06/3908/9

REPORT ON GROUND INVESTIGATION AT FOULSTONE & WOMBWELL SCHOOL

FOR

BARNSLEY METROPOLITAN BOROUGH COUNCIL

SEPTEMBER 2006

CC Geotechnical

Consulting Geotechnical & Geoenvironmental Engineers

Essex House, Bridle Road, BOOTLE, Merseyside. L30 4UE.

Telephone: (0151) 523 0202 Fax: (0151) 523 0252

CC Geotechnical

Document Issue Form

Number:	06/3908/9		
Revision:	0	**Issue Date:**	September 2006

Document Title: REPORT ON GROUND INVESTIGATION AT FOULSTONE & WOMBWELL SCHOOL

Comments :

Prepared For : BARNSLEY METROPOLITAN BOROUGH COUNCIL

Prepared By :	Richard Roberts BEng(Hons)	
Reviewed By :	C. Bolan CEng MICE MICT FGS	
Authorised By:	C. Bolan CEng MICE MICT FGS	

Distribution :

Name	No. Copies
BARNSLEY MBC	3

REPORT ON SITE INVESTIGATION AT FOULSTONE & WOMBWELL SCHOOL - BARNSLEY MBC
TABLE OF CONTENTS

		PAGE
1.0	**INTRODUCTION**	**1**
2.0	**SITE DATA**	**2**
2.1	Introduction	2
2.2	Site Description	2
2.3	Proposed Development	2
2.4	Published Geology	3
2.5	Hydrology	3
2.6	Hydrogeology	3
3.0	**FIELDWORK**	**3**
3.1	Introduction	3
3.2	Boreholes	4
3.3	Trial Pits	5
4.0	**LABORATORY TESTING**	**5**
5.0	**OBSERVED STRATIGRAPHY**	**6**
6.0	**RISKS TO FABRIC OF BUILDINGS**	**6**
6.1	Water Supply Mains	6
6.2	Concrete in the Ground	7
6.3	Ground Gas Assessment	7
7.0	**LEGISLATIVE BACKGROUND TO CONTAMINATED LAND ASSESSMENT**	**8**
8.0	**HUMAN HEALTH RISK ASSESSMENT METHODOLOGY**	**9**
9.0	**SITE SPECIFIC ASSESSMENT CRITERIA**	**9**
10.0	**HUMAN HEALTH RISK ASSESSMENT**	**9**
10.1	Introduction	9
10.2	Maximum Value Test Analysis	9
10.3	Mean Value Test Analysis	10
10.4	Asbestos Analyses	10
10.5	Assessment of Individual Results	10
11.0	**SUMMARY OF CONCEPTUAL MODEL**	**10**
11.1	Introduction	10
11.2	Further Assessment of Arsenic	11
12.0	**OFFSITE DISPOSAL OF SURPLUS SPOIL**	**12**
13.0	**MINING ASSESSMENT**	**12**
14.0	**FOUNDATION RECOMMENDATIONS**	**13**
14.1	Spread Foundations	13
14.2	Piled Foundations	13
14.3	Bridge Foundations	14
15.0	**GROUND SLABS**	**14**
16.0	**GROUNDWATER AND EXCAVATIONS**	**14**
17.0	**PAVEMENT DESIGN**	**15**
18.0	**SOAKAWAY ASSESSMENT**	**15**
19.0	**CONCLUSIONS AND RECOMMENDATIONS**	**15**
	APPENDIX A: DRAWINGS	

APPENDIX B: BOREHOLE SECTION SHEETS
APPENDIX C: TRIAL PIT SECTION SHEETS
APPENDIX D: GAS MONITORING DATA
APPENDIX E: SOIL ENGINEERING TEST RESULTS
APPENDIX F: SOIL CONTAMINATION DATA
APPENDIX G: WRAS ASSESSMENT
APPENDIX H: RISK ASSESSMENT METHODOLOGY
APPENDIX I: INPUT PARAMETERS AND HCV DERIVATIONS
APPENDIX J: SOIL CONTAMINATION DATA ASSESSMENT
APPENDIX K: WASTE DISPOSAL CLASSIFICATION
APPENDIX L: NOTES ON LIMITATIONS

1.0 INTRODUCTION

CC GEOTECHNICAL LTD was commissioned by ***BARNSLEY MBC*** to provide site investigation services in connection with the proposed construction of new educational facilities at the proposed site of ***Foulstone & Wombwell Schools***.

The specific services required of ***CC GEOTECHNICAL LTD*** included:

- The review of desk study documentation provided by Barnsley MBC
- The planning and undertaking of intrusive ground investigations to include inter alia - cable percussion boreholes, rotary boreholes, trial pits, insitu CBR testing, insitu soakaway testing
- The performance of appropriate soil laboratory engineering classification testing
- The procurement of soil and groundwater contamination analyses via an accredited laboratory
- The preparation of a Building Durability Risk Assessment based on soil and groundwater contamination data, together with appropriate protective recommendations
- The preparation of a Human Health Risk Assessment based on soil and groundwater contamination data, together with appropriate remedial recommendations
- The provision of recommendations for the stabilisation of shallow mineworkings, where such workings have been demonstrated to be present
- The provision of recommendations on the selection and design of foundations and floor slabs
- The provision of recommendations on pavement design
- The provision of recommendations on adoption of soakaway drainage

This report is presented in combined factual / interpretative form, and must be read in conjunction with the Notes on Limitations given in Appendix L.

2.0 SITE DATA

2.1 Introduction

For a comprehensive review of the historical and current context setting of the site, reference should be made to Soil Mechanics Desk Study Report A6022, published April 2006, as furnished to ***CC GEOTECHNICAL LTD*** by ***Barnsley MBC.***

2.2 Site Description

The site is located to the north and south of Pitt Street, in the Wombwell area of Barnsley, about 7.5km south east of Barnsley town centre as shown on Drawing 3908/9/1. The National Grid reference for the approximate site centre is E440290 N403880.

The site comprises two roughly rectangular plots of land of approximately equal area, located to the north and south of Pitt Street, which runs on an east-west axis at this location.

The area to the south of Pitt Street comprises of dense woodland on its western half, and open grassed fields on its eastern half. The River Dove defines the southern boundary of this area.

The site is bound by Pitt Street to the north, neighbouring residential housing and commercial properties to the east, contiguous parkland to the west and the River Dove to the south of the site.

2.3 Proposed Development

The proposed development layout is illustrated on Drawing 3908/4/2. It can be seen that the proposed development includes new 2 storey ALC blocks, car parking areas, and bus drop off facilities.

2.4 Published Geology

The documented geology of the site is summarised on British Geological Survey Sheets, principally:-

Table 1
Sheet 87 – BARNSLEY – Solid and Drift Edition, Scale 1:50000

Drift Geology	*Aluvium of Recent Origins*
Solid Geology	*Middle Coal Measures of Upper Carboniferous Origins*

The Middle Coal Measures strata underlying the site contain workable coal seams. The 1:50000 map indicates the Mansfield Marine Band outcropping to the south of the site and dipping to the north at an angle of about 1 in 16. The nearest point of outcropping is in the order of 200m south of the site, indicating a potential for the seam to be encountered at around 13m below rockhead.

2.5 Hydrology

The nearest surface watercourse is the River Dove, which flows on a roughly east-west alignment and forms the southern boundary of the site.

2.6 Hydrogeology

The documented lithology underlying the site may be represented as a series of discrete units as shown hereunder:

UNIT	COMMENT
Made ground	Probable permeable strata – may store perched groundwater
Alluvium	Semi -permeable strata – may store and transmit limited amounts of groundwater
Coal Measures	Minor aquifer – minor aquifers seldom produce viable quantities of water for abstraction, although they may be important in providing base flow to rivers

3.0 FIELDWORK

3.1 Introduction

The fieldwork was undertaken during August 2006 and comprised the drilling of six boreholes, and the excavation of seven trial pits. The positions of the boreholes and trial pits are as shown on Drawing 3908/9/2. The fieldwork was

planned in accordance with BS10175: 2001, and carried out in accordance with BS10175: 2001 and BS5930: 1999, insofar as they related to the scope of the investigation.

3.2 Boreholes

All boring tools were decontaminated prior to commencement, and between borehole moves.

The cable percussion boreholes were drilled by Dando 150 light cable percussion boring rigs, to rockhead. Standard Penetration Tests were carried out at regular intervals in granular strata. Bulk disturbed samples and jar samples were recovered at incremental depths in the boreholes.

Each borehole was advanced below rockhead by rotary open hole drilling methods, using 76mm diameter equipment with air/mist flush, to depths of about 30mbgl. The logs of the boreholes, annotated with sampling details, N values, and observations made during the rotary drilling are given in Appendix B.

On completion, each borehole was grouted to rockhead, and further backfilled using borehole arisings.

Monitoring wells comprising of a 1.0m upper section of 50mm diameter HDPE plain pipe surrounded by a bentonite/grout seal, atop a 50mm diameter HDPE slotted pipe section in a pea gravel surround, were installed in four of the six boreholes. The installations were fitted with gas valves and protected by flush covers set in concrete, and were periodically monitored for flow rate and composition of ground gas using a Gas Data LMSxi Type G4.18 infrared gas analyser and Gas Data GF60 flowmeter. The installations were also monitored for standing groundwater levels.

The results of the gas monitoring and the instrument calibration certificate are given in Appendix D.

Water monitoring observations are annotated on the Borehole Section Sheets in Appendix B.

3.3 Trial Pits

Trial pits were excavated to obtain a broad assessment of the near surface geology, to facilitate sampling for classification and contamination testing, and to enable a preliminary assessment of the likely drainage characteristics of the soils.

The excavations were undertaken by mechanical digger to depths of up to 3.0mbgl. The exposures within each excavation were carefully logged, and Mexicone CBR tests were carried out in the trial pit walls and floor. The arisings were then returned in the reverse sequence of their excavation, to preserve, insofar as was practical, the original lithology

The Trial Pit Section sheets annotated with sampling and testing data are given in Appendix C.

4.0 LABORATORY TESTING

A programme of soil engineering testing was undertaken, which comprised the following:

- Determination of soil moisture content in accordance with BS1377: Part 2: 1990
- Determination of Atterberg Limits in accordance with BS 1377: Part 2: 1990
- Determination of Particle Size Distribution in accordance with BS 1377: Part 2: 1990

The Soil Engineering Test Results are presented in Appendix E.

A laboratory chemical analysis programme was undertaken at a UKAS/MCERTS accredited laboratory, and comprised the analysis of six soil

samples to a broad-spectrum contamination suite, of which three were analysed for TPHCWG.

PID headspace analyses were carried out on counterparts of all samples sent for analysis.

The results of the soil chemical analyses are presented in Appendix F.

The results of the PID headspace analyses are given on the respective trial pit / borehole logs.

5.0 OBSERVED STRATIGRAPHY

The boreholes and trial pits generally confirmed the documented geology.

The succession generally commences with a depth of topsoil overlying significant depths of made ground, observed extending to depths of up to 10.3mbgl. The made ground generally comprises brick, ash, timber, coal, concrete, clay, gravel and sand. Large metal obstructions, approximately 0.1m thick, were encountered in TP9 at a depth of about 0.6mbgl. The made ground was occasionally interbedded with coal and mudstone gravel deposits, probably resulting from the extensive mining undertaken in the area. The made ground is underlain by weathered mudstone, which was weathered to silty sandy gravelly clay at the surface becoming fresh with depth.

Groundwater was not encountered during the initial fieldwork, or during standpipe monitoring visits.

6.0 RISKS TO FABRIC OF BUILDINGS

6.1 Water Supply Mains

Based on the criteria specified in Paper 9-04-03: Oct 2002 published by the Water Regulations Advisory Scheme (Ref 1) for pipe materials selection, the chemical analyses indicate that water supply mains must be laid in a remediated alignment, due to the concentration of arsenic and TPH's in the soils – see

Appendix G.

In this circumstance, the WRAS guidance states that PE/Al/PE mains should be laid in a sterile trench of width 1m + pipe diameter, and extending 300mm below the pipe.

6.2 Concrete in the Ground

The data obtained in the investigations has been assessed against the guidance given in BRE Special Digest 1: 2005, and is summarised on a site-specific basis as hereunder:

Table 2:
Design Chemical Classification

CONCRETE SPECIFICATION DATA SHEET		
Is the site brownfield or greenfield?	Brownfield	
Is the water table static or mobile?	Static	
Maximum Water Soluble Sulphate results	1976mg/l	Design Sulphate Class of DS-3 and ACEC Class of AC-3s
Lowest pH result	3.6	
Intended Service Life	100 years	Specify concrete to comply with the requirements of Design Chemical Classification of DC-3 as given in BRE Special Digest 1: 2005

6.3 Ground Gas Assessment

The gas monitoring data obtained on this site indicates that the site complies with Characteristic Situation 2 as defined in SA Wilson and GB Card document "Reliability and Risk in Gas Protection Design", and as such, the following gas protection measures are required:

- Well constructed cast in situ reinforced concrete ground slab
- All joints and penetrations sealed
- Waterproofing membrane sealed around penetrations
- Granular layer below slab passively vented to atmosphere with interleaved geocomposite strips or pipes

7.0 LEGISLATIVE BACKGROUND TO CONTAMINATED LAND ASSESSMENT

Land contamination is a material planning consideration within the planning regime. This means that a planning authority has to consider the potential implications of contamination both when it is developing strategic or local plans (or unitary development plans), and when it is considering individual applications for planning permission. Where contamination is suspected or known to exist at a site, a planning authority may require investigation before granting planning permission, or may impose conditions on the permission requiring appropriate investigation and, if necessary, remediation (Department of the Environment/Welsh Office, 1994).

Section 78A(2) of the Environmental Protection Act 1990 inserted under Section 57 of the Environment Act 1995 defines contaminated land for the purposes of Part IIA as:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that

- Significant harm is being caused
- Significant possibility of significant harm being caused
- Pollution of controlled waters is being caused
- Pollution of controlled waters is likely to be caused

Under the Act, "harm" is defined as:

"harm to the health of living organisms or other interference with the ecological systems of which they form apart and, in the case of man, includes harm to his property"

and pollution of controlled waters is defined as:

"the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter".

8.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

The risk assessment methodology employed by ***CC GEOTECHNICAL LTD*** is given in Appendix H.

9.0 SITE SPECIFIC ASSESSMENT CRITERIA

The assessment of the contamination data obtained on this site has been undertaken by comparison of the results with published SGV`s, and with derived GAC's obtained using the SNIFFER methodology, employing toxicological input data from sources generally in accordance with CLEA CLR 9.

The input data, Derivation Worksheets based on the methodology discussed in Report number LQ01 – 'Method for Deriving Site Specific Human Health Assessment Criteria in Soil', and Risk Evaluation Sheets are presented in Appendix I.

The statistical interpretations of the soil contamination data obtained in the investigations are given in Appendix J.

10.0 HUMAN HEALTH RISK ASSESSMENT

10.1 Introduction

The development will comprise the construction of education facilities with associated playing fields. Current risk assessment land classifications do not include a specific "school" classification. However a precautionary approach is recommended, and the land use has been taken to be equivalent to 'Residential Without Plant Uptake' pathways, as defined in CLEA CLR 10, and the results of soil analyses have been assessed against criteria derived for this scenario.

10.2 Maximum Value Test Analysis

A maximum value test on the contamination data is presented in Table 2 in Appendix J based on the soil contamination data in Table 1. It can be seen that 24 contaminants fail the Maximum Value Test.

The results for arsenic at TP3 has been identified as an outlier, and exceeds the SGV. Therefore, this result has been removed from the statistical analysis.

All other identified outliers are either low values, which distort the mathematical test, and are not indicative of contamination, or elevated values, which do not exceed the relevant human health criteria, and have been included in the Mean Value Test Analysis.

10.3 Mean Value Test Analysis

A mean value test analysis has been undertaken in accordance with the CLR 7 methodology, and the results presented in Table 3 in Appendix J. The 95th UCL values obtained from these analyses have been compared to their respective SGV / GAC, as shown in Table 4 of Appendix J.

The 95th UCL for arsenic exceeds the SGV.

All other 95th UCL's are all below their relevant criteria.

10.4 Asbestos Analyses

Chrysotile asbestos fibres were encountered in the sample analysed from TP10.

Asbestos fibres were not detected in any other sample analysed.

10.5 Assessment of Individual Results

An assessment of the individual results from the dataset show the following:

- The concentration of arsenic in TP3, TP4, TP8, TP9, TP11 and TP12 exceeds the SGV of 20mg/kg.

11.0 SUMMARY CONCEPTUAL MODEL

Based on the foregoing assessment, a conceptual model of the site may be constructed, demonstrating pollution linkages, as presented below:

Table 3 – Conceptual Model and Mitigation Measures

SOURCE	PATHWAY	TARGET	MITIGATION MEASURE
Arsenic in site soils	Accidental ingestion of soil Dermal contact with soil Dermal contact with dust Ingestion of dust	Pupils and staff	Investigation has shown superficial soils on playing fields to be significantly contaminated by arsenic – reassess by DQRA – see 11.2 hereunder
Asbestos fibres at TP10	Inhalation / ingestion of fibres	Installation and maintenance workers Human pupils and staff	Provide 300mm clean topsoil cover over all landscaped areas
Arsenic and TPH's in water main alignment	Direct attack on plastic mains – permeation through walls of mains	Installation and maintenance workers Human occupants	Use PE/Al/PE mains laid in a sterile trench alignment

11.2 Further Assessment of Arsenic

The foregoing assessment has been based on a conservative conceptual model (residential without plant uptake). However, the exposure parameters for the critical receptor on this site are significantly different than those adopted in the derivation of GAC`s for the "residential without plant uptake" conceptual model.

To obtain true site specific assessment criteria (SSAC`s), the following input parameters may be adopted:

Table 4: Site Specific Exposure Parameters

Parameter	Value	Justification
Exposure Duration	11-18 years (7 years)	Taken from BBC website
Time Averaged Body Weight	34.14kg	Based on data from LQ01 and ED
Time Averaged Body Height	1.57m	Based on data from LQ01 and ED
Childhood Ingestion Factor	0.868	Based on data from LQ01 and ED
Averaging Time	2555	Based on ED
Exposure Frequency	208 days	Based on term times

As exposure for arsenic is via the soil ingestion pathway, SSAC's for these contaminants may be derived using the algorithms given in LQ01 "Method for deriving site specific human health assessment criteria for contaminants in soil" (SNIFFER).

$$SSAC_{ingestion} = \frac{RI_{ingestion}}{SEI_{ingestion}} = \frac{RI_{ingestion}}{\frac{TADSR \times ED \times EF}{TABW \times AT}} = \frac{RI_{ingestion} \times TABW \times AT}{TASDR \times ED \times EF}$$

$$SSAC_{ingestion(arsenic)} = \frac{3 \times 10^{-4}\, mgkg^{-1}day^{-1} \times 34.14kg \times 2555days}{6.1260 \times 10^{-5}\, kgday^{-1} \times 7 \times 208days} = \frac{26.16831}{0.08919456} = 293mg/kgbw/day$$

On the basis of this SSAC, it may be concluded that the observed levels of contamination are probably not harmful, and the site does not require remediation.

12.0 OFFSITE DISPOSAL OF SURPLUS SPOIL

In July 2004, the Landfill Directive 1999/31/EC was invoked, and from this date, spoil arising from site construction must be assessed in accordance with Waste Acceptance Criteria (WAC) and EA Document RGN18 Waste Acceptance Criteria for Landfills for Non Hazardous Waste.

Based on the methodology discussed Environment Agency publications "Framework for the Classification of Contaminated Soils as Hazardous Waste" the soil contamination data has been analysed and any spoil from the site may be classified as "Non-Hazardous" waste. The calculations are given in Appendix K.

13.0 MINING ASSESSMENT

Shallow mineworkings can lead to crownhole development or subsidence at the ground surface. Carter & Symons (Site Investigations and Foundations Explained: 1989) propose the widely held view, that in areas where the thickness of competent rock cover is less than six times the worked seam thickness, it is unsafe to build, due to the risk of surface movements. They

propose that between six and ten times the worked seam thickness is unlikely to be affected by void migration or subsidence effects, and is safe to build on if rigid or raft foundations are employed. Where the rock cover is in excess of ten times the worked seam thickness, the zone is regarded as safe. Atkinson (Structural Foundations Manual: 1993) also proposes the so called ***"ten times seam thickness rule"***, without referring to the other classifications of "less than six", and "six to ten" times the seam thickness. This single 10:1 classification is also proposed in CIRIA Technical Guide 34: Construction Over Abandoned Mineworkings.

Boreholes on this site were drilled to depths of 20mbgl. No voids or loss in flush were encountered during drilling, and therefore, it may be concluded that the site is not underlain by any worked coal seams within the depth of influence of the proposed development, and subsidence or settlement associated with mine workings will not affect properties on the site.

14.0 FOUNDATION RECOMMENDATIONS

14.1 Spread Foundations for ALC Building

Spread foundations are not recommended, due to the depth of made ground encountered within the boreholes.

14.2 Piled Foundations for ALC Building

Piled foundations are recommended for this development. In these ground conditions, a range of piling techniques may be considered, including precast concrete driven, or CFA piles.

Precast concrete driven piles will provide an economic and technically suitable solution. Piles are installed to a "set", a downward movement per blow corresponding to the required carrying capacity, and calculated from the mass and height of fall of the driving hammer. Piling contractors must be required to provide these calculations for control of the fieldwork.

Typical carrying capacity of single isolated precast concrete piles are shown hereunder:

Pile Section mm x mm	Carrying Capacity kN
250 x 250	700
300 x 300	1200

Piling contractors must be required to verify these capacities and/or provide estimates of the capacity of their own pile types in isolation and in groups as appropriate to the proposed layout.

14.3 Bridge Foundations

It is recommended that piled foundations be adopted for the proposed new vehicular access bridge. Precast concrete driven piles are recommended as above.

15.0 GROUND SLABS

For normal service applications, ground-bearing slabs may be deployed subject to appropriate preparation of the subgrade. This preparation must include as a minimum:

- Removal of all organic soils
- Reduction of site levels to allow placement of 2 x 150mm compacted layers of granular fill (DTp Type 1 or equivalent + dpm + slab)
- Thorough compaction at subgrade level, with additional excavation and granular fill refilling at any areas showing excessive softness / deflection

16.0 GROUNDWATER AND EXCAVATIONS

It is unlikely that management of groundwater will significantly hamper spread foundation construction, although prudent contractors would allow for some pumping to maintain dry working conditions.

It should be assumed that foundation excavations in excess of 1.5mbgl will require temporary support.

17.0 PAVEMENT DESIGN

On the basis of insitu CBR measurements made by Mexicone, it is recommended that pavements be designed on the basis of a CBR of 4%.

18.0 SOAKAWAY ASSESSMENT

Based on the trial pit observations, soakaway drainage will probably function effectively on this site.

However, based on the soil contamination analyses and the presence of an environmental receptor (River Dove) at the southern boundary, it would be prudent to undertake leachate analyses on soils within the proposed soakaway locations, to determine if there is a risk to the River Dove from contaminants leached from the site soils.

19.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions of this ground investigation may be summarised as hereunder:

- The made ground on the site is sporadically affected by asbestos contamination. Suitable remediation should comprise the placement of 300mm of clean imported topsoil over all landscaped areas
- The gas monitoring data obtained on this site, indicates that the site complies with Characteristic Situation 2 as defined in SA Wilson and GB Card document "Reliability and Risk in Gas Protection Design", and as such, gas protection measures are required.
- The presence of deep deposits of made ground renders the site suitable for use of soakaway drains. However, a programme of leachability testing should be carried out at proposed soakaway locations, to assess whether contamination of the River Dove may potentially occur

- There are no mining voids within a depth that could potentially cause movements at the ground surface
- Piled foundations are recommended for the new building
- For normal service applications, ground bearing slabs may be considered, subject to appropriate preparation of the ground
- Piled foundations are recommended for the new vehicular access bridge
- Concrete in the ground should be specified in accordance with Design Chemical Class DC-3 as defined in BRE Special Digest 1:2005
- PE/Al/PE mains should be laid in a sterile trench of width 1m + pipe diameter, and extending 300mm below the pipe.
- Spoil for disposal will classify as non hazardous waste
- Pavements should be designed on the basis of a CBR of 4%.