site activity. The column will always show progress, details of water strikes and rises, field records of the SPT test and the Undisturbed sample blows. Other data may be present in this column and details of codes will be given in the remarks box at the bottom of the record sheet page.

Water Level Codes

M1 2.00	Water strike (with sequential number of the strike).
T1 1.90	Temporary rest level after 20 minutes.

Progress Codes

-(07/08/2002)-	Records the date at the depth of the borehole when the borehole takes more than one day to complete.
(TSL 3.00m)	Represents the rest level at the start of the shift (AM) or the end of the borehole shown with the date o observation.

Field Records

1,2-3,4,5,6	Detailed SPT records for each 75mm test interval (incomplete penetration tests will be recorded showing blows for measured penetration).
[U60]	U100 open tube sampler blows to drive the sampler the full length i.e. sample plus cutting shoe.

ROTARY CORE DRILLING RECORDS

Details of the rock fracture state are given in the Mechanical Log portion of the sheet SCR TCR and RQD are described in BS5930:1999. If is average fracture spacing over a particular lithology, Where the core is fully broken 0 indicates Non-Intact

Legend symbols are in accordance with BS5930:1999 but for clarity may only the show major constituent.

Strata descriptions are compiled by visual examination of samples obtained during boring, after BS 5930 and modified in accordance with Norbury et al (1986) and laboratory test results where applicable.

STRATA SURVEYS LIMITED

Location **Plymouth Grove, Birch Lane, Manchester**

Client: Linson Construction Pension Fund Project Ref.:

Borehole No. **BHA**

Job No.: **13855**

Equipment and methods **Continuous Dynamic SA-SO**

Drop Height	750mm
Drop Weight Mass	64kg
Cone Diameter	50mm
Casing Diameter	113mm
Casing Depth	3.00m

Start Date: **30/01/2007** Final Depth: **6.00m**

Blows	Penetration mm / blows	N100 - Blows per 100mm	Torque Nm (Cu) [N300]	Description	Strata Depth & Thickness m	Strata Reduced Level (m)	Strata Legend
		D1-0.3m		Made Ground (Grass over dark brown sandy topsoil FILL with some brick timer, gravel, cloth)	(1.00)		
		D2-0.6m					
		D3-0.9m			1.00	1.00	
2				Made Ground: (Top 100mm-Brown sand FILL with concrete gravel; 100mm- Firm brown sandy clay with brick fragment, gravel,100mm- Red crushed brick; Brownish grey slightly clayey sandy fine to coarse ash FILL)	(0.50)		
2					1.50		
1			HP50kPa	Firm orangish brown, grey mottled CLAY	(0.50)		
4					2.00	2.00	
2				Very stiff brown with fine grey viens slightly sandy CLAY with occasional coal fragments, fine to medium gravel including weathered sandstone			
1							
1							
1							
2							
1							
2							
3							
3							
3			HP170+k				
3							
3							
3							
3					(1.60)		
4							
3				no grey veins beyond 3.0m		3.00	
5							
3							
4			HP180kP				
4							
4							
3					3.60		
4							
3							
4						4.00	
4							
3							
4							
4							
4							
4							
4							
5							
4							
4				Continuous Dynamic Sounding Complete			
5						5.00	
						6.00	
						7.00	
						8.00	

Remarks 1) Borehole dry
2) Casing refused at 3.0m
3) Sampler refused at 3.6m

Logged by: KD Drilled by: MH

Ground level:

Co-ordinates:

Dynamic Probe Super Heavy (BS1377 Part 9 Test 3.2)

STRATA SURVEYS LIMITED

Location **Plymouth Grove, Birch Lane, Manchester**

Client: Linson Construction Pension Fund Project Ref.:

Borehole No. **BHB**

Equipment and methods **Continuous Dynamic SA-SO**

Job No.: **13855**

Start Date: **30/01/2007**

Final Depth: **5.00m**

Drop Height	750mm
Drop Weight Mass	64kg
Cone Diameter	50mm
Casing Diameter	113mm
Casing Depth	3.00m

Blows	Penetration mm / blows	N100 - Blows per 100mm	Torque Nm {Cu} [N300]	Description	Depth & Thickness m	Strata Reduced Level (m)	Legend
		D1-0.3m		Made Ground:(Grass over topsoil FILL with some brick, cloth, gravel, cotton wool balls)	(1.00)		
		D2-0.6m			1.00	1.00	
		D3-0.9m		Made Ground:(Top 200mm-Dark brown slightly clayey sand FILL with much broken brick, concrete, gravel, wood, cloth; bottom 200mm Red borken brick, mortar over fine to coarse gravel)	(1.20)		
2					2.20	2.00	
1				Stiff becoming very stiff dark brown slightly sandy laminated CLAY with many fine grey veins, occasional coal, fine to medium gravel including weathered sandstone			
3			HP130kP				
1					(1.50)	3.00	
1			(240)				
4			HP180+k				
3					3.70		
5						4.00	
6							
3							
4							
2							
5							
2							
2							
3							
2							
3							
3							
3							
4							
4							
6							
4							
5							
5							
4							
5							
6							
5							
4							
4							
5							
6							
5				**Continuous Dynamic Sounding Complete**		5.00	
6						6.00	
						7.00	
						8.00	

Remarks 1) Borehole dry
2) Casing refused at 3.0m
3) Sampler refused at 3.8m

Logged by KD Drilled by MH

Ground level

Co-ordinates.

Dynamic Probe Super Heavy (BS1377 Part 9 Test 3.2)

SSL dp1 0306 (Sandard) HDPSH.SHT 11/2006 07:40:40

STRATA SURVEYS LIMITED

Location **Plymouth Grove, Birch Lane, Manchester**

Client: Linson Construction Pension Fund Project Ref.:

Borehole No. **BHC**

Equipment and methods **Continuous Dynamic SA-SO**

Job No.: **13855**

Start Date: **30/01/2007**

Final Depth: **5.00m**

Drop Height	750mm
Drop Weight Mass	64kg
Cone Diameter	50mm
Casing Diameter	113mm
Casing Depth	3.00m

Blows	Penetration mm / blows	N100 - Blows per 100mm	Torque Nm (Cu) [N300]	Description	Strata Depth & Thickness m	Strata Reduced Level (m)	Strata Legend
				Made Ground (Reinforced concrete FILL)	(0.28) 0.28		
		D1-0.6m		Made Ground (Broken brick FILL)	(1.02) 1.30	1.00	
1				No recovery	(0.70) 2.00	2.00	
5				Brown fine to medium grained sandy CLAY	(0.10) 2.10		
2			HP120kP	Stiff becoming very stiff dark brown grey fissured slightly sandy laminated CLAY with a little coal, fine to medium gravel including weathered sandstone			
1			(259)				
6							
7							
3			HP180+k				
5							
6					(1.90)	3.00	
2							
1							
2							
2							
3							
3							
3							
4			HP180+k				
3							
4							
3							
4							
4							
3							
4							
4							
5							
5							
4							
4					4.00	4.00	
5							
4							
5							
4							
4							
4							
5							
4							
4							
3							
4							
				Continuous Dynamic Sounding Complete		5.00	
						6.00	
						7.00	
						8.00	

Remarks 1) Borehole dry
2) Casing refused at 3.0m
3) Sampler refused at 3.9m

Logged by KD Drilled by MH

Ground level

Co-ordinates:

Dynamic Probe Super Heavy (BS1377 Part 9 Test 3.2)

STRATA SURVEYS LIMITED

Job No.: **13855**

Location **Plymouth Grove, Birch Lane, Manchester**

Client: Linson Construction Pension Fund Project Ref.:

Borehole No. **BHD**

Equipment and methods **Continuous Dynamic SA-SO**

Start Date: **29/01/2006** Final Depth: **6.00m**

Drop Height	750mm
Drop Weight Mass	64kg
Cone Diameter	50mm
Casing Diameter	113mm
Casing Depth	2.00m

Blows	Penetration mm / blows	N100 - Blows per 100mm	Torque Nm {Cu} [N300]	Description	Depth & Thickness m	Strata Reduced Level (m)	Legend
		D1-0.26m		Made Ground (Reinforced concrete-100mm over brick clay, gravel FILL)			
		D2- 0.6m			(1.00)		
		D3-0.96m			1.00	1.00	
1				Made Ground (Firm dark brown sandy clay FILL with a little gravel, brick fragments, coal speckles)	(0.30)		
1					1.30		
1							
2			HP30kPa	MADE GROUND (Firm brown mottled slightly sandy Clay with a little gravel, brick, coal, rootlets)	(0.40)		
2			(53)				
2			HP50kPa		1.70		
2							
3				Stiff to very stiff dark brown slightly sandy CLAY with many fine grey veins, a little coal, fine to medium gravel including weathered sandstone			
3							
4			HP130kP			2.00	
3							
3							
3							
4							
4							
3							
4					(2.00)		
3							
4							
3						3.00	
3							
3							
3			HP180+k				
4							
4							
4							
5					3.70		
6							
5							
5						4.00	
4							
5							
5							
4							
5							
5							
5							
4							
5				**Continuous Dynamic Sounding Complete**			
5						5.00	
						6.00	
						7.00	
						8.00	

Remarks 1) Borehole dry
2) Casing refused at 2.0m
3) Sampler refused at 3.7m

Logged by **KD** Drilled by **MH**

Ground level

Co-ordinates:

Dynamic Probe Super Heavy (BS1377 Part 9 Test 3.2)

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STRATA SURVEYS LIMITED

Location **Plymouth Grove, Birch Lane, Manchester**

Client Linson Construction Pension Fund Project Ref..

Borehole No. **BHE**

Job No.: **13855**

Equipment and methods **Continuous Dynamic SA-SO**

Start Date: **29/01/2006**

Final Depth: **6.00m**

Drop Height	750mm
Drop Weight Mass	64kg
Cone Diameter	50mm
Casing Diameter	**113mm**
Casing Depth	**2.00m**

Blows	Penetration mm / blows	N100 - Blows per 100mm	Torque Nm (Cu) [N300]	Description	Strata Depth & Thickness m	Strata Reduced Level (m)	Legend
		D1-0.3m		Made Ground (Reinforced concrete-200mm, brick, soil, gravel FILL-200mm, clay, brick-250mm; Brown sandy clay with brick, concrete)	(1.10)	1.00	
		D2-0.5m					
		D3-0.9m					
1	200		V65kPa		1.10		
1			(65)	Firm brown orange brown, grey mottled slightly sandy CLAY with a little fine gravel and occasional coal speckles	(0.30)		
1					1.40		
2			HP120kP	Stiff becoming very stiff dark brown grey fissured slightly sandy CLAY with a little coal, fine to medium gravel including weathered sandstone			
1							
2						2.00	
3							
4							
4							
3							
3			V120kPa				
2							
3			HP160kP				
2					(2.25)		
3							
3							
4			HP180kP				
3							
4						3.00	
4			HP110kP				
4							
5							
5							
4			HP170kP				
4							
4					3.65		
5							
4						4.00	
5							
4							
5							
4							
4							
4							
5							
6							
4							
5				**Continuous Dynamic Sounding Complete**		5.00	
6							
						6.00	
						7.00	
						8.00	

Remarks 1) Borehole dry
2) Casing refused at 3.0m
3) Sampler refused at 3.8m

Logged by KD Drilled by MH

Ground level

Co-ordinates:

Dynamic Probe Super Heavy (BS1377 Part 9 Test 3.2)

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APPENDIX 3 LABORATORY TEST RESULTS

STRATA SURVEYS LIMITED

APPENDIX 3.1 Summary of Test Results

Client: Linson Construction Pension Fund

Job No.: 13855

Site Name: Plymouth Grove, Birch Lane, Manchester

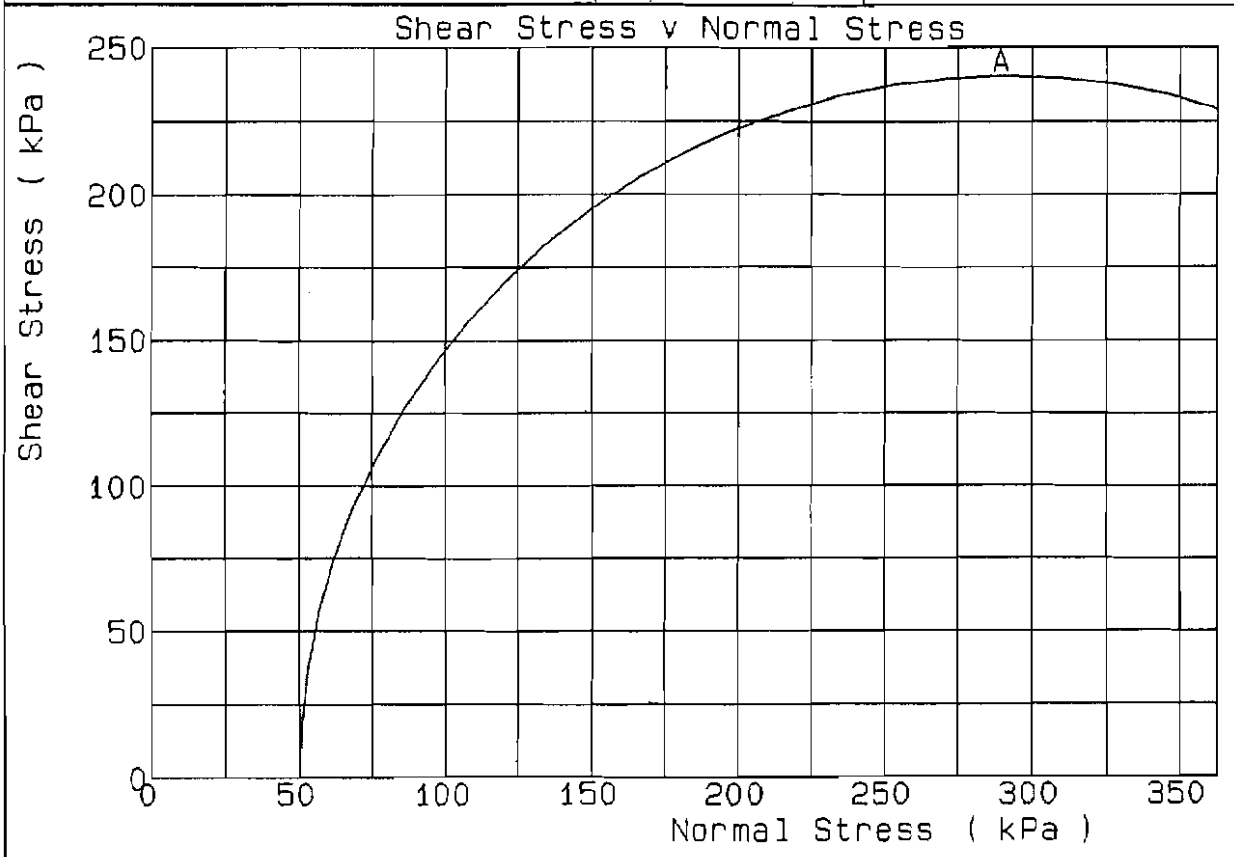
Laboratory Test Result Summary

					Classification					Triaxial Compression									Chemical					Additional			
Location Number	Sample Type No.	Sample Depth Top m	Sample Depth Bottom m	Description	LL	PL	PI	% Retained 425µm	Moisture Content %	Bulk Density Mg/m³	Dry Density Mg/m³	Test Type	Specimen Diameter mm	Specimen Length mm	Lateral Pressure {Deviator Stress} kPa	Cohesion Intercept kPa	Friction Angle	Cu kPa	pH	SO_4 % Total	SO_4 mg/l 2:1 Extract	SO_4 mg/l in Water	Cl_2 %	Grading	Oedometer	Hand Pene. kgf/cm²	Others
BHA	D 2	0.60		Made Ground (Brown fine-coarse sand and brick Fill)															9 6		757 2						
BHB	U 1	3.00		Very stiff brown grey fissured laminated slightly sandy CLAY with a little fine-medium gravel					19	2.080	1 750	UU	84	168	50 {481}			240									
BHC	U 1	2 35		Very stiff brown grey mottled slightly sandy CLAY with some fine-medium gravel and rootlets					15	2.145	1.858	UU	84	168	50 {521}			259									
BHD	U 1	1.50		Made Ground (Firm brown light brown mottled slightly sandy Clay Fill with a little fine-medium gravel, fine brick, coal and dark grey sandy partings)					22	2.037	1.675	UU	84	168	50 {107}			53									
BHE	D 3	0.90		Made Ground (Black ashy topsoil Fill)															7.6		12.4						
BHE	U 1	1.30		Firm brown orange brown grey mottled slightly sandy CLAY with a little fine gravel and occasional coal	53	21	32	0	26	1.995	1.581	UU	84	168	50 {131}			65									

APPENDIX 3.2 Triaxial Compression Tests Mohrs Circles

STRATA SURVEYS LIMITED

Job: 13855 Plymouth Gr. Triaxial Undrained Shear Inc.No. 1
BoreHole: B Sample: U1/A Depth: 3.00m



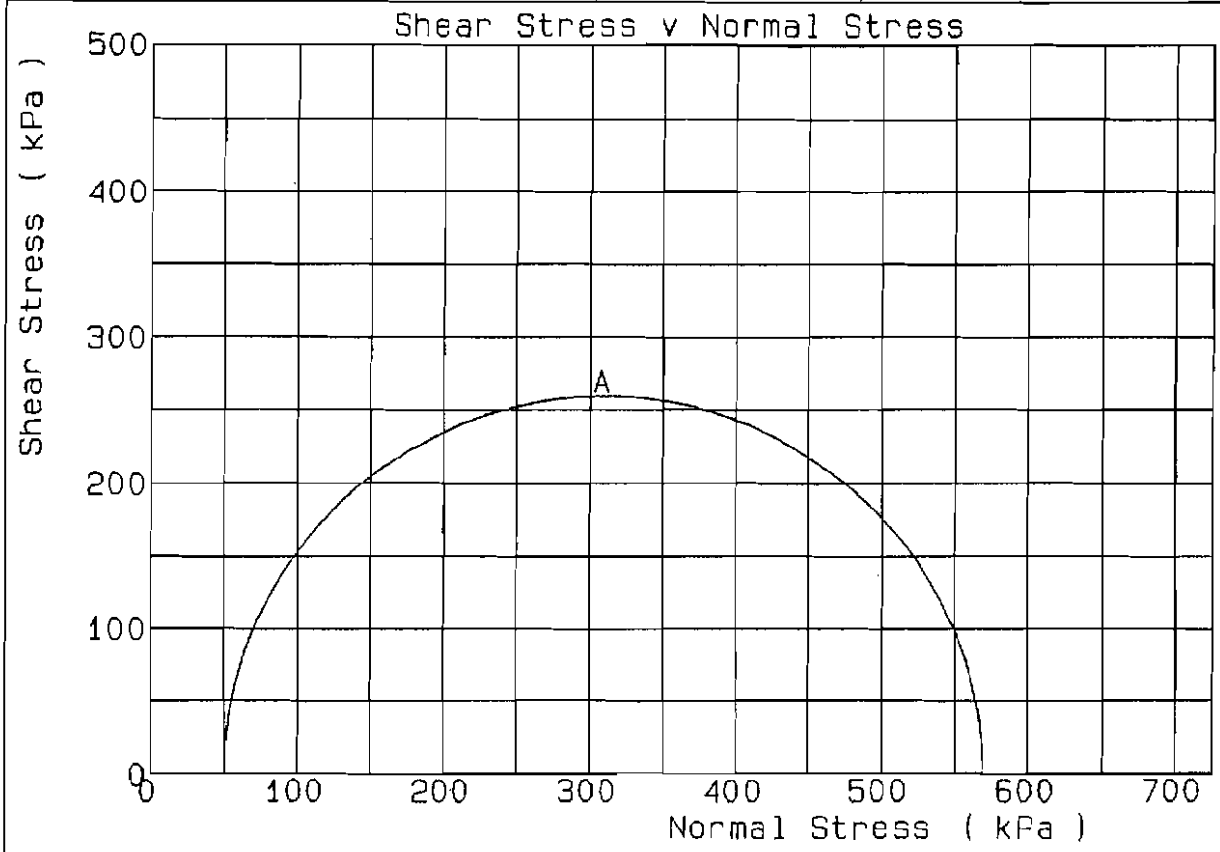
Reference		A
Height	mm	168.0
Diameter	mm	84.0
Bulk Density	Mg/cum	2.080
Moisture content	%	18.87
Dry Density	Mg/cum	1.750
Cell pressure	kPa	50
Loading rate	mm/min	3.793
Shear Stress *	kPa	240.5
Strain *	%	19.6

* At maximum deviator stress

Cohesion (c)	240 kPa
Angle of Shear Resistance (phi)	0 deg

Strata Surveys Limited

Job: 13855 Plymouth Gr. Triaxial Undrained Shear Inc.No. 1
BoreHole: C Sample: U1/A Depth: 2.35m



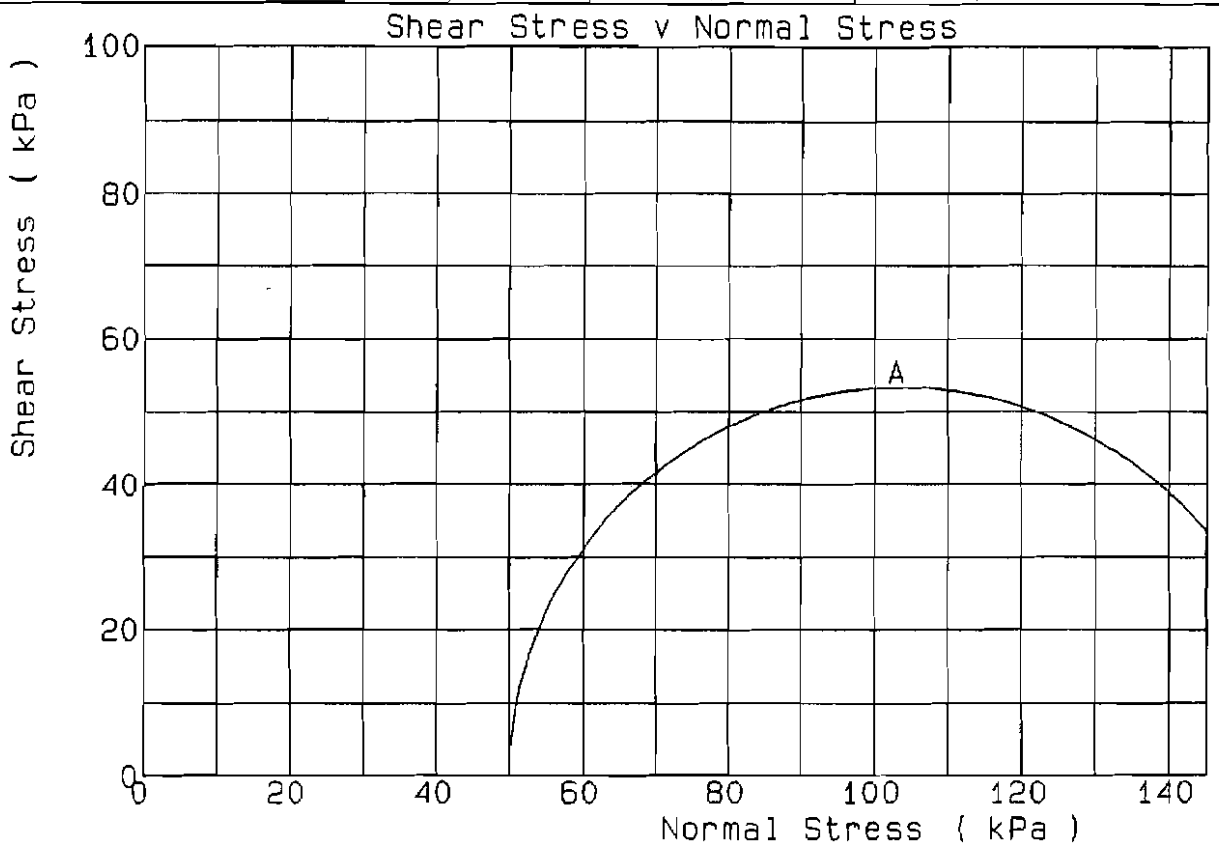
Reference		A
Height	mm	168.0
Diameter	mm	84.0
Bulk Density	Mg/cum	2.145
Moisture content	%	15.44
Dry Density	Mg/cum	1.858
Cell pressure	kPa	50
Loading rate	mm/min	3.970
Shear Stress *	kPa	259.7
Strain *	%	19.9

* At maximum deviator stress

Cohesion (c) 259 kPa
Angle of Shear Resistance (phi) 0 deg

Strata Surveys Limited

Job: 13855 Plymouth Gr. Triaxial Undrained Shear Inc.No. 1
BoreHole: D Sample: U1/A Depth: 1.50m



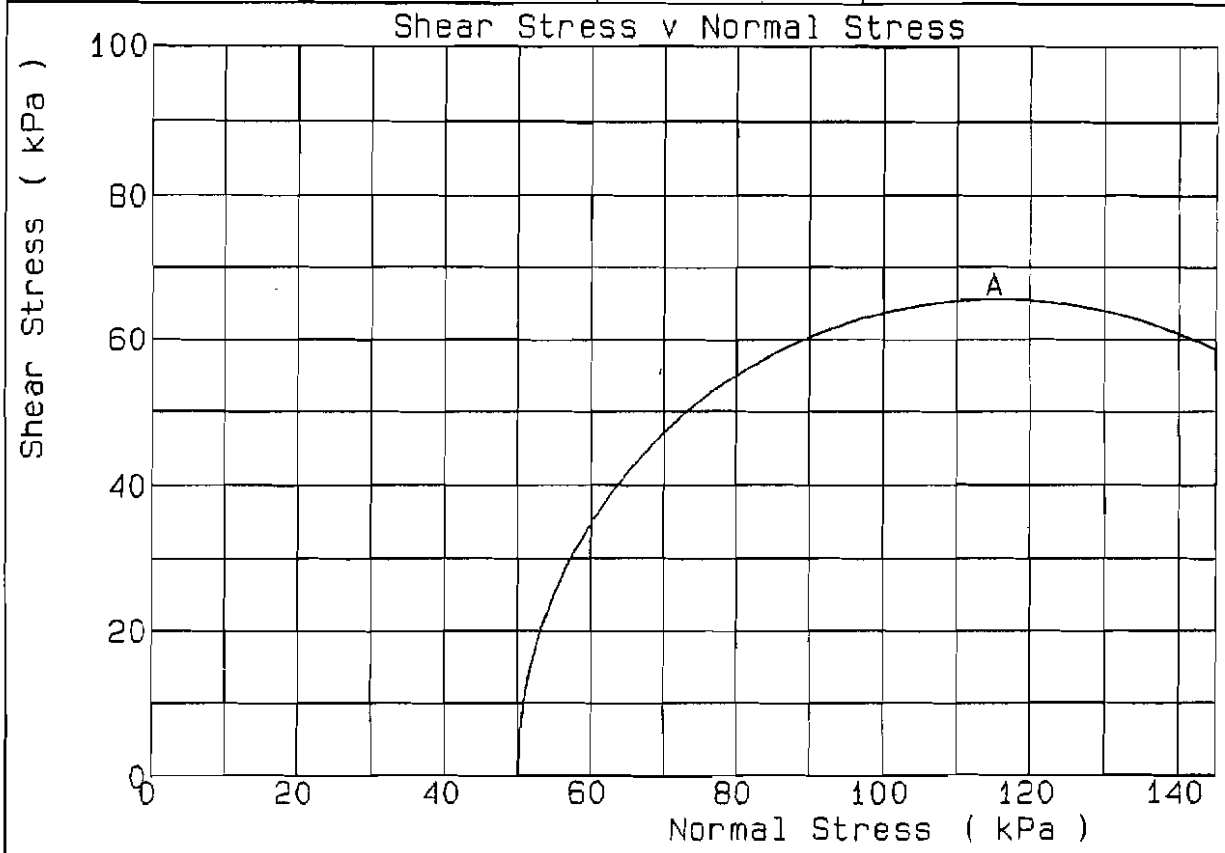
Reference		A
Height	mm	168.0
Diameter	mm	84.0
Bulk Density	Mg/cum	2.037
Moisture content	%	21.65
Dry Density	Mg/cum	1.675
Cell pressure	kPa	50
Loading rate	mm/min	3.859
Shear Stress *	kPa	53.4
Strain *	%	18.7

* At maximum deviator stress

Cohesion (c) 53 kPa
Angle of Shear Resistance (phi) 0 deg

Strata Surveys Limited

Job: 13855 Plymouth Gr. Triaxial Undrained Shear Inc.No. 1
BoreHole: E Sample: U1/A Depth: 1.30m



Reference		A
Height	mm	168.0
Diameter	mm	84.0
Bulk Density	Mg/cum	1.995
Moisture content	%	25.17
Dry Density	Mg/cum	1.581
Cell pressure	kPa	50
Loading rate	mm/min	4.057
Shear Stress *	kPa	65.6
Strain *	%	15.9

* At maximum deviator stress

Cohesion (c)	65 kPa
Angle of Shear Resistance (phi)	0 deg

Strata Surveys Limited

APPENDIX 3.3 Chemical Contamination Tests

STRATA SURVEYS LIMITED

Scientific Analysis Laboratories

Report Number:	95040-1
Date of Report:	21-Feb-2007
Client:	Strata Surveys Ltd, Strata House, Holmes Chapel Road, Middlewich. CW10 0JB
Client Contact:	Mr Neil Johnson
Client Job Reference:	13855
Client Site Reference:	Plymouth Grove
Client Purchase Order:	5170
Date Job Received at SAL:	09-Feb-2007
Date Analysis Started:	13-Feb-2007
Date Analysis Completed:	20-Feb-2007

The results reported relate to samples received at the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS or MCERTS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs

Key to symbols used in this report:
W: Analysis was performed at another SAL Laboratory
S: Analysis was sub-contracted
N: Analysis is not UKAS accredited
U: Analysis is UKAS accredited
M: Analysis is MCERTS accredited

Report checked
and authorised by:

Miss Debra Hau
Project Manager

UKAS TESTING
1549

Group

Index to caveats used in this report

Value	Description
ND	Not Detected
AR	As Received
-	Not Required

SAL Reference: 95040
Project Site: Plymouth Grove
Customer Reference: 13855

Soil Analysed as Soil
Miscellaneous

	SAL Reference	95040 001	95040 002	95040 003
	Customer Sample Reference	BHB D2 0.60M	BHD D3 0.95M	BHE D2 0.50M
	Test Sample	-	-	-

Determinant	Technique	LOD	Units	Symbol			
Asbestos (Screen Only)	Visual			N	ND	-	-
Boron (water-soluble)	ICP/OES	1	mg/kg	N	<1	<1	<1
Chromium VI	ICP/OES	1	mg/kg	N	<1	<1	<1
Sulphate (Total)	ICP/OES	0.01	%	N	**0.43**	**0.08**	**0.05**
Sulphur (Total)	ICP/OES	0.01	%	N	**0.14**	**0.03**	**0.02**
Cyanide (Total)	Colorimetry	1	mg/kg	U	<1	<1	<1
Cyanide(free)	Colorimetry	1	mg/kg	U	<1	<1	<1
Phenols (Total-Mono)	Colorimetry	1	mg/kg	U	<1	<1	<1
Sulphide	Colorimetry	10	mg/kg	N	<10	<10	<10
Thiocyanate	Colorimetry	10	mg/kg	N	<10	<10	<10
pH	Probe			U	**6.6**	**6.9**	**10.0**

SAL Reference: 95040
Project Site: Plymouth Grove
Customer Reference: 13855

Soil Analysed as Soil
Polyaromatic Hydrocarbons (US EPA16)

					SAL Reference	95040 001	95040 002	95040 003
					Customer Sample Reference	BHB D2 0.60M	BHD D3 0.95M	BHE D2 0.50M
					Test Sample	-	-	-
Determinant	**Technique**	**LOD**	**Units**	**Symbol**				
Naphthalene	GC/MS	0.1	mg/kg	U		**0.1**	<0.1	<0.1
Acenaphthylene	GC/MS	0.1	mg/kg	U		<0.1	<0.1	<0.1
Acenaphthene	GC/MS	0.1	mg/kg	U		<0.1	<0.1	<0.1
Fluorene	GC/MS	0.1	mg/kg	U		<0.1	<0.1	<0.1
Phenanthrene	GC/MS	0.1	mg/kg	U		**0.3**	**0.4**	<0.1
Anthracene	GC/MS	0.1	mg/kg	U		<0.1	**0.1**	<0.1
Fluoranthene	GC/MS	0.1	mg/kg	U		**0.4**	**0.6**	<0.1
Pyrene	GC/MS	0.1	mg/kg	U		**0.4**	**0.6**	<0.1
Benzo(a)Anthracene	GC/MS	0.1	mg/kg	U		**0.2**	**0.4**	<0.1
Chrysene	GC/MS	0.1	mg/kg	U		**0.2**	**0.4**	<0.1
Benzo(b/k)Fluoranthene	GC/MS	0.1	mg/kg	U		**0.3**	**0.6**	<0.1
Benzo(a)Pyrene	GC/MS	0.1	mg/kg	U		**0.2**	**0.3**	<0.1
Indeno(123-cd)Pyrene	GC/MS	0.1	mg/kg	U		<0.1	**0.2**	<0.1
Dibenzo(ah)Anthracene	GC/MS	0.1	mg/kg	U		<0.1	<0.1	<0.1
Benzo(ghi)Perylene	GC/MS	0.1	mg/kg	U		**0.1**	**0.2**	<0.1

APPENDIX 4 BOREHOLE LOCATION PLAN


Plymouth Grove
BHA
BHB
BHC
BHD
BHE
Birch Lane

APPENDIX 5 SITE LOCATION PLAN

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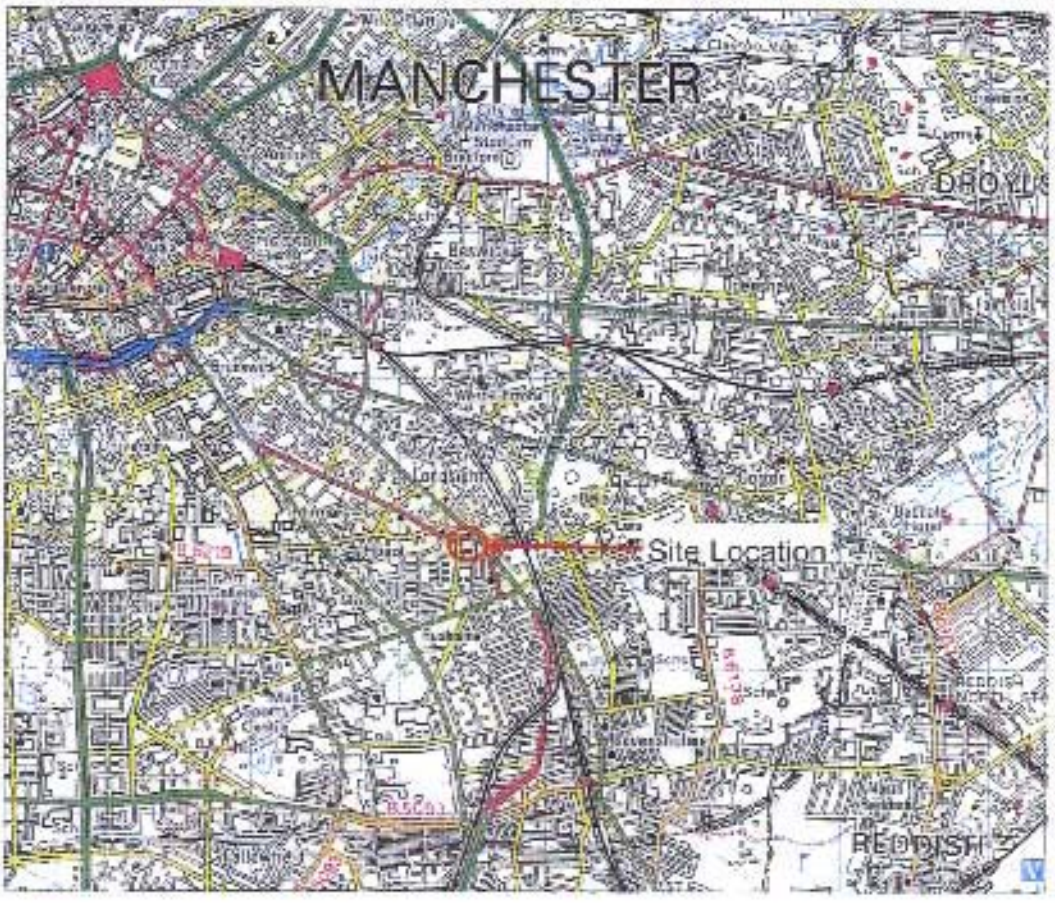
STRATA SURVEYS LIMITED

SITE LOCATION

Plymouth Grove / Birch Lane, Manchester



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