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SUPPLEMENTARY SITE INVESTIGATION OF LAND AT EGERTON ROAD, FALLOWFIELD, MANCHESTER

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SUPPLEMENTARY SITE INVESTIGATION OF LAND AT EGERTON ROAD, FALLOWFIELD, MANCHESTER

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EXECUTIVE SUMMARY

Introduction	Tier Environmental was commissioned by Watkin Jones Group to undertake a geoenvironmental appraisal of land at Egerton Road, Fallowfield. The purpose of the investigation was to provide further investigation and interpretation in order to fully characterise the risk to receptors associated with the redevelopment of the site for a residential land use.
Site location	The site is located at the corner of Clifton Avenue and Egerton Road, Fallowfield, Manchester. A site location plan is included as Drawing No. T/10/917/GA/1, within Appendix A. Ordnance Survey Grid Reference 385570,393680.
Site history	The site has been used as a school and, more recently a St John's Ambulance station.
Fieldwork	8 No. window sample boreholes were advanced to a maximum depth of 4.45m bgl. 3 No. further hazardous gas and groundwater monitoring visits were undertaken on the 4 No. gas and groundwater monitoring wells which were installed in WS1, WS5, WS6 and WS7.
Laboratory testing	Samples of soil, soil leachate and groundwater were submitted for analysis of a range of metal, other inorganic and organic components. All testing was undertaken at accredited laboratories.
Ground conditions	The southern half of the site is underlain by a thin veneer of Made Ground, which is in turn underlain by a high strength Glacial Till. The northern half of the site is underlain by Made Ground to a maximum of 3.50m bgl, below which is a low strength Glacial Till, which is then underlain by the high strength Glacial Till which is ubiquitous beneath the site.

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Foundations and floor slabs	It is recommended that all of the plots are founded on the high strength Glacial Till. Due to the variation in the depth to the founding stratum, plots 1 to 16 are likely to be founded on traditional strip footings; whereas plots 17 to 28 are likely to be founded on piled foundations. Care must be taken to ensure that piles do not reach the underlying Major Aquifer. Due to excessive Made Ground across the site, suspended floor are recommended.
Contamination	The Made Ground soils at the site have been shown to pose a risk to end users via direct contact and through hazardous soil gas generation. To mitigate this risk, a remediation strategy is presented which includes a clean cover system and basic hazardous gas protection measures.

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1. INTRODUCTION

Tier Environmental was commissioned by Watkin Jones Group to undertake a supplementary geoenvironmental appraisal of land at Egerton Road / Clifton Avenue, located at Fallowfield, Manchester (the "Site").

Phase I and Phase II investigations have previously been undertaken for this site by Betts Associates Geoenvironmental. It is understood that The Contaminated Land Section at Manchester City Council (MCC) has received a copy of the following reports:

- Phase 1 Desk Study Report at Egerton Road, Fallowfield, Betts Associates Geo-environmental, Reference: 0611002/DS, Dated: December 2006.
- Phase 2 Ground Investigation Report at Egerton Road, Fallowfield, Betts Associates Geo-environmental, Reference: 0611002, Dated: December 2006.

These reports have also been made available to Tier Environmental, for the purposes this investigation. It is understood that the Phase II report was deemed to be inadequate with regard to assessing the potential risk to receptors at the site. Tier Environmental have been asked to provide the missing information and interpretation, with a view to producing a Remediation Strategy report to satisfy the contaminated land conditions associated with Planning Application No. 094446/FO/2010/S1.

Taking into account the planned future use of the Site, the objectives of this appraisal were:

- To undertake a review of the investigation reports by Betts Associates Geoenvironmental.
- To further determine soil and groundwater conditions, including whether significant contamination could have resulted from past or current land use(s).
- To determine the potential risks posed by any ground contamination and provide recommendations on remedial measures to manage such risks.

- To undertake chemical analysis for the leachable and groundwater concentrations of contaminants of concern.
- To assess the risk to controlled waters.
- To determine risks posed to the Site from hazardous ground gases.
- To provide advice relating to geotechnical issues associated with the Site.

This report, which was designed to meet the requirements of all relevant current guidance including the CLR series of reports, presents the factual information available during this appraisal, interpretation of the data obtained and recommendations relevant to the defined objectives.

It has been assumed in the production of this report that the Site is to be redeveloped for a residential land use, with 28 residential dwellings being constructed. In addition, it is assumed that ground levels will not change significantly from those described in this report. If this is not the case, then amendments to the recommendations made in this report may be required.

Where the report refers to the potential presence of invasive plants (such as Japanese Knotweed) or asbestos-containing materials, such observations are for information only and should be verified by a suitably qualified expert.

The comments and opinions presented in this report are based on the findings of the desk study, ground conditions encountered during intrusive investigation works performed by Tier Environmental and the results of tests carried out within one or more laboratories. There may be other conditions prevailing on the Site which have not been revealed by this investigation and which have not been taken into account by this report. Responsibility cannot be accepted for any conditions not revealed by this investigation. Any diagram or opinion on the possible configuration of the findings is conjectural and given for guidance only. Confirmation of intermediate ground conditions should be undertaken if deemed necessary.

This report has been prepared for the sole use of Watkin Jones Group. No other third party may rely upon or reproduce the contents of this report without the written approval of Tier Environmental. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk and the authors do not owe them any Duty of Care or Skill.

2. SITE DETAILS AND DESCRIPTION

Table 2.1. Current Site Overview.

Site name	Egerton Road, Fallowfield
Site address	The site is located at the corner of Clifton Avenue and Egerton Road, Fallowfield, Manchester. A site location plan is included as Drawing No. T/10/917/GA/1, within Appendix A.
National Grid Reference	Ordnance Survey Grid Reference 385570,393680.
Site shape	The site is broadly rectangular in shape
General topography and ground levels	The site is relatively flat lying, with a slight dip along the north of the site. A topographic survey has been provided to Tier Environmental which shows site levels to vary from 99.9m AOD in the south west to 99.2m AOD in the north. During the site walkover, however, it was noted that the topographic survey was undertaken prior to demolition and, as such, the ground levels have changed slightly since its production.
Site boundaries	The site is bounded by residential buildings on all sides.
Current land use	The site is currently unused.
Existing structures	Since the demolition of the site, only two brick structures are present; a small wall running east / west in the north east of the site and a small rectangular brick structure in the south east of the site.
Site ground surfaces	The southern half of the site has a gravel surface, whereas the northern half of the site is grassed.
Invasive plant species	Suspected Japanese Knotweed (JKW) has been identified in the north west corner of the site. It is understood that the client is dealing with this issue separately and that the site has been registered with the Environment Agency as a hazardous waste producer.

The main Site features are shown on Drawing No. T/10/917/GA/1, within Appendix A.

3. PREVIOUS INVESTIGATION FINDINGS

The Betts Associates reports include a description of the site (prior to demolition). The study of past historical uses suggests that the site was open farmland up until 1893 when the site was shown as a large residential property. By 1967 the property was replaced by Egerton School. In 1978 the school changed to current use as St John's Ambulance HQ. Surrounding history shows predominantly residential development around the site, numerous small ponds, and a former railway siding to the north.

With regard to the environmental setting, the site has been shown to be underlain by varying depths of Made Ground to a maximum depth of 3.50m bgl (in the north of the site), which is in turn underlain by a soft becoming stiff Glacial Till to a maximum depth of 7.65m bgl. Below the drift deposits lies the Chester Pebble Beds Formation (Major Aquifer). The closest surface water body is noted to be Cringle Brook, which is culverted at around 135m south of the site. The site is not considered to be at risk from shallow coal mining and does not lie within 250 metres of any known landfill sites.

Chemical analysis of the Made Ground soils suggests that they contain elevate d concentrations of arsenic, copper, zinc, TPH and benzo (a) pyrene which were found to pose a risk to human health; however, since the production of this report there has been an update in contaminated land guidance and, as such, the results of the chemical analysis will be compared to the Generic Assessment Criteria (GAC) presented in Appendix G of this report.

As noted by MCC, no groundwater or leachable analysis was undertaken as part of the previous study and, as such, the risk to controlled waters has not been fully assessed.

3 No. hazardous gas monitoring visits were undertaken on the 2 No. boreholes that were undertaken as part of the previous investigation. CIRIA C665 suggests that a program of 6 hazardous gas monitoring visits would be appropriate for this site and, in addition, it is considered by Tier Environmental at least 3 monitoring wells would be required.

4. PROPOSED DEVELOPMENT

It is understood that the Site is to be redeveloped for 28 private dwellings. In order to bring current levels in line with those of the surrounding land, levels are to be raised the northern area of the site. The proposed layout of the Site is presented in Tier Environmental Drawing No. CL(19)01, Rev. No. P2, which is included within Appendix A of this report.

5. PRELIMINARY CONCEPTUAL MODEL

Based on the previous site investigations, a revised conceptual site model and conceptual exposure model has been developed for the proposed future land use. This summarises the understanding of surface and sub-surface features, the potential contaminant sources, transport pathways and receptors. In assessing the likely contaminants present at the Site, reference has also been made to Defra and Environment Agency supporting documentation. A preliminary qualitative risk assessment has also been made of the likelihood of the linkage operating and its potential significance.

The potential pollutant linkages identified and the qualitative risk assessment for these are presented in Table 5.1. The terms used in the qualitative risk assessment are defined in Appendix E.

5.1. Justification

The following factors are considered pertinent in defining the conceptual model.

Land Use

- Made Ground soils have been shown to have potentially unacceptable concentrations of inorganic and organic contaminants, with respect to human health for the proposed land use.
- Made Ground soils have not been fully assessed with regard to controlled waters.
- Hazardous soils gases have not been fully assessed.

Potential Sources

- Metal, sulphate, PAH and asbestos contamination within Made Ground soils as a result of previous development.
- Hazardous soils gases generated from deleterious material within the Made Ground soils.

Potential Pathways

- Dermal contact, ingestion and inhalation of contaminants on site.
- Leaching of contaminants from potentially contaminated Made Ground soils.
- Migration of contaminated dusts during decommissioning and redevelopment works.
- Vertical migration of mobile contaminants through the natural soils.
- Migration of hazardous gases through permeable strata and accumulation in the proposed dwellings.

Potential Receptors

- Future users of the site and proposed buildings following redevelopment of the site.
- Users of adjacent areas due to the potential for off site migration of gases, vapours or contaminated dust during redevelopment.
- Site investigation, demolition, construction and ground workers (during the investigation, decommissioning and redevelopment of the site), and future underground service maintenance workers, from hazardous short term exposure.
- Major Aquifer at depth.
- Proximal Cringle Brook

5.2. Uncertainties

The following uncertainties exist in the conceptual model.

- The presence of any features unrecorded by the historical maps.
- Any unrecorded geological features.

- Any unreported pollution events during the sites' history.

Table 5.1. Revised Assessment of Potential Pollutant Linkages.

Pollutant linkage				Qualitative risk assessment
	Source	Pathway(s)	Receptor(s)	
1	Potential metal and PAH contamination within Made ground soils as a result of previous development.	Dermal contact, ingestion and inhalation of contaminants on site. Migration of contaminated dusts during decommissioning and redevelopment works.	Future users of the site Users of adjacent areas due to the potential for offsite migration of gases, vapours or contaminated dust during redevelopment. Site investigation, demolition, construction and ground workers Buildings	Moderate
2	Potential metal and PAH contamination within Made Ground soils as a result of previous development.	Vertical migration of mobile contaminants through natural soils.	Controlled Waters	Low
3	Hazardous soils gas generation from Made Ground soils.	Migration of hazardous gases through permeable strata and accumulation in the proposed buildings.	Future users of the site and proposed buildings	Moderate

For definition of the terms used in the qualitative risk assessment, please see Appendix E.

6. FIELDWORK

6.1. Scope of Investigation

The information contained in this report is limited to areas of land accessible during the investigation within the Site boundary, as indicated on the Site plan, presented in Appendix A as Drawing No. T/10/917/GA/2. It should be noted that as a recent topographical survey of the site is not available at the time of writing, the levels of the boreholes cannot be estimated.

Tier Environmental scoped the intrusive ground investigation using guidance presented in BS 10175:2001, the CLR series of documents (Defra and Environment Agency, 2002a-2002e) and BS EN 1997:2004 and 2007. The investigation, which was supervised by a Tier Geoenvironmental Engineer, took place on the 8th December 2010 and comprised:

- Drilling of 8 No window sample boreholes to depths of between 2.45m and 4.45m bgl to determine the nature of shallow soils and to allow *in situ* geotechnical testing and the retrieval of samples for laboratory analysis.
- Installation of 4 No. combined gas and groundwater monitoring wells within Made Ground soils in boreholes WS1, WS5, WS6 and WS7.

Exploratory holes without instrumentation were backfilled with arisings and bentonite seals. The exploratory hole location and current Site features are shown on Drawing No. T/10/917/GA/2, within Appendix A of this report.

Depths and accurate descriptions of strata and groundwater observations made during investigation works, together with details of the samples recovered, are presented on the Engineer's exploratory hole records in Appendix L.

Tier Environmental' standard strata description criteria are compliant with BS EN ISO 14688:2002 and 2004 and BS EN ISO 14689:2003. A brief description of field sampling and testing techniques is provided in Appendix J.

6.2. Chemical Testing

Based upon the historical information available for the Site and the potential pollutant linkages identified for the proposed redevelopment, Tier Environmental scheduled chemical laboratory testing on selected soil and groundwater samples. The purpose of the testing was to:

- Confirm the presence of chemicals of concern within Made Ground soils at the site, as suggested during the previous site investigation;
- Determine the leachability of the aforementioned chemicals of concern;
- Determine the presence of the aforementioned chemicals of concern within any shallow perched groundwaters.

Tier Environmental' schedule of chemical laboratory testing is presented in Table 6.1. The testing was carried out by Derwentside Environmental Testing Laboratory.

Table 6.1. Schedule of Chemical Testing.

Laboratory analysis	Made Ground	Groundwater
Tier Environmental standard soil suite*	1	N/A
Tier Environmental standard leachate suite*	4	N/A
Tier Environmental standard water suite*	N/A	3
Asbestos screen	1	N/A
Banded TPH	0	4
Leachable Banded TPH	4	N/A

*For definition of Tier Environmental standard analytical suites, please see Appendix J.

NA - not applicable.

All analyses were undertaken using tests accredited to UKAS and/or MCERTS standards, where available. The analytical laboratory results are presented in Appendix K to this report and discussed in Section 8, below.

7. GROUND CONDITIONS AND MATERIAL PROPERTIES

7.1. Strata Profile

A summary of the strata profile determined at this site is given in Table 7.1.

Table 7.1. Strata Profile.

Strata	Depths recorded (m bgl)	Thickness (m)	General description and comments
Made Ground	Between 0.40m bgl (WS3 and WS4) and 2.40m bgl (WS1)	Maximum of 2.40m (WS1)	Made Ground was generally found to comprise the following types: • A dark grey gravel of limestone (considered to be an imported sub base). • A dark brown / black sandy gravel of brick, limestone, sandstone, clinker and coal. • Very low strength brown sandy gravelly clay with brick fragments.
Glacial Till	From depths of between 0.40m bgl (WS3 and WS4) and 2.40m bgl (WS1)	Unproven	Glacial Till at the site was generally found to comprise the following types: • A very low strength very soft consistency light brown very sandy clay. • A high strength very stiff consistency brown sandy gravelly clay.

Made Ground

The Made Ground encountered at this Site was generally found to comprise three types. The Made Ground in the southern half of the site was found to comprise a dark grey slightly clayey slightly sandy angular gravel of limestone (WS2, WS3 and WS4) to depths of between 0.40m bgl (WS3 and WS4) and 1.10m bgl (WS2). This is considered to represent a sub base type material.

The Made Ground in the northern half of the site was found to comprise a dark brown gravelly sand with brick, clinker, coal, sandstone and limestone anthropogenic constituents. This was found to be underlain by a very low strength soft consistency clay in WS1, WS6 and WS8. Made Ground in this area of the site was generally found to depths of between 1.80m bgl (WS8) and 2.40m bgl (WS1). SPT N values within the Made Ground were found to be between 0 and 4.

During our works, there was no olfactory or visual evidence of hydrocarbon or similar contamination within the Made Ground.

Glacial Till

Glacial Till at the site was generally recorded as two types; a very low strength light brown clay which was generally found to overlie a high strength brown gravelly clay. The very low strength clay was recorded most often in the northern area of the site and is considered to be unsuitable for founding purposes (SPT N values of between 3 and 6) and was recorded to a maximum depth of 3.30m bgl.

During our works, there was no olfactory or visual evidence of hydrocarbon or similar contamination within the Glacial Till.

Bedrock

Bedrock was not proven during this investigation.

7.2. Groundwater Observations and Monitoring

Table 7.2 provides a summary of the groundwater observations during fieldworks. The observations showed that groundwater was restricted to a small, localised perched groundwater body within the area of WS1 and WS7. The groundwater was found to be within the upper surface of the Glacial Till, in the north of the site where these soils were recorded as being very low strength. Remaining boreholes were found to be dry.

Table 7.2. Field Observations of Groundwater.

Borehole	Strike (m bgl)	Rise in groundwater after 20 mins. (m bgl)	Formation	Observations
WS1	2.50	2.50	Glacial Till	Very low flow
WS7	2.00	1.20	Glacial Till	Very low flow

Sampling from groundwater monitoring installations was performed according to the methods presented in Appendix J.

Groundwater monitoring was performed on 3 occasions from the period between 28th December 2010 and the 27th January 2011. The full results of this monitoring are presented in Appendix M.

These results showed that groundwater was restricted to the northern half of the site and ranged in depth from 1.00m to 1.50m bgl. Groundwaters were samples on the 27th January 2011. Groundwater was found not to recharge within 1 hour, following the purge of the wells.

7.3. Ground Gas Monitoring

Ground gas monitoring installations were constructed in WS1, WS5, WS6 and WS7, within Made Ground soils at the site, in accordance with the Conceptual Site Model.

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Monitoring comprised measurement of pressure, methane (CH_4), percent of lower explosive limit (LEL), carbon dioxide (CO_2), oxygen (O_2), hydrogen sulphide (H_2S) and gas flow rate.

The ground gas monitoring presented in this report was performed between 28th December 2010 and the 27th January 2011. The rationale behind this monitoring period was to add three visits to the existing three visits undertaken by Betts Associates. This would bring the total of visits to 6, in accordance with CIRIA C665.

The full ground gas monitoring results from the installations are presented in Appendix M.

The total atmospheric pressure range of all ground gas monitoring data included in both the Betts Associates and Tier Environmental reports was from 991 to 1020 mbar. This range covers low, moderate and high atmospheric pressures. Monitoring events included periods of stable, rising and falling pressure. During monitoring, no detectable concentrations of methane were recorded. The maximum concentration of carbon dioxide of 8.1 %vol was recorded in BH01 by Betts Associates on the 13th December 2006. The maximum peak flow rate of 5.4 l/hr was recorded by Tier Environmental in WS5 on 6th January 2011; however, this quickly dropped to below the level of detection.

The results of the ground gas monitoring have been assessed in accordance with the criteria specified for this Site, which were derived as described in Appendix F. The conclusion of the assessment is that although there is has been an absence of significant steady flow rates, the maximum recorded carbon dioxide concentration has exceeded 5% and, as such, it is considered that the site is within CIRIA Characteristic Situation 2 or NHBC Amber 1.

8. RESULTS OF CHEMICAL TESTING

Results of chemical analysis are presented in full in Appendix K.

8.1. Data Interpretation Approach

The analytical data obtained were reviewed for completeness and consistency. The data for each sample type was then compiled and subjected to detailed analysis as described below. Results of chemical testing from the previous investigation were added to the results from this investigation in order to produce a more accurate picture of the nature of contamination at the site (if any). Total soil concentrations were compared to the GACs for a residential land use, as described in Appendix G of this report.

No zoning of the Site was undertaken as part of the interpretation. The historic land use and proposed development pattern meant that zoning was not appropriate or beneficial to the site investigation or subsequent data interpretation.

Assessment of outliers and data distribution

Assessment of data distribution and the identification of statistical outliers was performed iteratively, applying appropriate data distribution and outlier tests for the complete and outlier-censored datasets.

The presence of outliers was determined using Grubbs' test working with untransformed values for normally distributed data and natural log-transformed values for non-normally distributed data.

The data were tested for normality by at least two of the following methods:

- Probability histogram
- Probability (q-q) plots
- Shapiro-Wilk normality test

Outliers were considered to form part of the overall site dataset *except* they were not considered to be statistically representative of the shallow soils as a whole.

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Calculation of 95% upper confidence limit of the sample mean

Based upon the normality and outlier tests, the 95% UCL of each contaminant of concern was calculated by:

- One-sample t-test for datasets that are normally distributed or close to normal distribution;
- One-sided Chebyshev test for datasets that are significantly non-normal.

Where both the one-sample t-test and one-sided Chebyshev 95th percentile results were both below the critical concentration, normality tests were not undertaken, as this would have had no effect upon the final outcome.

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Table 8.1. Calculated 95th percentile upper confidence estimates of the true mean values and comparison to the critical concentration of those determinants which recorded exceedences during initial screening within Made Ground Soils.

Determinant	Units	No. samples	Critical concentration for residential land use[1]	95% UCL with outliers	95% UCL with outliers removed[2]	Comments
Arsenic	mg/kg	8	20	18.75	No outliers	Distribution is normal - Grubbs Test applied
Copper	mg/kg	8	2330	3749.82	88.53	Distribution is log normal - Grubbs Test applied
Lead	mg/kg	8	450	1671.28	No outliers	Distribution is normal - Grubbs Test applied
Benzo (a) anthracene	mg/kg	8	7.9	9.76	No outliers	Distribution is normal - Grubbs Test applied
Benzo (a) pyrene	mg/kg	8	1	8.89	No outliers	Distribution is normal - Grubbs Test applied
Benzo (b) fluoranthrene	mg/kg	8	7	8.6	No outliers	Distribution is normal - Grubbs Test applied
Chrysene	mg/kg	8	9.3	10.38	No outliers	Distribution is normal - Grubbs Test applied
Dibenzo (a,h) anthracene	mg/kg	8	0.9	1.38	No outliers	Distribution is normal - Grubbs Test applied
Indeno (1,2,3-cd) pyrene	mg/kg	8	4.2	5.52	No outliers	Distribution is normal - Grubbs Test applied
Naphthalene	mg/kg	8	8.7	7.46	No outliers	Distribution is normal - Grubbs Test applied

1. SGV, generic assessment criterion or site-specific assessment criterion, as appropriate. 2. Outliers only removed where they were not considered to be statistically representative of the shallow soils as a whole. 3. Shaded rows indicate that the 95th percentile exceeds the GAC.

8.2. Human Health

Metals and Metalloids

After initial screening against the relevant GACs, exceedences were recorded for arsenic, copper, and lead. Following statistical analysis, it was found that the 95% UCL for both copper and lead were found to exceed the GAC. It is therefore considered that Made Ground at the site should be regarded as being contaminated with respect to copper and lead for a residential land use.

PAHs

After initial screening against the relevant GACs, exceedences were recorded for the range of PAHs highlighted in Table 8.1. Following statistical analysis, it was found that the 95% UCL for all of the aforementioned PAHs were above the GAC. It is therefore considered that Made Ground at the site should be regarded as being contaminated with respect to PAHs for a residential land use.

Hydrocarbons

No visual or olfactory evidence of hydrocarbon contamination was encountered during the site investigation.

Of the 7 soil samples sent for TPH analysis, a majority of samples recorded detectable concentrations of hydrocarbons; however, total TPH tests(as opposed to speciated TPH tests) were undertaken by Betts Associates and, as such, it is not possible to determine the source of this contamination. For this part of the assessment, the results have been screened against the most conservative GAC from the LQM (2009) GACs for the TPHCWG set of hydrocarbon bands. These are considered the most appropriate set of assessment criteria to be used for the specified land use. This approach is considered extremely conservative (given that leachate testing and groundwater testing have shown very low concentrations of TPH); however, due to the vulnerability of the end users, it is considered the Made Ground soils at the site should be regarded as being contaminated with relatively low levels of widespread TPH.

8.3. Leachability Testing

Analytical data from leachate testing have been evaluated against GAC values appropriate to the conceptual model for the site. The derivation of the GAC values is described in Appendix H. Those applied for this Site were selected from Freshwater Environmental Quality Standards (EQS) in order to determine the risk posed to the main controlled waters receptors at the site.

Table 8.2. Summary of Leachate Analysis Results and Screening against Generic Assessment Criteria.

Determinand	Units	LoD	No. samples tested	GAC	No. samples >GAC
Arsenic	µg/l	1	4	50	0
Cadmium	µg/l	0.5	4	5	0
Chromium	µg/l	0.1	4	200	0
Copper	µg/l	0.1	4	10	0
Lead	µg/l	1	4	10	0
Mercury	µg/l	0.1	4	1	0
Nickel	µg/l	1	4	150	0
Selenium	µg/l	1	4	10	0
Zinc	µg/l	1	4	250	0
Naphthalene	µg/l	0.01	4	10	0
Acenaphthylene	µg/l	0.01	4	0.1	0
Acenaphthene	µg/l	0.01	4	0.1	0
Fluorene	µg/l	0.01	4	0.1	0
Phenanthrene	µg/l	0.01	4	0.1	0

Anthracene	µg/l	0.01	4	0.1	0
Fluoranthene	µg/l	0.01	4	0.1	1 (0.16 max)
Pyrene	µg/l	0.01	4	0.1	2 (0.75 max)
Benzo(a)anthracene	µg/l	0.01	4	0.1	1 (0.11 max)
Chrysene	µg/l	0.01	4	0.1	1 (0.13 max)
Benzo(b)fluoranthene	µg/l	0.01	4	0.1	1 (0.13 max)
Benzo(k)fluoranthene	µg/l	0.01	4	0.1	0
Benzo(a)pyrene	µg/l	0.01	4	0.01	2 (0.08 max)
Indeno(1,2,3-cd)pyrene	µg/l	0.01	4	0.1	0
Dibenzo(a,h)anthracene	µg/l	0.01	4	0.1	0
Benzo(g,h,i)perylene	µg/l	0.01	4	0.1	1 (0.11 max)

LoD - Analytical limit of detection; GAC - generic assessment criterion; NA - not applicable.

[1] For the purposes of calculating the mean values, those samples reported as below the analytical limit of detection (LoD) have been assigned a concentration equivalent to 0.5 * LoD.

8.4. Groundwater Sampling

Analytical data for surface water samples have been evaluated against appropriate GAC values for the surface water sampled. The derivation of the GAC values is described in Appendix H.

The results indicate that the only exceedences of the GAC were very marginal and included benzo (a) pyrene (WS6 and WS7 at 0.02 µg/l and 0.03 µg/l respectively compared to a GAC of 0.01 µg/l) and pyrene (all samples with results ranging from 0.11 µg/l to 0.29 µg/l, compared to a GAC of 0.1 µg/l).

9. CONTROLLED WATERS RISK ASSESSMENT

9.1. Introduction

The PCSM has suggested that there may be a significant pollutant linkage from metals, PAHs and petroleum hydrocarbons within Made Ground soils to controlled waters, namely Cringle Brook (135m to the south) and the underlying Major Aquifer. Through the preliminary qualitative risk assessment, the risk has been determined as low, due to the presence of a previously reported low permeability clay layer between the source and the receptor. It has therefore considered prudent to undertake a controlled waters risk assessment as part of this investigation in an attempt to more fully understand the risk to proximal ground and surface waters.

No groundwater samples have been analysed prior to the Tier Environmental site investigation. As stated in Section 7.2, a groundwater monitoring visits has been by Tier Environmental. The results of these monitoring visits, as well as the results from the soil analysis, have been used in the production of this risk assessment.

The site currently comprises the existing open ground, as described in Section 2 of this report. The development will involve the development of 28 No. private dwellings. The proposed site layout suggests that there will be a similar ratio of buildings, hardstanding and landscaped areas to those which were at the site, prior to demolition, as presented in Appendix A of this report.

This controlled waters risk assessment adopts a source - pathway - receptor framework with respect to the identification and estimation of risks related to the site preparation, construction and foundation methods which are to be applied. The assessment also draws upon relevant factual information within this report, including that related to the environmental setting, geological and hydrogeological conditions prevailing at the site.

9.2. Environmental Setting

The PCSM has highlighted the different aspects of the environmental setting of the site and it is not the intention of this risk assessment to repeat the information; however, for ease of reference, salient points are outlined below:

- The site is not within 500m of a significant surface water body; however, Cringle Brook (which appears to be culverted) lies approximately 135m south of the site.
- The site is underlain by the Chester Pebble Beds Formation which comprises the main Aquifer in the vicinity. Whilst this unit is considered to be a Major Aquifer of high vulnerability, the site is also underlain by Glacial Till (minimum 2.20m thick - Betts Associated BH02) which is regarded as being very low permeability.
- Groundwater movements within the Major Aquifer will be controlled by intergranular and fracture flow.
- The area of the site has not been designated as a Source Protection Zone for groundwater abstraction. The closest well is >1000m north of the site. The Local Authority are not aware of any private abstraction wells within 1km of the site.
- There are six discharge consents to surface water within 500m of the site.
- No significant pollution incidents have been recorded within 250m of the site.
- There are no designated ecological sites or sensitive land uses within 500m of the site.

9.3. Conceptual Model of Site Hydrology and Hydrogeology

During this investigation, groundwater levels have been measured at the site on a total of 3 occasions from boreholes WS1, WS5, WS6 and WS7, the locations of which are presented in Drawing No. T/10/917/GA/2, located in Appendix A of this report. .

During the Betts Associates site investigation, perched groundwater inflows included a rapid inflow into TP01 and slight seepages into TP02 and TP02A, all of which were at the Made Ground / Glacial Till interface. Perched groundwater was recorded during the Tier Environmental investigation in WS1 and WS7 within the upper very soft layer of the Glacial Till. The nature of window sampling, however, means that groundwater measurements are somewhat inaccurate and it is likely that the actual level of groundwater inflow from these boreholes was also at the Made Ground / Glacial Till interface.

The Betts Associates report suggested that, during monitoring, groundwater levels in the north of the site (BH02) were consistently around 0.90m bgl and that groundwater in the south of the site (BH01) was found to be absent. Although there does not appear to be any reason for this to be untrue, as this report does not rely on the Betts Associates report, this information is only used indicatively. Results from the Tier Environmental monitoring suggest that groundwater levels within the north of the site remain at between 1.00m and 1.50m bgl, and groundwater is restricted to this area. Groundwater did not recharge within 1 hour of purging.

The overall pattern from groundwater monitoring is that there is a small localised groundwater body within Made Ground soils within the northern half of the site. Shallow clay encountered within TP03 (Betts Associates) suggests that the deeper area of Made Ground is restricted to this site, creating a bowl shaped feature which has allowed perched waters to collect. Further evidence of this bowl is indicated in 1851 town plans, which depict a garden area with paths following around perimeter of suspected natural depression.

Although no data regarding flow rates are available for the site, the gentle dip of the water table suggests that rates will be static or relatively very low. Boreholes did not recharge within 1 hour after purging, during Tier Environmental groundwater monitoring.

The PCSM also highlighted Cringle Brook, approximately 135m south of the site (and at approximately the same level), as a potential receptor. As part of this risk assessment, a visit to the brook was made. It

appears that Cringle Brook has been culverted as it passes the site. Due to the presence of the culvert, the cohesive nature of the soils at the site, it is considered that lateral flow of mobile contaminants to Cringle Brook is very unlikely.

9.4. Controlled Waters Risk Assessment

The conceptual site model of the site, which is based upon ground investigations to date, suggests that the site is underlain by a small, localised groundwater body which has formed within Made Ground soils which have collected in a former natural depression within the Glacial Till.

Leachate testing of Made Ground soils within this area suggests that low levels of PAHs have the capability to leach into the perched groundwater body; however, exceedences are considered to be very marginal. In addition, the relatively high SOM in these Made Ground soils suggests that organic chemicals have been sequestered into the humic matter within the soil, rendering much of the chemicals immobile. This is reflected in the low concentrations of PAHs encountered during groundwater analysis.

Given the very marginal exceedences of the GACs for pyrene and benzo (a) pyrene recorded in groundwaters, and the presence of low permeability of the clay which lies between the Made Ground soils and underlying Major Aquifer, it is considered that the risk to groundwaters is negligible. In addition, the bowl shaped nature of the clays in the north of the site and the presence of a culvert around Cringle Brook also suggests that the risk to surface waters is negligible.

10. REVISED CONCEPTUAL MODEL AND GENERIC QUANTITATIVE RISK ASSESSMENT OF POLLUTANT LINKAGES

The combined conceptual site model and conceptual exposure model, developed from the previous site investigation information and presented in Section 5, has been revised in light of the supplementary ground investigation and the chemical analysis results presented above.

The revised conceptual model has been developed for the proposed future land use. This summarises the understanding of surface and sub-surface features, the potential contaminant sources, transport pathways and receptors.

The revised conceptual model is presented in schematic form in Appendix A, Drawing No. T/10/917/GA/3. The potential pollutant linkages identified and a generic quantitative risk assessment (based on the GAC values defined in Section 8) are presented in Table 10.1. The terms used in the generic quantitative risk assessment are defined in Appendix F.

10.1. Justification

Summary of Salient Investigation Results

The following information is considered salient when addressing the Conceptual Site Model:

- Made Ground soils have been shown to be contaminated by a number of metals and PAHs, with respect to a residential land use.
- The risk to controlled waters is considered to be negligible, as detailed in Section 9.4.
- Gas monitoring by both Betts Associates and Tier Environmental suggest that the site should be regarded as being within CIRIA Characteristic Situation 2 or NHBC Amber 1.

Potential Sources

- Metal and PAH contamination within Made Ground soils as a result of previous development.
- Hazardous soils gases generated from deleterious material within the Made Ground soils.

Potential Pathways

- Dermal contact, ingestion and inhalation of contaminants on site.
- Migration of contaminated dusts during decommissioning and redevelopment works.
- Migration of hazardous gases through permeable strata and accumulation in the proposed dwellings.

Potential Receptors

- Future users of the site and proposed buildings following redevelopment of the site.
- Users of adjacent areas due to the potential for off site migration of gases, vapours or contaminated dust during redevelopment.
- Site investigation, demolition, construction and ground workers (during the investigation, decommissioning and redevelopment of the site), and future underground service maintenance workers, from hazardous short term exposure.

10.2. Uncertainties

The following uncertainties exist in the conceptual model.

- Any unrecorded geological features.

Table 10.1. Revised Assessment of Potential Pollutant Linkages.

Pollutant linkage				Qualitative risk assessment
	Source	Pathway(s)	Receptor(s)	
1	Metal and PAH contamination within Made ground soils as a result of previous development.	Dermal contact, ingestion and inhalation of contaminants on site. Migration of contaminated dusts during decommissioning and redevelopment works.	Future users of the site Users of adjacent areas due to the potential for offsite migration of gases, vapours or contaminated dust during redevelopment. Site investigation, demolition, construction and ground workers Buildings	Moderate
2	Hazardous soils gas generation from Made Ground soils.	Migration of hazardous gases through permeable strata and accumulation in the proposed buildings.	Future users of the site and proposed buildings	Moderate

For definition of the terms used in the qualitative risk assessment, please see Appendix F.

11. CONCLUSIONS AND RECOMMENDATIONS

11.1. General

This geoenvironmental appraisal has been performed for land at Egerton Road, Fallowfield, Manchester. It has been assumed in the production of this report that the Site is to be redeveloped for 28 private dwellings. In addition, it has been assumed that ground levels will not change significantly from those described in this report. If this is not the case, then amendments to the interpretation and conclusions in this report may be required.

It should be noted that due to changes in site levels since the production of the topographic survey which has been presented to Tier Environmental, the actual level of the boreholes undertaken by Tier are unknown and, as such, the depths indicated in the foundation recommendations sections of this report are for general indication only. This can be revised upon production of an up to date topographic survey.

11.2. Structural and Geotechnical

Foundations

The site is underlain by varying depths of Made Ground, which has been found to be between 1.00m and 2.00m bgl in the southern half of the site and in excess of 3.50m bgl in the northern half of the site. Due to the inherent variability and instability, it is considered that the Made Ground is not suitable founding strata for the proposed development.

The upper surface of the Glacial Till has been shown to be of very low strength and soft consistency, with SPT N values ranging from 3 to 6. It is therefore considered that these soils would also provide an unsuitable founding stratum.

It is recommended that the proposed developments are founded on the underlying high strength very stiff consistency Glacial Till. SPT N values within this unit range from 14 to 34, but were generally found to be around 20. It is therefore considered that bearing resistance of 200 kN/m^2 would be achievable in the in the southern half of the site (Blocks 1 to 16) for a traditional strip footing at a depth of around 2.00m bgl and 0.60m wide. Total settlements for these foundations are unlikely to exceed 25mm.

Due to the excessive depth of Made Ground and very low strength Glacial Till in the north of the site (Blocks 17 to 28), it is recommended that traditional piled foundations are taken through these soils and founded on the underlying high strength Glacial Till. It should be noted that piled foundations should not be taken through this unit, due to the risk of perched groundwater travelling down pile runs into the underlying Major Aquifer. Vibro stone columns are not considered suitable for this site, as the very low shear strengths recorded in the Made Ground and upper clay layers could result in unacceptable differential settlements.

Portions of the Site may be covered by former or existing facilities on the site, e.g., hard standing, floor slabs and foundations. This material is unsuitable for foundations and relict foundations and floor slabs should be broken out to avoid the formation of hard spots.

Floors

Suspended floors are recommended across the site, due to the presence of >600mm of Made Ground across the site (this includes soils imported due to the requirement to raise levels to those mentioned in this report).

Groundworks, Excavation Stability and Groundwater Dewatering

Excavations into existing made ground and the underlying natural soils should be assumed to be unstable. No man entry into unsupported excavations should be allowed without an appropriate risk assessment. Reference to CIRIA report 097 (1983) should be made to establish suitable means of support or battering of excavation sides.

Based on the results of this investigation, inflows of groundwater into excavations should be expected. Perched water was encountered in the northern half of the site to a depth of between 1.00m and 1.50m bgl. To control this groundwater localised pumping from sumps should generally be adequate, suitable filters should be used to prevent the possibility of removing fines from the granular soils. However, groundwater control by more robust means, such as well pointing, may be required locally.

11.3. Soil and Groundwater Contamination

Risk Evaluation for the Proposed Land Use

Human health receptors

The human health risk assessment has shown that the Made Ground soils at the site pose a risk to end users, adjacent site users and construction workers. In addition, the investigation has shown that hazardous soils gases also pose a risk to end users. Details on how to mitigate this risk is detailed in Section 12 of this report.

Controlled waters receptors

The controlled waters risk assessment has shown that the risk to controlled waters is negligible.

Ecological receptors

No potential pollutant linkages to ecological receptors have been identified for the Site.

Utilities

It is recommended that the results of the chemical testing and details of the proposed remedial works are provided to the appropriate utility companies to determine the necessity for service protection. It is, however, considered likely that barrier pipe will be required.

11.4. Construction and Maintenance Workers

Contamination may pose a short-term (acute) or long-term (chronic) risk to workers during construction and maintenance. The potential risks must be specifically assessed as part of the health and safety evaluation for the works to be performed in accordance with prevailing legislation. Site practices must conform to the specific legislative requirements and follow appropriate guidance (e.g., HSE, 1991; CIRIA, 1996).

12. REMEDIATION STRATEGY

12.1. Clean Cover System

As highlighted in Section 11.3 of this report, Made Ground soils at the site are considered to pose a risk to end users of the site, with regard to a residential land use. In order to remove the remaining pollutant linkages at the site, it is considered that the landscaped areas and private gardens of the site should be covered with a 600mm deep clean cover system (450mm subsoil, 150mm topsoil), underlain by a suitable geomembrane. This should only be the case in areas of the site where Made Ground soils still exist; where Made Ground soils are removed in order to accommodate future levels, a 300mm growing medium will be required.

The source of the material will be inspected and tested prior to placement on site to ensure its suitability and absence of any deleterious materials such as glass, metal, roots, invasive weed species and the like. During placement, the imported materials will be tested for the Tier Environmental standard soil suite (as described is Appendix I of this report) and banded TPH at a rate of 1 sample per $50m^3$ for topsoil and $150m^3$ for subsoil.

A suitable geomembrane should be placed in all landscaped and areas, prior to the installation of the clean over materials. To achieve the final profile of the site, clean subsoil and topsoil to a minimum combined thickness of 600mm will be imported to the landscaped areas.

12.2. Verification

It will be necessary to ensure that the development of the site does not cause an increased risk to receptors. All materials imported to the site, in particular subsoil, will be tested to determine its suitability for use on the site in the landscaped areas and private gardens. The imported material will be tested for the standard Tier Environmental soil suite listed in Appendix I of this report and Banded TPH as part of a validation testing exercise. The purpose of the testing is to validate the quality of any materials imported to the site and to determine the contaminant concentrations of materials. Imported materials will need to be tested at a rate of 1 sample per $50m^3$ for topsoil and 1 per $150m^3$ for subsoil (with a minimum of 3 samples). In addition to the chemical testing, the depth of clean cover will also be validated. Hand dug pits will be excavated in every fourth plot and a 25m grid within the landscaped

areas to ensure that a combined thickness of 600mm subsoil and topsoil has been achieved over the geomembrane. These hand dug pits will be photographed and submitted to the local authority.

12.3. Contingency for any Unknowns

Whilst relatively uniform ground conditions have been encountered across the site, a small risk exists of the presence of localised unidentified Made Ground soil contamination.

Should any suspicious material be encountered during the redevelopment works, works shall be ceased within this part of the site and the area should then be investigated further by a suitably qualified geo-environmental engineer and sampled as necessary. The local authority should also be notified immediately. Samples will be forwarded to a UKAS/MCERTS accredited laboratory for a suite of analytical testing deemed appropriate based upon an appraisal of the material identified.

Once the results of the analysis are known and have been interpreted, the required remedial action (if any) will be determined and approved with the relevant regulatory authorities.

12.4. Waste Disposal

If materials are disposed off-site, then material exported from site to landfill shall be hauled by a registered waste carrier in accordance with Duty of Care Regulations, 1991 and the Hazardous Waste Regulations, 2005.

It will be necessary to register the site in advance of the intended reclamation works with the Environment Agency before disposal to landfill can take place. There will be the requirement for the waste producer to provide appropriate Waste Acceptance Criteria (WAC) testing of the soils for disposal, to ensure that the soils are appropriately classified and that the landfill is licensed to receive such soils. A consignment note shall be completed, signed and retained by all parties involved. The consignment note shall state the volume of waste, a physical description of the material and statement of its chemical composition. The waste consignment notes shall be kept by the contractor for a period of at least two years.

12.5. Ground Gas

Based upon currently available data, the overall Site ground gas regime has been assessed as CIRIA CS2 or NHBC Amber 1. It is therefore proposed that the following hazardous gas protection measures are incorporated into the design of the developments, in accordance with CIRIA C665:

- Reinforced concrete cast *in situ* floor slab (suspended, non suspended or raft) with at least 1200 g DPM and underfloor venting.
- Beam and block or pre-cast concrete and 2000 g DPM/ reinforced gas membrane and underfloor venting.
- All joints and penetrations sealed.

It should be noted that, due to the risk of puncture or tearing during installation, Tier Environmental recommend that a 2000 g membrane for both suspended and ground bearing floors. The exact specification of the membrane used at the site should be agreed with the local authority prior to installation on site.

During engineering and construction activities, the ground gas data indicate that the following aspects are to be considered during the preparation of relevant site H&S plans, method statements and related documents, and appropriate working methods adopted:

- Carbon dioxide concentrations in ground gas. The measured CO2 concentrations in ground gas reported are significantly elevated relative to background and could present an asphyxiation risk in excavations and other confined spaces. The Health & Safety Executive has published information defining safe occupational exposure levels for CO_2 and the latest guidance must be consulted to determine whether the ground gas regime necessitates specific precautions during site works.

Basic radon protection measures are not currently required for the proposed development on this site.

12.6. Environmental Monitoring and Mitigation

Introduction

In order to mitigate the environmental impacts of the works on nearby residents and sensitive areas, a programme of measures will be implemented during the remediation works.

Dust Mitigation

Appropriate measures shall be implemented at all times during the remediation works, to minimise dust emissions. Soils will be dampened down, as necessary, and activity will be minimised in extremely windy conditions to prevent dust nuisance. An adequate supply of water shall be maintained on site at all times to allow for dust suppression activities to be carried out at short notice.

When dusty material is being loaded onto trucks, extra care will be taken to ensure that the drop height is minimised. Trucks will be suitably covered when leaving the site with contaminated material to prevent dust migration.

The amount of disturbed surfaces left exposed for significant time periods will be minimised. Stockpiles of fine or loose materials should be tamped down or covered if necessary to reduce the production of dust.

Traffic both entering and working on the site shall obey a maximum speed limit of 10 mph.

Vapour and Odours

Based upon the absence of recorded olfactory evidence of contamination during the site investigation, excavation works are not considered likely to give rise to significant odour problems. Where required, however, the contractor will monitor the atmosphere and, in the case of excessive vapours being detected at the site boundary, will cover the excavation face releasing the vapours with soil or sand (some suitable material will be required to be kept of site as a contingency) and any stockpiles will be located away from residential properties.

Soils excavated for the remediation of any previously unidentified hotspots will be not be stockpiled on site but will be tipped directly into a truck or skip for offsite disposal.

Plant and machinery shall be serviced regularly to ensure that exhaust fumes are not excessive.

Noise

The requirements of BS 5228:1997 "Noise and Vibration Control on Construction Sites" shall be adhered to at all times. All machinery shall be fitted with effective silencers and shall be serviced at regular intervals. No plant shall be operated with engine covers raised.

Run-off into Drains

All potential drainage on site and any discharge points will be identified, including land drains, foul sewers, surface water drains and any combined drains. These will be marked, as appropriate, for easy identification.

Works will be minimised during periods of heavy rainfall to reduce the likelihood of contaminated run-off. Temporary containment and cover measures or tamping down of stockpiles to reduce run-off shall be used where necessary.

12.7. Invasive Plants

Japanese Knotweed was observed on this Site in the very north west corner. It is understood that the Japanese Knotweed is to be removed from site and these works will be undertaken by a separate contractor. As such, this issue is beyond the scope of this report.

12.8. Verification Report

As requested by Manchester City Council, a Verification Report will be compiled which will contain the following information:

- A summary of the desk study, site investigation reports and remediation strategy.
- Details of who carried out the work.
- Details and justification of any changes from the remediation strategy specified in this report.
- Laboratory and *in-situ* test results for verification purposes.

- Plans showing treatment areas and details of any differences from the original remediation strategy.
- Photographic records.
- Waste management details and records.
- Confirmation that remediation objectives have been met.

13. REGULATORY APPROVALS

The conclusions and recommendations presented above are considered reasonable based on the findings of the site investigation. However, these cannot be guaranteed to gain regulatory approval and, therefore, the report should be passed to the appropriate regulatory authorities and/or other organisationsfor their comment and approval prior to undertaking any works on site.

It is recommended that conditions placed on any planning permission are discharged prior to commencement of site works.

14. REFERENCES

BRE (1999). Radon: Guidance on Protective Measures for New Dwellings. IHS BRE Press, Bracknell.

BRE (2005). Concrete in Aggressive Ground. Special Digest 1 (revised edition). IHS BRE Press, Bracknell.

BS 10175:2001 Investigation of Potentially Contaminated Sites - Code of Practice. British Standards Institution, London.

BS EN 1997-1:2004 Eurocode 7. Geotechnical Design. General Rules. British Standards Institution, London.

BS EN 1997-2:2007 Eurocode 7. Geotechnical Design. Ground Investigation and Testing. British Standards Institution, London.

BS EN ISO 14688-1:2002 Geotechnical Investigation and Testing. Identification and Classification of Soil. Identification and Description. British Standards Institution, London.

BS EN ISO 14688-2:2004 Geotechnical Investigation and Testing. Identification and Classification of Soil. Principles for a Classification. British Standards Institution, London.

BS EN ISO 14689-1:2003 Geotechnical Investigation and Testing. Identification and Classification of Rock. Identification and Description. British Standards Institution, London.

CIRIA (1983) Trenching Practice. Report 097, 2nd edition, CIRIA, London.

CIRIA (1995a) Protecting Development from Methane. Report 149, CIRIA, London.

CIRIA (1995b) Methane Investigation Strategies. Report 150, CIRIA, London.

CIRIA (1995c) Interpreting Measurement of Gas in the Ground Report 151, CIRIA, London.

CIRIA (1995d) Risk Assessment for Methane and Other Gases from the Ground. Report 152, CIRIA, London.

CIRIA (1996) A Guide for Safe Working on Contaminated Sites. Report 132, CIRIA, London.

DEFRA and Environment Agency (2002a) Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and Related Research. R&D Report CLR7, Environment Agency, Bristol.

DEFRA and Environment Agency (2002b) Potential Contaminants for the Assessment of Land. Report CLR8, Environment Agency, Bristol.

DEFRA and Environment Agency (2002c) Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Report CLR9, Environment Agency, Bristol.

DEFRA and Environment Agency (2002d) The contaminated land exposure assessment (CLEA) model: technical basis and algorithms. Report CLR10, Environment Agency, Bristol.

DEFRA and Environment Agency (2002e) Model Procedures for the Management of Land Contamination. Report CLR11, Environment Agency, Bristol.

Environment Agency (2000) Technical Aspects of Site Investigation. Report P5-065/TR, Environment Agency, Bristol.

Environment Agency (2002) Guidance on Monitoring Landfill Leachate, Groundwater and Surface Water. Report LFTGN02, Environment Agency, Bristol.

Environment Agency (2007) Evaluation of Models for Predicting Plant Uptake of Chemicals from Soil. Report SC050021/SR, Environment Agency, Bristol.

Environment Agency (2008) Science Report SC050021/SR7 Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values.

Environment agency, 2007. Inter-laboratory comparison of in vitro bioaccessibility measurements for arsenic lead and nickel in soil, Science Report SC040060/SR2.

Environment Agency, 2009 Human health toxicological assessment of contaminants in soil (Science Report Final SC050021/SR2)

Gibbons, R. (1994) Statistical Methods for Groundwater Monitoring. Wiley, New York.

Highways Agency (2006) Design of Pavement Foundations. Document HD 25/IAN 73/06.

HSE (1991) Protection of Workers and the General Public During the Development of Contaminated Land. HMSO, London.

HSE (2005) Occupational Exposure Limits. HSE report EH40/2005, HMSO, London.

ICRCL (1986) Notes on the Fire Hazards of Contaminated Land. Guidance Note 61/84, 2nd Edition, Interdepartmental Committee on the Redevelopmentg of Contaminated Land, London.

Jeffries, J.(2009). A review of body weight and height data used within the Contaminated Land Exposure Assessment model (CLEA). Project SC050021/ Technical Review 1. Bristol: Environment Agency

LQM Ltd (2009) Generic Assessment Criteria for Human Health Risk Assessment. Land Quality Press, Nottingham.

NRA (1994) Protocol for a Leaching Test to Assess the Leaching Potential for Soils from Contaminated Sites. R&D Note 181.

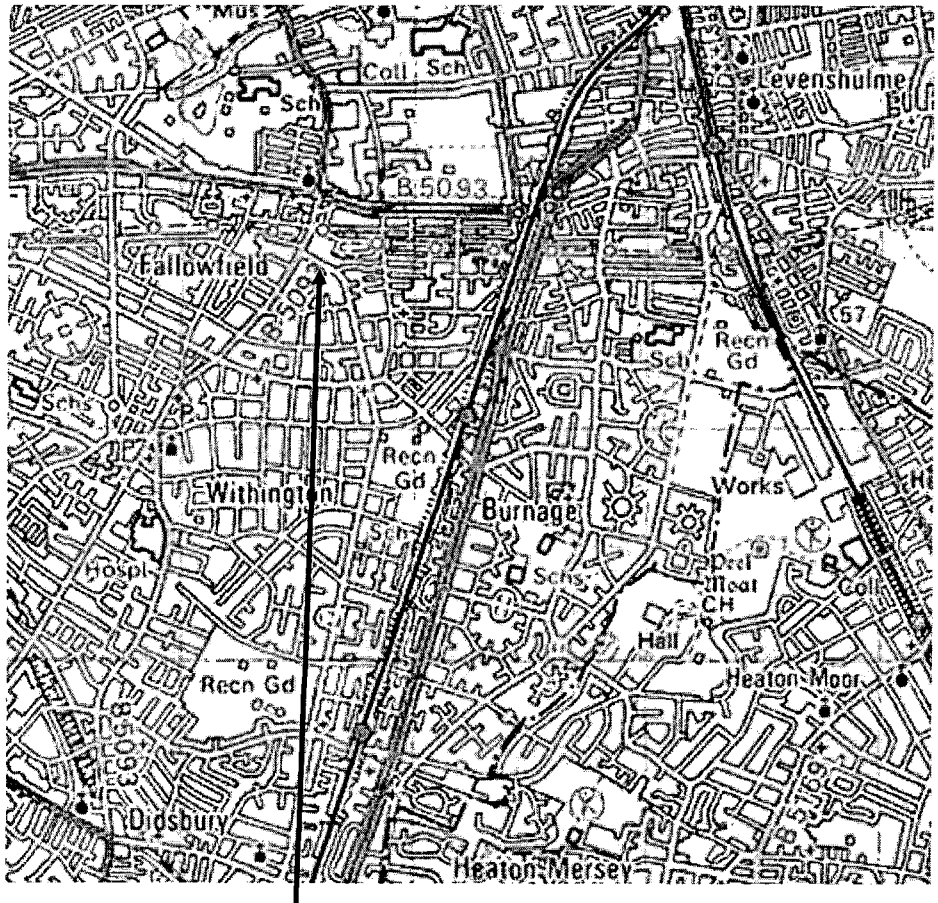
WHO (2000) Air Quality Guidelines for Europe. 2nd edition, WHO Regional Office for Europe, Copenhagen.

APPENDIX A - FIGURES AND DRAWINGS

Contract Number	T/10/917
Contract	Egerton Road, Manchester
Client	Watkin Jones Group

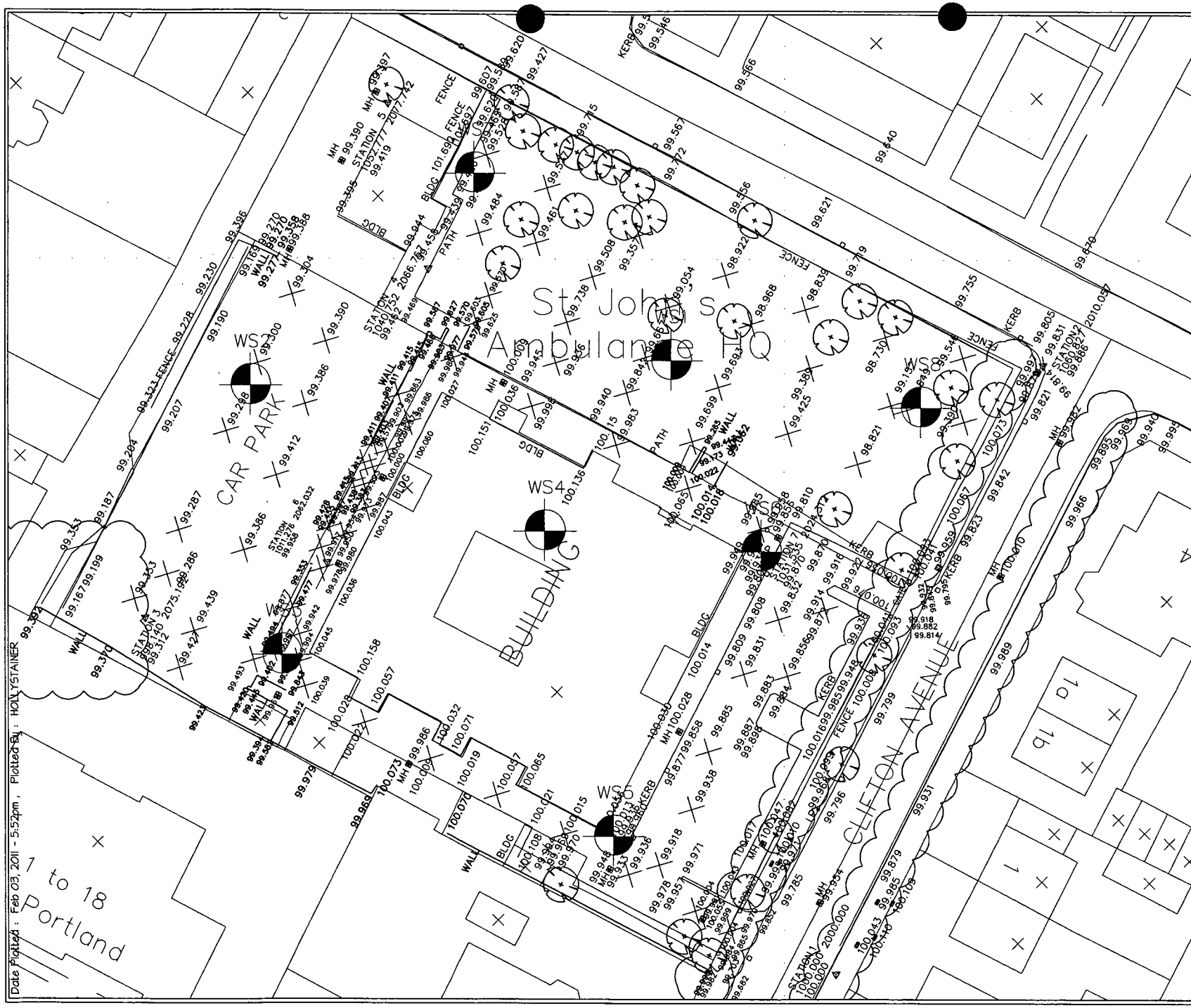
Tier Consult

Site Location Plan



Reproduced from the Ordnance Survey 1:25,000 scale map with the permission of The Controller of Her Majesty's Stationary Office, © Crown Copyright. All rights reserved.

Scale	1:50,000		
Drawn by	HS	Approved	PJB
Drawing Number	T/10/917/GA/1		



Date Plotted : Feb 03, 2011 - 5:52pm , Plotted By : HOLLYSTAINER

DO NOT SCALE

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: Final

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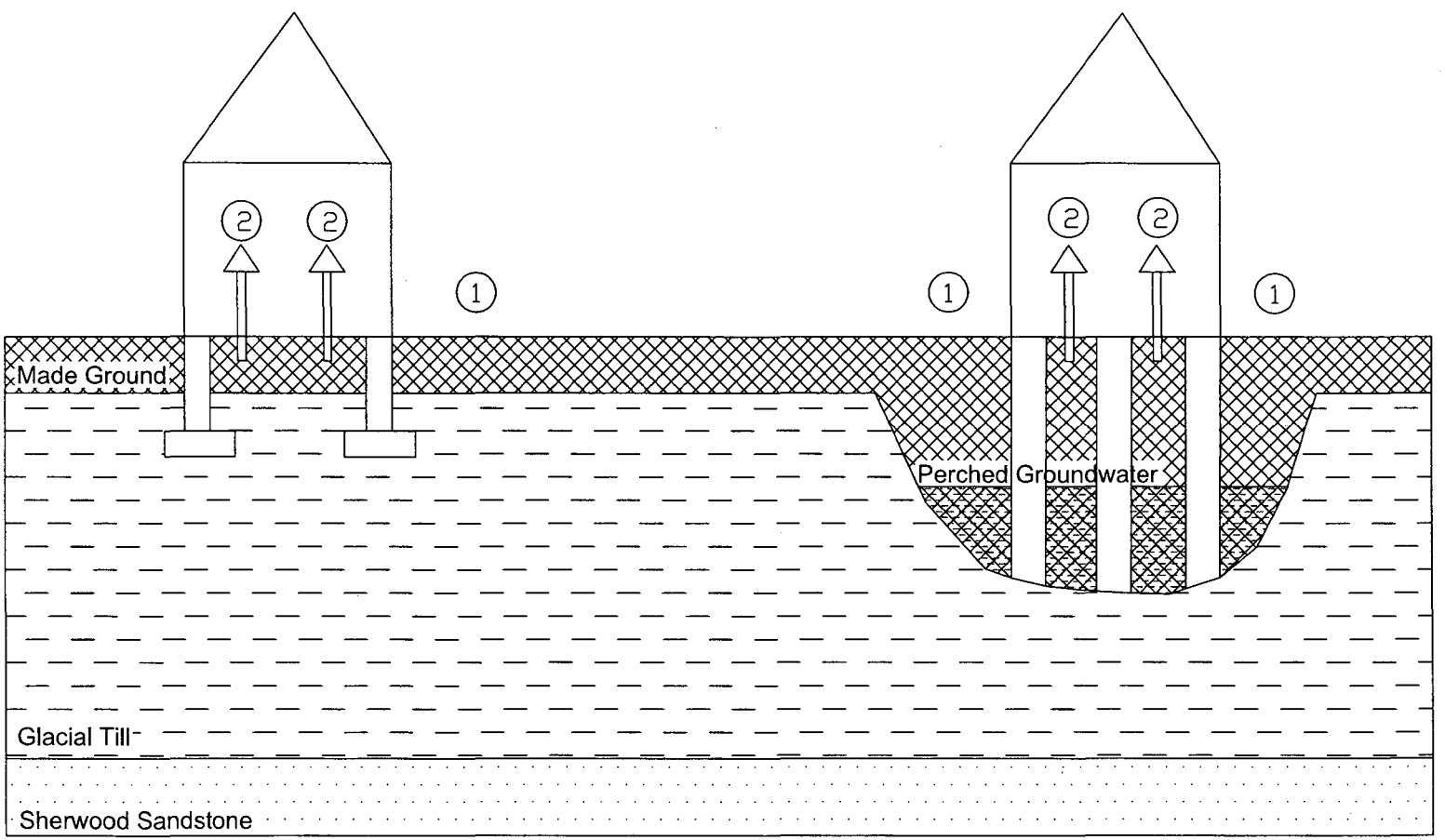
CLIENT: Watkin Jones Group

ARCHITECT: N/A

PROJECT: Egerton Road, Manchester

TITLE: Exploratory Hole Location Plan

SCALE @ SIZE:	CHECKED:	APPROVED:
1:200	JB	PJB
CAD FILE:	DESIGN/DRAWN: HS	DATE: February 2011
PROJECT No: T/10/917	DRAWING No: T/10/917/GA/2	REV: F



DO NOT SCALE

This drawing is purely schematic and is a representation of the ground conditions and process, based upon information derived from the desk study and Phase I Preliminary Risk Assessment.

The numbers attributed to the potential pollutant pathways presented in this drawing correspond to those within the preliminary conceptual site model (Table 10.1) within the main body of this report.

This model should be revised, following the availability of any site investigation information to ensure its relevance to actual conditions.

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: FINAL

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CLIENT: Watkin Jones Group

ARCHITECT: N/A

PROJECT: Egerton Road, Manchester

TITLE: Revised Conceptual Site Model

SCALE @ SIZE:	CHECKED:	APPROVED:
NTS	JB	JB
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APPENDIX B - GLOSSARY OF TERMS

ACEC	Aggressive Chemical Environment for Concrete (classification)
aOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
Designated location	Site (and the ecosystem on that site) protected under national of international legislation. A potential ecological receptor to be considered as part of the assessment of land contamination. Example designated locations include SSSIs (q.v.), SACs (q.v.), national nature reserves, Ramsar sites and bird special protection areas.
DQA	Data Quality Assessment
DQO	Data Quality Objective
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
K_{ow}	Octanol-water partition coefficient
LEL	Lower Explosive Limit

LL	Liquid Limit
LoD	Limit of Detection (analytical)
LoQ	Limit of Quantification (analytical)
Mean Value Test	Statistical test (described in CLR7) to estimate the mean value of a normally distributed population of data at a given level of confidence. Normally for contaminated land assessment, the 95th percentile (referred to as the 95%UCL or US95) is applied as a reasonable but conservative estimate of the mean concentration for comparison with the relevant assessment criteria.
Maximum Value Test	Statistical test (described in CLR7) to identify whether an elevated concentration within a normally distributed data set forms part of the underlying population from which it has been sampled or whether it is an outlier (such as a localised area of contamination) that merits further consideration.
MC	Moisture Content
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
PI	Plasticity Index
PID	Photoionisation Detector
PL	Plastic Limit
ppm	Parts per million
ppmv	Parts per million by volume
QA	Quality Assurance
QC	Quality Control
SAC	Special Area of Conservation

SOM	Soil Organic Matter
SPT	Standard Penetration Test
SPZ	Source Protection Zone (see Appendix E)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest
SVOC	Semi-Volatile Organic Compound
TEF	Toxicity Equivalent Factor
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
US95	95th percentile estimate of the true mean value of a data population (also known as 95%UCL).
VOC	Volatile Organic Compound

APPENDIX C - PREVIOUS SITE INVESTIGATION REPORT

BETTS ASSOCIATES
GEO ENVIRONMENTAL

Watkin Jones Homes

Phase 1 - Desk Study Report

at

Egerton Road, Fallowfield

December 2006

REPORT NO: 0611002/DS

- *Phase 1 Desk Studies and Site Walkovers*
- *Phase 2 Intrusive Contaminated Land Investigations*
- *Geotechnical Appraisals and Ground Investigations*
- *Landfill Gas Assessments and Remedial Design*
- *Remediation Design and Implementation*
- *Remediation Project Management and Supervision*
- *Site Abnormal Assessments (foundations and contaminated land)*

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DOCUMENT ISSUE RECORD

Contract No:	0611002/DS
Client:	Watkin Jones Homes
Contract:	Egerton Road, Fallowfield
Document:	Phase 1 Desk Study Report

Prepared by:	M Fawcett
Checked by:	D Wiseman
Date:	December 2006

REVISION RECORD

Revision	Date	Description	Prepared by
0	Dec 2006	Draft	M Fawcett

BETTS ASSOCIATES
GEO ENVIRONMENTAL

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Executive Summary

BETTS ASSOCIATES GEO ENVIRONMENTAL

Action?

1.1	The site is located at the corner of Clifton Avenue and Egerton Road, Fallowfield, Manchester (Ordnance Survey Grid Reference 385570,393680).	
1.2	A St Johns Ambulance training building of single story construction is currently situated in the centre of the site. The remainder of the site is currently tarmacadam to the frontage and rear, and open maintained grass to the north. Mature trees are present along the perimeters	
1.3	It is understood that the proposed development will be 3 number 3 / 4 storey residential blocks, two of which will have interconnecting basement car parking. Basement parking is anticipated to extend approximately 3m bgl	
1.4	Summary of Site History – The earliest map available shows the subject site as open farmland up until 1893 when the site was shown as a large residential property. In 1967 the property was demolished and replaced with Egerton School and school bungalow. In 1978 the school changed to current use as St Johns Ambulance HQ. Surrounding history shows predominantly residential development around the site, numerous small ponds, and a former railway siding to the north	
1.5	The site upon lies upon Glacial Clays overlying Bunter Pebble Beds (Sherwood Sandstone)	
1.6	Environmentally the site is of some concern, it has been shown that there have been potentially contaminative activities on site from the demolition of previous residential structures and there is a major aquifer beneath the site. It is anticipated that a 'protective cover' of glacial clay will be present.	
1.7	The site is not shown to be at risk of flooding.	
1.8	Filled / landscaped areas / potential former pond and potential demolition fill may pose a ground gas risk	*Gas monitoring Required*
1.9	Less than 1% of Homes are above the action level – No Radon protections necessary	
1.10	In this qualitative risk assessment, a low/moderate risk implies that some remedial action is likely to be necessary at the site, although until a contamination ground investigation is carried out this cannot be confirmed.	*Ground Investigation Required – target potential hotspots*

2 INTRODUCTION

This investigation was carried out on behalf of Watkin Jones Homes. The purpose of the work was to carry out a desk study (and to design a ground investigation - if deemed necessary) to establish ground conditions to provide geotechnical and contamination risk information for the design of foundations for proposed three separate three to four storey residential buildings (two with interconnecting basement parking). Basements are anticipated to extend to 3mbgl. The remaining area is predominantly landscaped / maintained gardens and areas of hard standing.



Proposed Development Layout

3 SITE DESCRIPTION

3.1 Location and Topography

The site is located at the corner of Clifton Avenue and Egerton Road, Fallowfield, Manchester (Ordnance Survey Grid Reference 385570,393680). See Site Location Plan in Appendix A.

The site is essentially rectangular in shape. A St Johns Ambulance training building of single story construction is currently situated in the centre of the site. The remainder of the site is currently tarmacadam to the frontage and rear, and open maintained grass to the north. Mature trees are present along the perimeters and within the landscaped area to the east / north east.

Site topography is generally level, with slight fall to the north west. The area of landscaping is separated by a small retaining wall in the eastern corner with an area approximately 1m lower. Some ponding of water was noted in the lower area. A slight mound of landscaped material exists in the locality of the proposed basement

3.2 Geology

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

Geology	Drift	Solid
BGS Sheet 98	Glacial Clays	Bunter Pebble Beds (Sherwood Sandstone)

3.3 Coal Mining

The site does not fall into a geographic area defined by The Coal Authority to be at risk from past, current or proposed coal mining.

3.4 Salt Mining

The site is shown to lie outside the compensation district area.

3.5 Hydrogeology and Hydrology

The Environment Agency's Groundwater Vulnerability Map of South Pennines (Sheet 17, 1:100,000) shows the site to lie on a major aquifer (highly permeable).

The soils directly beneath the site have been classed as having high leaching potential. These are soils in which pollutants are likely to penetrate the soil layer. Worst case to be assumed until otherwise proved.

The nearest surface water course is 184m away– no details given.

3.6 Desk Study

3.6.1 Site History from Ordnance Survey Maps

A search of Ordnance Survey maps was undertaken to establish the land use history of the site. Extracts of the maps discussed below can be found in Appendix B of this report. Unless otherwise stated, all distances quoted are taken from the site boundary, which is marked on the map. The centre of the site is marked 'X' on the maps. NSC denoted no significant change.

Pub Year	Scale	Site Features	Surrounding Land Uses
1848	10560	Open farmland – hedges / ditches running sw ne on west and east boundary – possible pond in eastern corner?	Road way and large house 'Fallowfield Grove' to northern boundary. Numerous small ponds to east of site
1893-1894	2500	Site shown as Norton House – residential? Residential to west of site – majority of site garden with trees	Widespread residential development. Railway trending east west 100m with associated sidings on an embankment
1899	10560	NSC	NSC
1907	2500	NSC	Sand pit shown 140m to NE
1908-1909	10560	NSC	NSC
1911	10560	NSC	NSC
1922	2500	NSC	Sandpit infilled
1923-1933	10560	NSC	NSC
1934	2500	NSC	NSC
1938	10560	NSC	NSC
1955-1956	10560	NSC	NSC
1957-1958	2500	No longer labelled as Norton house	NSC
1957-1958	1250	NSC	NSC
1958-1984	1250	NSC	Railway sidings removed
1965-1968	10560	NSC	NSC
1967-1987	1250	Now labelled as Egerton School and school bungalow – building layout changed – Norton house demolished (now parking)	NSC
1968	2500	NSC	NSC
1972-1981	10000	NSC	NSC
1975	1250	NSC	NSC
1978-1988	1250	Now labelled as St Johns Ambulance HQ	NSC
1980-1987	10000	NSC	NSC
1984	1250	NSC	NSC
1989-1994	10000	NSC	Demolition along Whiteoak Road to south
1992	1250	NSC	NSC
1994-1995	1250	NSC	NSC
1995	1250	NSC	NSC
1999	10000	NSC	Further demolition along Whiteoak Road to south
2004	10000		Redevelopment along Whiteoak Road to south Development of superstore on former railway sidings

3.6.2 Summary of Site History

The earliest map available shows the subject site as open farmland and a possible pond up until 1893 when the site was shown as a large residential property. In 1967 the property was demolished and replaced with Egerton School and school bungalow. In 1978 the school changed to current use as St Johns Ambulance HQ.

Surrounding history shows predominantly residential development around the site, numerous small ponds, and a former railway siding to the north 100m.

3.7 Environmental Data

Data sheets describing these features can be found in Appendix B of this report.

'Significant' both positive and negative, features in these data types are listed below.

Data Types Showing Significant (positive and negative) Issues	No. of Listings (or Yes/No) and Distance (m) from Site			Details of Listings
	0- 250	250-500	>500	
GENERAL				
Local Authority Pollution Prevention and Controls (and enforcements).			1	Not significant: 618m J Sainsbury – Petrol Filling Station
WATER RELATED				
Discharge Consents		6	4	Not Significant
Nearest Surface Waters	Yes			184m – no details given (error in data see river quality)
Controlled Waters (Pollution Incidents & Prosecutions)		3	6	Not significant
River Quality	1			11m Fallowfield Beck – River Quality C
Groundwater Abstractors			1	1384m – groundwater well – not significant due to distance
Flooding	1			Fluvial 47m to NE
WASTE				
Landfill Sites (recorded by BGS & Local Authority)				None recorded
GEOLOGICAL				
Shallow Mining Hazard				No Hazard
Mining Instability				No Hazard
Ground Dissolution Instability				No Hazard
Landslide Instability				Very Low Risk
Compressible Ground Instability				No Hazard
Running Sands Instability				Very Low to Low Risk
Shrinkable Swelling Instability of Clays				Very Low Risk to No Hazard
Radon Protection Measures				Less than 1% of Homes are above the action level – No Radon protections necessary
INDUSTRIAL LAND USE				
Fuel Station Entries	1	1		Fallowfield Filling Station 185m to SW. TCS 224m to SW – not significant due to distance
Contemporary Trade Directory Entries (Within 250m deemed significant)	4	12		Dry cleaners 93m NW, garage 178m to SE, Fallowfield Filling Station 185m to SW, builders merchants 199m to NE. None deemed significant due to distance

3.7.1 Summary of Environmental Data

Environmentally the site is of some concern, it has been shown that there have been potentially contaminative activities on site from the demolition of previous residential structures and there is a major aquifer beneath the site. It is anticipated that a 'protective cover' of glacial clay will be present.

3.8 Initial Contamination Conceptual Model

For details on how the conceptual model is evaluated please refer to Appendix C

This section of the report aims to identify land which could potentially be affected by contamination, such that it could affect the value or re-use of the land, or such that mitigation would be required for certain proposed end uses of the land.

3.8.1 Sources

The past uses of the site are relatively well known. There are obvious significant contamination sources in the vicinity of the site.

On site –

- Demolition waste and infilled areas – heavy metals and possible source of ground gas

Adjacent -

- Fuel filling station, railway sidings and dry cleaners – but all at distance

3.8.2 Receptors

The main receptors are the future users of the site (residents). Future plantings in gardens are also receptors, as are buildings and underground services. Construction workers are short-term receptors. Similar receptors in the vicinity are also potential targets.

Another receptor is the water environment. Below the site lies a major aquifer so groundwater may be a significant receptor. From published data the soils which lie below the site have a high leaching potential. The nearest water abstraction is >1000m from the site.

On site –

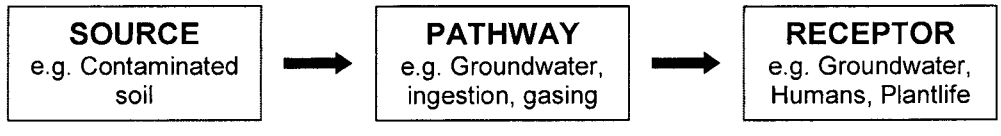
- Future users of the site (residents)
- Construction workers
- Future plantings in gardens
- Major aquifer

Adjacent -

- Major aquifer
- Water abstraction is >1000m from the site so deemed unlikely receptor (not within the EA groundwater protection zone)

3.8.3 Source-pathway-receptor linkages

The current potential risks to the receptors arising from the various source-pathway-target (receptor) linkages are assessed below. A risk may be considered significant if all three of the stages are present and therefore providing a pollution linkage. The various pathways are considered separately. The assessment is based on the future use which it is understood will be residential with some landscaped areas of root uptake.



Target (Receptor)	Potential Source-Pathway Linkage	Estimated Degree of Risk to Target
➢ Site end users	Inhalation of soil gases, odours or dust.	Low/ Moderate
➢ Site end users	Ingestion of, and skin contact with, contaminated soil.	Low/ Moderate
➢ Site end users	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc	Low/ Moderate
➢ Construction/ maintenance workers.	Inhalation of soil gases, odours or dust.	Low *
➢ Construction/ maintenance workers.	Ingestion of, and skin contact with, contaminated soil	Low *
➢ Plants	Adverse effects on growth caused by presence of contaminants in soil	Low/ Moderate
➢ Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards	Low/ Moderate
➢ Foundations	Sulphate attack of foundations	Low
➢ Water Supplies	Hydrocarbons penetrating plastic water supply pipes.	Low/ Moderate
➢ Groundwater	Migration of soluble contaminants into groundwater on or off site	Low/Moderate
➢ Surface water	Migration of soluble contaminants and/or direct run-off of contaminants	Low

* assuming normal PPE worn

In this qualitative risk assessment, a low/moderate risk implies that some remedial action is likely to be necessary at the site, although until a contamination ground investigation is carried out this cannot be confirmed.

It is recommended that an intrusive ground investigation is undertaken.

The contamination ground investigation is to be carried out to confirm the initial assessment made in this report and determine the levels of any contamination present on the site.

3.9 Scope of Ground Investigation

The objectives of the intrusive ground investigation will be to:

- Clarify the 'Initial Contamination Conceptual Model'.
- Clarify the initial risk assessment.
- Provide data for the design of any remedial works that may be required.
- Benchmark the contamination status of the site.
- Provide geotechnical information for foundation design.

Samples of soil and groundwater (where possible) for contamination testing should be taken from the made ground and from some of the underlying natural soils, especially if considered to be contaminated.

Scope –

- Trial pitting using JCB 3CX with breaker attachment or similar
- Light cable percussive boreholes sunk to 8mbgl to ensure sufficient depth for basement parameters are established.
- Ground gas/water monitoring wells should be installed and monitored for at least 3 separate occasions. Further monitoring may be required on the basis of the preliminary results.

4 REFERENCES

4.1 Geological Survey of Great Britain Sheet 98, 1:50,000

4.2 BS 5930:1999 *Code of Practice for Site Investigation.*

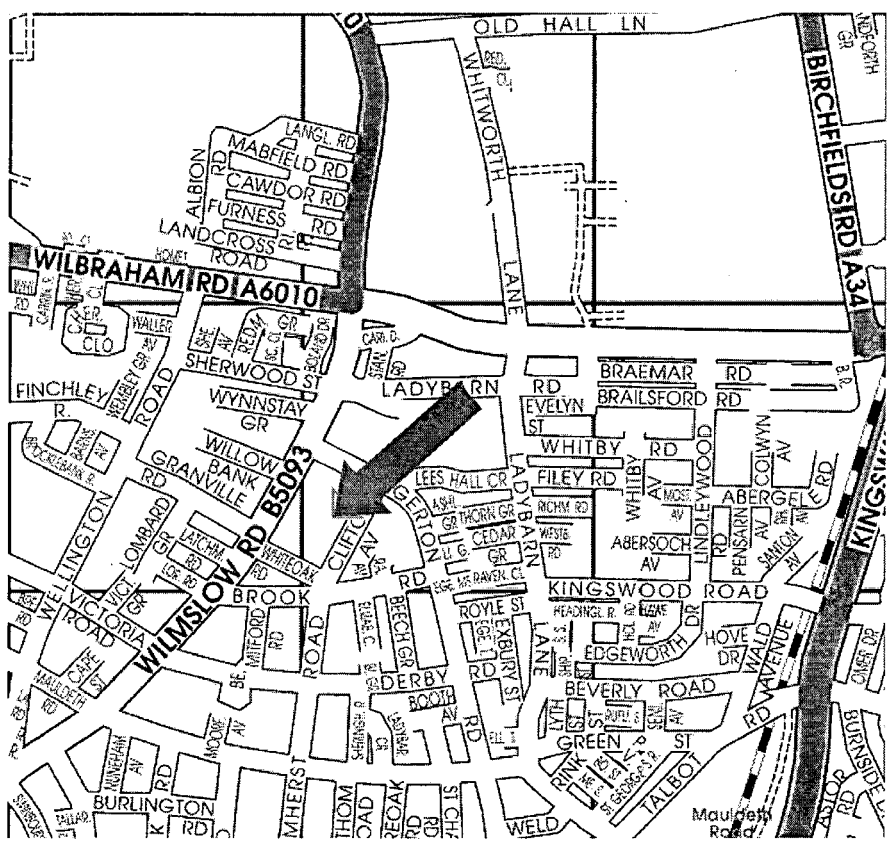
4.3 R & D Publication CLR 8 (March 2002) *Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and Related Research.* Environment Agency.

4.4 R & D Publication CLR 10 (March 2002) *The Contaminated Land Exposure Assessment Model (CLEA): Technical basis and algorithms.* Environment Agency.

4.5 *Contaminated Land Risk Assessment*; A Guide to Good Practice; CIRIA C552: 2001.

APPENDIX A

(i) Site Location Plan



OS X	385550
OS Y	393625
Nearest Post Code	M14 6UB

APPENDIX B

(i) Envirocheck Data Sheets

(ii) Historical Mapping

APPENDIX C

(iii) Conceptual Model

The report aims to identify land which could potentially be affected by contamination, such that it could affect the value or re-use of the land, or such that mitigation would be required for certain proposed end uses of the land.

The assessment also aims to identify land which would be regarded as 'contaminated land' under the terms of the Environmental Protection Act 1990, Part IIa. This act includes a stricter test for contaminated land than that outlined above. Land is considered to be contaminated if either:

- the land is causing significant harm to people, ecosystems or infrastructure; or
- there is a significant possibility that such harm could be caused; or
- pollution of controlled waters is being, or is likely to be, caused.

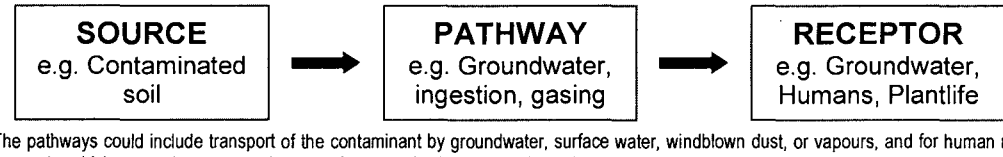
The following situations are defined as being where harm is to be regarded as significant:

- chronic or quite toxic effect, serious injury or death to humans;
- irreversible or other adverse harm to the ecological system;
- substantial damage to or failure of buildings;
- death of, or disease or other physical damage affecting, livestock or crops;
- pollution of controlled waters.

The risk assessment uses a 'Source-Pathway-Receptor' methodology for assessing whether a source of contamination could potentially lead to harmful consequences. This means that there needs to be a pollutant linkage from source to receptor for harm to be caused, this linkage consisting of:

- a source of pollution;
- a pathway for the pollutant to move along;
- a receptor that is affected by the pollutant.

As an example, the pollutant source could be an identified leak of oil or an area of dumped waste.



The pathways could include transport of the contaminant by groundwater, surface water, windblown dust, or vapours, and for human receptors will include the means by which contaminants enter the body, for example skin contact, ingestion and inhalation.

Receptors include people, other living organisms, the built environment and groundwater and surface waters (these latter two also being contaminant pathways).

The source-pathway-receptor methodology relationship allows an assessment of the environmental risk to be determined, based on the nature of the source, the degree of exposure of the receptor to the source and the sensitivity of the receptor.

This section of the report is based on the information set out in the previous sections of the report and should not be read independently of such sections.

Initial Conceptual Model

From the available information the preliminary conceptual model is visualised as follows:

Target (Receptor)	POTENTIAL SOURCE-PATHWAY LINKAGE
Site users / residents	Inhalation of soil gas, odours or dust.
	Ingestion of, and skin contact with, contaminated soil.
	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc.
Construction/ maintenance workers.	Inhalation of soil gas, odours or dust
	Ingestion of, and skin contact with, contaminated soil
Plants	Adverse effects on growth caused by presence of contaminants in soil
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards
	Sulphate attack of foundations
	Hydrocarbons penetrating plastic water supply pipes
Groundwater	Migration of soluble contaminants into groundwater on or off site. Migration of oils into groundwater on or off site.
Surface water	Migration of soluble contaminants and/or direct run-off of contaminants. Migration of oils into groundwater on or off site.

Initial Environmental Risk Assessment

General

It is accepted that an environmental risk assessment can be based on a source-pathway-target model. An examination is carried out as to whether a target will be at risk from a contamination source, that a source exists, and whether there are any pathways (routes of exposure) which might actually link the source to the target.

Environmental risk assessments rely heavily on numerical trigger concentrations or guidelines because exposure of targets to contamination is difficult to quantify directly. Quantification of risk is therefore mainly undertaken for general scenarios in order to derive trigger levels. These are derived for various contaminants for particular targets and routes of exposure. An example of a sensitive target would be users of a domestic back garden, where routes of exposure might be skin contact, dust inhalation, direct ingestion and indirect ingestion via cultivation and consumption of fruit and vegetables.

In March 2002, the first parts of the new CLEA risk assessment guidance were released by DEFRA/Environment Agency.

The risk assessment approach is an extension of the 'fit for use' concept whereby land is cleaned up to a standard fit for the proposed use, that is, so all remaining risks are acceptable. However, as well as being 'fit for use', the environmental risk assessment approach also addresses the soil and water environment so that these are also safeguarded where necessary. For example if a site was contaminated with heavy metals and the development comprised the proposed construction of hard standings and buildings only, the fit-for-use approach might require no remediation for the site. However, consideration of the wider environment needs to address whether groundwater is being contaminated, and if so whether remediation is required for this reason.

The following classification presented by CIRIA has been used in the assessment of risk:

Estimation of risk from consideration of magnitude, consequences and probabilities				
Probability	Consequences			
	Severe	Moderate	Mild	Minor
High	Very high	High	Moderate	Moderate / Low
Medium	High	Moderate	Moderate / Low	Low
Low	Moderate	Moderate / Low	Low	Very Low
Unlikely	Moderate / Low	Low	Very Low	Very Low

Reference: Contaminated Land Risk Management; A Guide to Good Practice, CIRIA C552:2001

APPENDIX D

(iv) Notes on Limitations

The desk study report includes examination and provision of historical maps and an environmental database search covering geology, hydrogeology, historical, land use, water abstractions, groundwater source protection zones, landfill sites, radon, trade directory entries, petrol filling stations and nature reserves for the site and surrounding area. A Coal Authority Report has been obtained as part of the investigation.

This report does not consider ecological impacts (eg bats) or botanical risks (eg Japanese knotweed). It is recommended that these are considered as part of the assessment of development constraints for the site.

The assessment and judgements given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented.. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information. Actual risks can only be assessed following a physical investigation of the site.

This report was prepared by Betts Geo Environmental Ltd for the sole and exclusive use of Watkin Jones Ltd in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

This document has been prepared for the titled project only and should any third party wish to use or rely upon the contents of the report, written approval from Betts Geo Environmental Ltd must be sought.

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BETTS ASSOCIATES
GEO ENVIRONMENTAL

Watkin Jones Homes

Phase 2 Ground Investigation Report at Egerton Road Fallowfield

December 2006

REPORT NO: 0611002

- *Phase 1 Desk Studies and Site Walkovers*
- *Phase 2 Intrusive Contaminated Land Investigations*
- *Geotechnical Appraisals and Ground Investigations*
- *Landfill Gas Assessments and Remedial Design*
- *Remediation Design and Implementation*
- *Remediation Project Management and Supervision*
- *Site Abnormal Assessments (foundations and contaminated land)*

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Checked by:	D Wiseman
Date:	December 2006

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BETTS ASSOCIATES
GEO ENVIRONMENTAL

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(i) Site Location Plan
(ii) Exploratory Hole Location Plan

APPENDIX B iv

(i) Borehole Logs
(ii) Trial Pit Logs
(iii) Environmental Monitoring Results

APPENDIX C v

(i) Laboratory Test Results

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(v) Notes on Limitations

Executive Summary

1.1 The site is located at the corner of Clifton Avenue and Egerton Road, Fallowfield, Manchester (Ordnance Survey Grid Reference 385570,393680).

1.2 A St Johns Ambulance training building of single story construction is currently situated in the centre of the site. The remainder of the site is currently tarmacadam to the frontage and rear, and open maintained grass to the north. Mature trees are present along the perimeters

1.3 It is understood that the proposed development will be 3 number 3 / 4 storey residential blocks, two of which will have interconnecting basement car parking. Basement parking is anticipated to extend approximately 3m bgl

1.4 Summary of Site History – The earliest map available shows the subject site as open farmland up until 1893 when the site was shown as a large residential property. In 1967 the property was demolished and replaced with Egerton School and school bungalow. In 1978 the school changed to current use as St Johns Ambulance HQ.

Surrounding history shows predominantly residential development around the site, numerous small ponds, and a former railway siding to the north

1.5 The site upon lies upon Glacial Clays overlying Bunter Pebble Beds (Sherwood Sandstone)

1.6 Environmentally the site is of some concern, it has been shown that there have been potentially contaminative activities on site from the demolition of previous residential structures and there is a major aquifer beneath the site. A 'protective cover' of glacial clay is however present.

1.7 The site is not shown to be at risk of flooding.

1.8 Filled / landscaped areas / potential former pond and potential demolition fill may pose a ground gas risk

1.9 **Ground Conditions** - The exploratory holes generally encountered a descending sequence of localised made ground, overlying firm to stiff glacial clay which in turn overlies sandstone rock head.

1.10 **Contamination** – no significant visual signs of contamination were noted during the site work

1.11 Analysis of the soils indicate only slightly elevated occurrences of TPH and elevated occurrences of PAH (Benzo(a) pyrene). Given the clay cover to the aquifer, no abstractors are located within 1000m and made ground in the basement to be removed it is deemed that there is no significant risk to the proposed development. However consideration to drag down of contaminants to the aquifer by piling should be considered along with the Local Authority and Environment Agency approval

Executive Summary

1.12 The site lies over a major aquifer however is not within a source protection zone. Groundwater was encountered as a perched body upon the glacial clay at the made ground boundary and groundwater within the sandstone. The borehole was grouted within the sandstone to stop the risk of sub artesian flows

1.13 **Foundations – Block 1 and 2** - Given that a basement is proposed foundation depths are anticipated to be 3.5mbgl. Foundations in the firm to stiff clay (Glacial Till) are recommended to an allowable bearing capacity of 190kN/m2 for lightly reinforced footings. Settlements should be less than 25mm. Where higher capacities are required piles may be necessary.

1.14 A lightly loaded ground bearing basement slab would be possible on the glacial clay. Formation level needs careful inspection and soft spots removed where required.

1.15 **Foundations – Block 3** – No basement is proposed. Foundation depths are anticipated to be 2mbgl. Foundations in the firm to stiff clay (Glacial Till) are recommended to an allowable bearing capacity of 180kN/m2 for lightly reinforced footings. Settlements should be less than 25mm. Where higher capacities are required piles will be required.

1.16 Given the thickness of made ground suspended floors well be required for Block 3

1.17 Limit tests show medium susceptibility to shrinkage and swelling (modified Plasticity Index of 16 to 22%). A detailed tree survey is recommended and foundations protected accordingly.

1.18 **Basement Construction Block 1 and 2:**

Conventional concrete retained basement could be used, however consideration to the following must be made:

- Cost of temporary shuttering for control of perched water
- Relatively slow speed of construction
- Proximity of adjacent properties and boundary lines – in regards to 'overdig'

As such consideration to the following construction is recommended:

- Secant piled wall – capping ring beam
- Sheet pile wall – capping ring beam

Cost analysis is recommended.

1.19 The concrete design should be Design Sulphate Class of DS-1 and ACEC class of AC-1s as defined by BRE Special Digest 1as defined by BRE Special Digest 1 for shallow foundations.

1.20 **Car Parking / hardstanding design** - a CBR value of 3% is suggested on the clay stratum

Executive Summary

1.21 **Gas Protection** - The envirocheck report states that no Radon protective measures are necessary for the construction of new dwellings or extensions.

1.22 Given that construction is to be a ventilated basement and the majority of made ground is to be removed for the construction of the basement, landfill gas monitoring results indicate only elevated occurrence of CO_2 (8.1%) with no significant flow, the following are recommended

- Reinforced concrete cast insitu ground slab
- All joints and penetrations sealed
- Passively vented under floor sub space
- Waterproof/gas resistant membrane

Given that construction is to be a ventilated basement (or suspended floor in Block 3) and the majority of made ground is to be removed for the construction of the basement it is suggested that this is a conservative level of protection.

1.23 **Waste Disposal** - Made ground is to be removed off site within the basement area along with the natural clay material – it is suggested that separation and separate disposal may provide cost savings.

1.24 **Further Investigation** - Restricted areas where trial pits could not be formed were within the main building on the basis that the amount of damage to the existing building at this speculative stage was unacceptable to the vendor. It advised that this area should be investigated at a later date to confirm interpolated geological conditions

1.25 It is recommended that the results of the contamination testing (including the history of the site) be presented to the proposed landfills, to obtain their acceptance of the information to date and to determine the actual WAC limits used by them.

1.26 Remedial action is required

- Excavation of majority of made ground and removal of perched water (basement area)
- Clean Cover of topsoil to landscaped areas
- Design of piling to reduce risk of drag down of contaminants to aquifer
- Use of specialist water supply pipelines

2 INTRODUCTION

This investigation was carried out on behalf of Watkin Jones Homes. The purpose of the work was to carry out a ground investigation to establish ground conditions to provide geotechnical and contamination risk information for the design of foundations for proposed three separate three to four storey residential building (Block 1 and 2 with interconnecting basement parking). Basements are anticipated to extend to 3mbgl. The remaining area is predominantly landscaped open space and areas of hard standing.



Proposed Development Layout

3 SITE DESCRIPTION

3.1 Location and Topography

The site is located at the corner of Clifton Avenue and Egerton Road, Fallowfield, Manchester (Ordnance Survey Grid Reference 385570,393680). See Site Location Plan in Appendix A.

The site is essentially rectangular in shape. A St Johns Ambulance training building of single story construction is currently situated in the centre of the site. The remainder of the site is currently tarmacadam to the frontage and rear, and open maintained grass to the north. Mature trees are present along the perimeters and within the landscaped area to the east / north east.

Site topography is generally level, with slight fall to the north west. The area of landscaping is separated by a small retaining wall in the eastern corner with an area approximately 1m lower. Some ponding of water was noted in the lower area. A slight mound of landscaped material exists in the locality of the proposed basement

3.2 Geology

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

Geology	Drift	Solid
BGS Sheet 98	Glacial Clays	Bunter Pebble Beds (Sherwood Sandstone)

3.3 Coal Mining

The site does not fall into a geographic area defined by The Coal Authority to be at risk from past, current or proposed coal mining.

3.4 Salt Mining

The site is shown to lie outside the compensation district area.

3.5 Hydrogeology and Hydrology

The Environment Agency's Groundwater Vulnerability Map of South Pennines (Sheet 17, 1:100,000) shows the site to lie on a major aquifer (highly permeable).

The soils directly beneath the site have been classed as having high leaching potential. These are soils in which pollutants are likely to penetrate the soil layer. Worst case to be assumed until otherwise proved.

The nearest surface water course is 184m away– no details given.

3.6 Desk Study

A search of Ordnance Survey maps, Environmental Data was undertaken as a previous phase of work. As such this report should be read in conjunction with 'Phase 1 Desk Study Report Ref 0611002/DS'

4 FIELDWORK

4.1 Scope

The fieldwork was carried out on the 4th of October 2006 and comprised:

- 2 No. light cable percussive boreholes – to a max depth of 8mbgl
- 5 No. machine dug trial pits – to a max depth of 3.5mbgl

The exploratory hole positions were selected and set out by Betts Geo Environmental Ltd, as shown on the Site Plan in Appendix A.

Prior to any intrusive works, each location was checked for services using a cable avoidance tool (CAT) and review of statutory service plans.

Targeted Investigation

One borehole was sunk in the middle of the proposed basement (Block 1 & 2) and a further two trial holes at either end, targeted at the area of fill for contamination testing and for geotechnical information.

Restricted areas where trial pits could not be formed were within the main building on the basis that the amount of damage, at this speculative stage was unacceptable to the vendor. It advised that this area should be investigated at a later date to confirm interpolated geological conditions

All samples and cores were logged by an engineer in general accordance with the recommendations of BS5930: 1999. Detailed descriptions, together with relevant comments, are given in the exploratory hole logs included in Appendix B.

Combined installations for gas/water monitoring were constructed within the two boreholes. Construction details are shown on the borehole logs.

4.2 Environmental Monitoring

Gas / water monitoring wells installed were monitored on 3 visits, monitoring ground water levels, % Methane, % Carbon Dioxide, % Oxygen, barometric pressure and gas flow rates. Results of these can be seen in Appendix B

5 LABORATORY TESTING

The following laboratory tests were carried out on samples unless indicated otherwise generally in accordance with BS1377: 1990, *Methods of test for soils for civil engineering purposes*, parts 1 to 8. Where non-standard procedures have been undertaken, this will be recorded on the report sheet. The results are reported in tabular and/or graphical form included as Appendix C of this report.

Geotechnical Test	Number of samples	Comment
Moisture Content	4	moisture contents were undertaken using the oven-drying method in accordance with BS1377: Part 2: 1990. The results are tabulated in the Summary of Classification Tests.
Liquid Limit, Plastic Limit and Plasticity Index	4	liquid and plastic limit tests were performed in accordance with BS1377: Part 2: 1990. The results are tabulated in an A Line Plot (in accordance with BS5930: 1999) and the Summary of Classification Tests.
Quick Undrained Triaxials	1	Single stage unconsolidated undrained triaxial compression tests without the measurement of pore pressure were undertaken in accordance with BS1377: Part 7: 1990. Each test was carried out on a single specimen nominally 100mm in diameter and 200mm in length.
Hand Shear Vane	1	Laboratory Hand Shear Vane

Chemical Test	Number of samples	Comment
pH values and water soluble sulphate (SO_4) contents	11	tested to determine their values in accordance with BS1377:Part 3:1990 clause 5.

Contamination Test	Number of samples	Comment
arsenic, cadmium, chromium (total), lead, mercury, selenium, copper, nickel and zinc. Speciated polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), organic matter	8	soil samples were analysed in accordance with UKAS/MCERTS standards The results are tabulated in the Summary of Contamination Analysis. The number of samples to be tested was specified by the engineer.

6 GROUND CONDITIONS

6.1 General

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS5930: 1999. Detailed descriptions, together with relevant comments, are given in the logs included in Appendix B.

Summary Table:

Stratum	Depth to base (mbgl)	Description	Strength parameters
Made Ground / Hard standing / Top soil	0.60 – 3.50m	Concrete or tarmac hardstanding covering sub base / sand onto generally reworked gravely clay with occasional brick, wood, cobbles and rare boulders	Not suitable for founding
Glacial Clay (Boulder Clay)	5.70 – 7.65m	Glacial Clay comprising slightly silty sandy gravely CLAY was encountered in all the exploratory holes, and was proved to a depth of 5.70 – 7.65m bgl in the boreholes. The material encountered was generally sandy gravelly clay with occasional cobbles. The gravel content generally comprised of sandstone, mudstone	Hand vanes carried out gave shear strengths of between 70 and >120 kPa indicating firm conditions generally becoming stiff with depth. SPT's gave N values of 20 – 58 – taking the lowest a conservative 100kpa can be assumed Modified Plasticity Index of Medium
Rockhead		Weak red fine to medium grained SANDSTONE	

6.2 Groundwater

Groundwater was encountered as described in the table below **during site work**:

Exploratory Hole No	Depth BGL	Stratum	Comment
BH01	6m	Glacial Clay	Water added to advance casing in hole
BH02	6m	Sandstone	Water added to advance casing in hole
TP's	between 1.10 and 1.80m.	Made Ground / Clay interface	Seepages were recorded in TP01, TP02,TP2A, TP05. Old land drains were encountered.

Groundwater was encountered as described in the table below **post site work** during monitoring:

Exploratory Hole No	Depth BGL	Stratum	Comment
BH01	5.02m	Clay	Only moisture at base of well
BH02	0.77 – 0.96m	Made ground	

6.3 Contamination (visible and olfactory)

General made ground potentially contains some ash, brick and clinker.

6.4 Other Issues

During the fieldwork several unrecorded/abandoned clay field drains were encountered.

7 GEOTECHNICAL ASSESSMENT

7.1 Introduction

It is understood that the proposed development will consist of demolition of the existing structure and construction of three number 3 / 4 storey residential buildings. Block 1 and 2 will have basement car parking throughout the length and between the two structures to a proposed depth of 3mbgl is anticipated. Block 3 has no basement proposed. Hard standing / additional parking is proposed to the south of the building and the remaining areas landscaped. At the time of writing details of the proposed loadings were not known and as such only general foundation recommendations can be given.

7.2 Site Preparation and Excavation

Shallow excavations for foundations and service trenches should be straightforward with the exception of the removal of the existing floors and foundations, which will require a breaker for removal.

All excavations should be planned and due consideration should be given to providing temporary support or suitable battering. Excavations should be regularly inspected by a competent person to ensure continued safety. Further advice on the safety of excavations is given *in Health and Safety in Construction.*

7.3 Control of Groundwater

Shuttering and pumping should be anticipated at the made ground / clay interface in any excavation

7.4 Foundations

Block 1 & 2

It is recommended that foundations are taken below the existing made ground. Foundations in the firm to stiff clay (Glacial Clay) encountered (3.5mbgl) should be suitable for the proposed structure. A minimum shear strength of around 75kPa can be assumed for the clay at the proposed basement level. Applying a factor of safety against failure of 3 this will give an allowable bearing capacity of 190kN/m2. Where higher capacities are required piles may be necessary.

Calculations on the allowable bearing capacity indicate settlements of less than 25mm for a square pad using the above allowable bearing capacity.

Localised softening of the clay stratum at formation may be experienced with precipitation or excessive trafficking and as such the base of foundation excavations should be blinded as soon as practicable after excavation.

Based on the above a conventional concrete retained basement could be used, however consideration to the following must be made:

- Cost of temporary shuttering for control of perched water / sands and gravels
- Speed of construction
- Heave protection due to proximity of trees
- Proximity of adjacent properties and boundary lines – in regards to 'overdig' to produce space to construct.

As such consideration to the following construction is recommended:

- Secant piled wall – capping ring beam
- Sheet pile wall – capping ring beam

However consideration to the following must be made by the piling contractor:

- Drag down of contaminants to the aquifer
- Potential artesian water from aquifer
- Space between retaining structure and foundations for internal loads – may need piled foundations to allow sufficient space between the two

Suggested typical retaining wall design parameters to be used –

Stratum	Bulk Weight Density kN/m3	Internal Friction (deg)	Undrained Shear strength kN/m2
Made Ground	18.5	0	35
Soft to Firm Clay	20.6	0	35
Firm to Stiff Clay	20.6	0	50 - 75

Block 3

It is recommended that foundations are taken below the existing made ground. Foundations in the firm to stiff clay (Glacial Clay) encountered (2.1mbgl) should be suitable for the proposed structure. A minimum shear strength of around 75kPa can be assumed for the clay at the proposed formation level. Applying a factor of safety against failure of 3 this will give an allowable bearing capacity of 180kN/m2. Where higher capacities are required piles may be necessary.

Calculations on the allowable bearing capacity indicate settlements of less than 25mm for a square pad using the above allowable bearing capacity.

Localised softening of the clay stratum at formation may be experienced with precipitation or excessive trafficking and as such the base of foundation excavations should be blinded as soon as practicable after excavation.

7.5 Heave / Shrinkage Potential

Atterberg Limits tests performed on samples taken showed them to be of low to medium susceptibility to shrinkage and swelling (modified Plasticity Index (I'P) of 16 to 22%). It is suggested that the more conservative medium is adopted for design. As there are many trees close to the proposed development we recommend that a detailed tree survey is carried out to enable foundation depths to be determined in accordance with NHBC Standards, *Chapter 4.2, Building near trees*, and foundations protected accordingly.

7.6 Floor Slabs

Block 1 & 2

A lightly loaded ground bearing slab would be possible on the glacial clay for the floor of the basement. Formation level needs careful inspection and soft spots removed where required.

Block 3

Given the thickness of made ground suspended floors are required

7.7 Protection of Buried Concrete

The results of the chemical testing indicate water soluble sulphate contents in the range 0.025 to 0.096 g/l with pH values in the range 5.89 to 8.17. It is considered for concrete design purposes that brownfield site and static groundwater conditions are applicable, and the results indicate a Design Sulphate Class of DS-1 and ACEC class of AC-1s as defined by BRE Special Digest 1.

7.8 Soakaways

It is suggested that the materials encountered in the trial pit indicates the material to be not suitable for a soakaway.

7.9 Car Parking / Hard standing

According to the criteria of Highways Agency HD 25/95 volume 7 section 2 Part 2 HD 25/94, a CBR value of 3% is expected for the clays assuming a low water table. Placement of geotextiles within the areas of roads / parking could also be designed to minimise the subgrade thickness.

8 GROUND GAS ASSESSMENT

8.1 Ground Gas Protection Requirements – Radon

The Envirocheck report states that no Radon protective measures are necessary for the construction of new dwellings or extensions.

8.2 Ground Gas Protection Requirements – Methane and Carbon Dioxide

Summary table

	Oxygen	Methane	Carbon dioxide	Barometric Pressure	Flow
BH1	5.5 – 8.6	nil	5.2 – 8.1	974 - 1006	nil
BH2	15.1 – 20.0	nil	1.8 – 2.7	983 - 1006	nil

BRE Report 212 (Ref Building Research Establishment Report 212 (1991) *Construction of New Buildings on Gas Contaminated Land*, BRE) states that the precautions are not mandatory against carbon dioxide unless 5.0% volume is exceeded, although they should be considered above 1.5%.

Using the Wilson Card paper the results for the site methane (and carbon dioxide) emission rates (per unit area of ground) are all deemed insignificant because the gas flow rates are all below 1.0 l/hr.

According to the criteria proposed by Wilson & Card the combination of negligible flow rate, carbon dioxide levels above 5%, and the type of site (old landfill), implies that design measures should be in accordance with characteristic situation 3 of table 5 as given by Wilson and Card. For a residential development such as that proposed, the following protection measures are given in Table 6 of Wilson and Card:

- Reinforced concrete cast insitu ground slab
- All joints and penetrations sealed
- Passively vented under floor sub space
- Waterproof/gas resistant membrane

Given that construction is to be a ventilated basement and the majority of made ground is to be removed for the construction of the basement it is suggested that this is a conservative level of protection. For further details see appendix F)

9 CONTAMINATION ASSESSMENT

9.1 General

For details on how guidelines were determined please refer to Appendix F

For ease of description and disposal / reuse of material / identify any migration of contaminant sources, made ground / natural strata and groundwater will be dealt with separately.

The end use has been determined to be open spaces

9.2 Made Ground

Determinant	Screening Value (mg/kg) *Residential with plant uptake*	Screening Value (mg/kg) *Open space*	Outlier?	UBV95 (mg/kg)	Source
Arsenic	20	86.3	No	20.51	Made Ground
Copper	653	110000	Yes	4349	Made Ground
Zinc	139	80000	No	455	Made Ground
TPH	1000	1009.85	No	1000	Made Ground
Benzo (a) Pyrene	0.54	9.00	No	3.96	Made Ground

9.3 Natural Strata

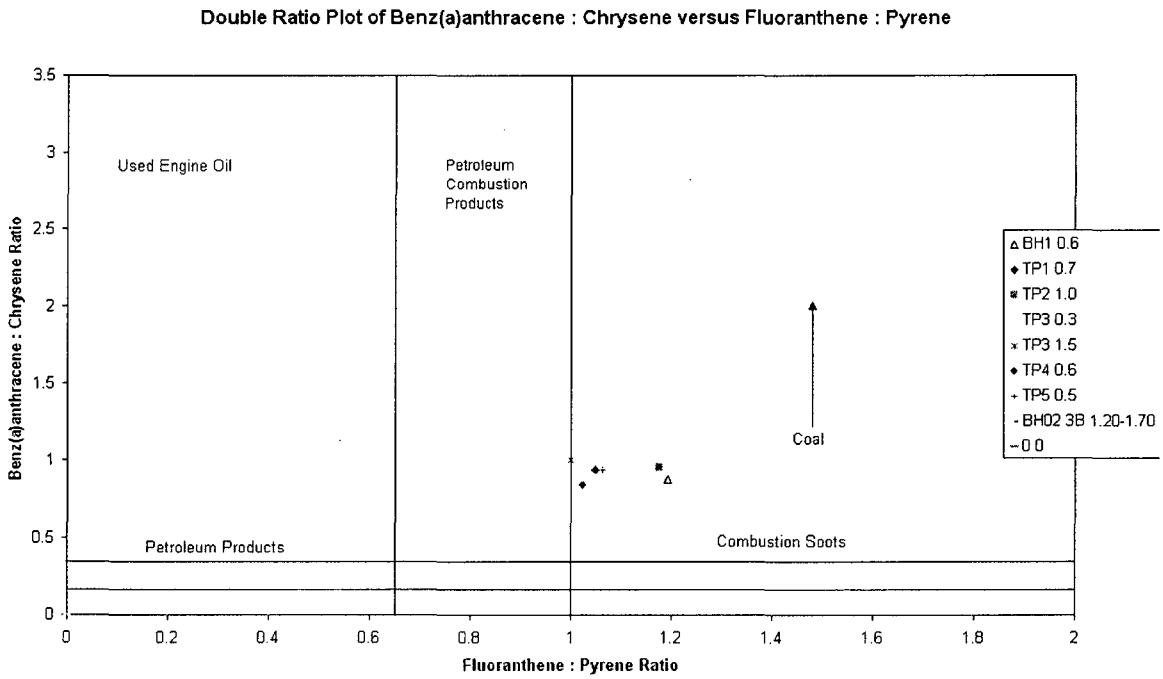
Determinant	Screening Value (mg/kg)	Screening Value (mg/kg)	Outlier?	UBV95 (mg/kg)	Source
		Uncontaminated			

9.4 Summary of Contamination

The results of the chemical testing show that the soils on the site are suitable for the proposed development. All levels of contaminants screened were below relevant guideline values except for the items discussed below:

High PAH (benzo (a) pyrene

The PAH's have been plotted for the slightly elevated samples – it is suggested that the signature 'fingerprint' is associated with burnt fuel / combustion soot (typical of demolition fill)



The high PAH is deemed not to be an outlier statistically. Whilst the PAH levels exceeded guidance against residential with plant uptake, with the exception of Benzo (a) pyrene, they did not exceed values for open space which is more applicable to the landscaped maintained end use of green areas.

Arsenic

Residential with plant uptake - Very slightly elevated occurrences of arsenic were identified within the made ground. It is not statistically shown to be an outlier.

Open space – not elevated against 'Atrisk' Values

Copper

Residential with plant uptake - Elevated occurrences of copper were identified within the made ground. It is statistically shown to be an outlier in TP01.

Open space – not elevated against 'Atrisk' Values

Zinc

Residential with plant uptake - Elevated occurrences of copper were identified within the made ground. It is statistically shown not to be an outlier.

Open space – not elevated against 'Atrisk' Values

TPH

Slightly elevated occurrence of TPH was identified in the made ground. It is not statistically shown to be an outlier. No visual or olfactory evidence was noted regarding hydrocarbons in the exploratory holes

9.5 Final Contamination Conceptual Model

9.5.1 General

This section of the report aims to clarify the 'Initial Contamination Conceptual Model' in the light of the findings of the ground investigation. Furthermore, this section of the report is based on the information set out in the previous sections, and should not be read independently of the other sections of the report.

9.5.2 Sources, Pathways & Receptors

The potential sources of contamination are considered to have not changed from those highlighted in the Initial Contamination Conceptual Model. The potential receptors and pathways are considered to have not changed.

9.6 Final Risk Assessment

9.6.1 General

This section reassesses likely risks to the identified receptors, arising from potential contamination sources. It provides a final qualitative assessment of the risks involved, indicating whether (where appropriate) any immediate action is required to mitigate certain risks. It also discusses (where appropriate) what longer term measures or remedial works may be required in the future if the site were to be developed.

Significant points to be considered have not changed from the 'Initial Environmental Risk Assessment'.

It is considered that the site has not been assessed by the local authority as a contaminated site under the terms of the Environmental Protection Act 1990 Part IIa.

9.6.2 Final Environmental Risk Assessment

Target (Receptor)	Potential Source-Pathway Linkage	Estimated Degree of Risk to Target	Remedial Action Required (where appropriate)
Site end users	Inhalation of soil gases, odours or dust.	Low	Providing remedial actions in section 9.9 are undertaken
Site end users	Ingestion of, and skin contact with, contaminated soil.	Low	Providing remedial actions in section 9.9 are undertaken
Site end users	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc	Low	Providing remedial actions in section 9.9 are undertaken
Construction/ maintenance workers.	Inhalation of soil gases, odours or dust.	Low *	** assumes basic PPE is used
Construction/ maintenance workers.	Ingestion of, and skin contact with, contaminated soil	Low *	** assumes basic PPE is used
Plants	Adverse effects on growth caused by presence of contaminants in soil	Low	Providing remedial actions in section 9.9 are undertaken
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards	Low/ Moderate	
Foundations	Sulphate attack of foundations	Low	See section 7.7
Water Supplies	Hydrocarbons penetrating plastic water supply pipes.	Low	Providing remedial actions in section 9.9 are undertaken
Groundwater	Migration of soluble contaminants into groundwater on or off site	Low	Providing remedial actions in section 9.9 are undertaken
Surface water	Migration of soluble contaminants and/or direct run-off of contaminants	Moderate	Providing remedial actions in section 9.9 are undertaken

9.7 Outline Strategy for Risk Reduction

Any proposed imported soils should be tested for contamination to ensure that they are suitable for the proposed use, and it is generally advisable to test a minimum of three samples so that a representative mean value can be calculated.

Site workers should wear gloves, boots and overalls and wash their hands before eating drinking and smoking. Excessive dust generation should be avoided.

It is recommended that during all excavations adequate ventilation should be maintained. If man entry is required, gas monitoring should be carried out as a precaution.

Given the existence of made ground on the site it would be prudent to maintain vigilance during site clearance and construction, in case any further areas of suspected contamination are encountered.

If areas are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.

9.8 Remedial Actions

On the information gathered in this study it is suggested that remedial actions are required for its intended proposed end use:

Remedial Actions:

Excavation of majority of made ground and removal of perched water as part of construction process (basement area)

Clean Cover of topsoil to landscaped areas

Design of piling to reduce risk of drag down of contaminants to aquifer

Use of specialist water supply pipelines

Excavation of basement area

Removal of made ground within the basement area – the work should be supervised by a qualified engineer and validation report (see Appendix H for guidance) for the removal produced.

The PAH's have been plotted and it is suggested that the signature 'fingerprint' is associated with burnt fuel / combustion soot.

Clean Cover to Landscaped areas

It is suggested that 600mm of clean topsoil cover should be provided where planting is proposed. If hardstanding is proposed no remedial actions are required.

Risk of drag down of contaminants to aquifer

A risk of potentially contaminating the aquifer exists in that piling may drag down contaminants from the made ground through the impermeable clay to the sandstone aquifer.

Factors that reduce the risk:

- There is 2m of clay overlying the aquifer
- The majority of made ground is to be removed off site
- The site is not within a groundwater protection zone
- There are no groundwater abstractors within 1000m of the site

It is unlikely that piling will cause a significant pathway / risk for contaminants.

It is recommended that the piling contractor is given this report to enable a design method least likely to cause a pathway. Local Authority and Environment Agency approval should be sought.

Use of specialist water supply pipelines

In accordance with the 'Water Regulations Advisory Scheme' guidance notes on 'the selection of materials for water supply pipes to be laid in contaminated land' 2002 – It is recommended that the developer seeks approval from the local water supplier. It is anticipated given the PAH and TPH results that specialist pipelines will be required

9.9 Off-site Disposal of Surplus Soil

It is recommended that the results of the contamination testing (including the history of the site) be presented to the proposed landfills, to obtain their acceptance of the information to date and to determine the actual WAC limits used by them. Depending on the classification of the soils, it may be feasible to remove the hotspot around separately and get soils classified in two phases to reduce cost and waste minimisation (see appendix G for further guidance)

9.10 Further Investigation?

Restricted areas where trial pits could not be formed were within the main building, it advised that this area should be investigated at a later date to confirm interpolated geological conditions.

10 REFERENCES

10.1 *Phase 1 Desk Study Report Ref 0611002/DS*

10.2 *Geological Survey of Great Britain Sheet 98, Stockport, 1:50,000*

10.3 BS 5930:1999 *Code of Practice for Site Investigation.*

10.4 BS1377: 1990 *Methods of Test for Soils for Civil Engineering Purposes.*

10.5 R & D Publication CLR 8 (March 2002) *Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and Related Research.* Environment Agency.

10.6 R & D Publication CLR 10 (March 2002) *The Contaminated Land Exposure Assessment Model (CLEA): Technical basis and algorithms.* Environment Agency.

10.7 *Contaminated Land Risk Assessment*; A Guide to Good Practice; CIRIA C552: 2001.

10.8 *Health and Safety in Construction,* HSG150, HSE, 1996.

10.9 BRE Special Digest 1, *Concrete in Aggressive Ground,* 2005.

10.10 *Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Waste,* Environment Agency, WM2 Version 1.0, June 2003.

10.11 *Construction over abandoned mine workings, P.R Healy and J.M Head 2002.*

10.12 *DoE (1991), The Building Regulations Approved Document C, Site Preparation and Resistance to Moisture, HMSO*

10.13 *Building Research Establishment Report 212 (1991), Construction of New Buildings on Gas Contaminated Land*

10.14 *Baker W (1987), Investigation Strategy - lecture at City of Birmingham Development Department Symposium on Methane Generating Sites, 9 December 1987, Industrial Research Laboratories, Birmingham*

10.15 *Building Research Establishment Report 211 (1999) Radon: Guidance on Protective Measures for New Dwellings*

10.16 *CIRIA Report 149 (1995) Protecting Development from Methane*

10.17 *Passive Venting of Soil Gases Beneath Buildings (Vol 1) 1997. Ove Arup (for DETR)*

10.18 *Waste Management Paper 27 Landfill Gas 2nd edition, Department of the Environment (1991)*

10.19 *CIRIA Report 150 Methane Investigation Strategies 1993*

10.20 *CIRIA Report 151 Interpreting Measurements of Gas in the Ground (1995)*

10.21 *S A Wilson & G B Card (1999) Reliability and risk in gas protection design. Ground Engineering, February 1999 pp 33-36*

10.22 *NHBC Standards, Chapter 4.2, 2003 Building Near Trees*

10.23 *Highways Agency HD 25/95 volume 7 section 2 Part 2 HD 25/94*

10.24 *Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) (1987) Guidance Note 59/83 Guidance on the Assessment and Redevelopment of Contaminated Land*

10.25 *Darmendrail D (2001) The French approach to contaminated land management, BRGM/RP-51098-FR, 150p, 3 Fig, 3 Tables, 5 App*

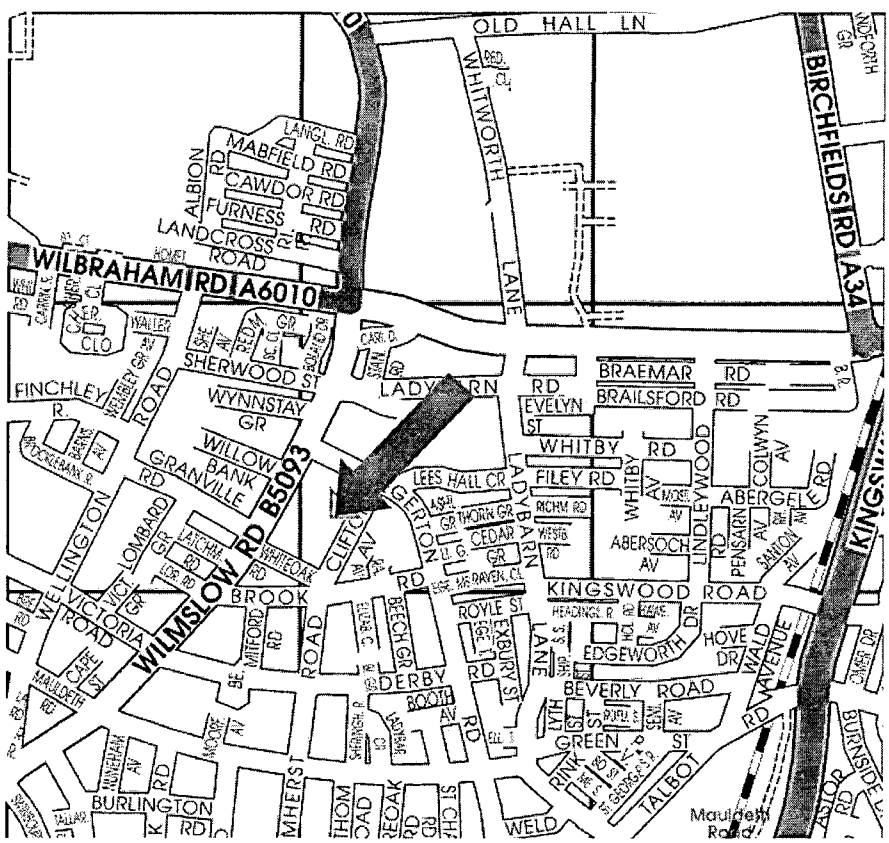
10.26 *Anon (1997) Dutch in Policy Retreat on Contaminated Land ENDS (Environmental Data Services), 269, 46*

10.27 *Water Regulations Advisory Scheme (2002) The selection of materials for water supply pipes to be laid in contaminated land*

APPENDIX A

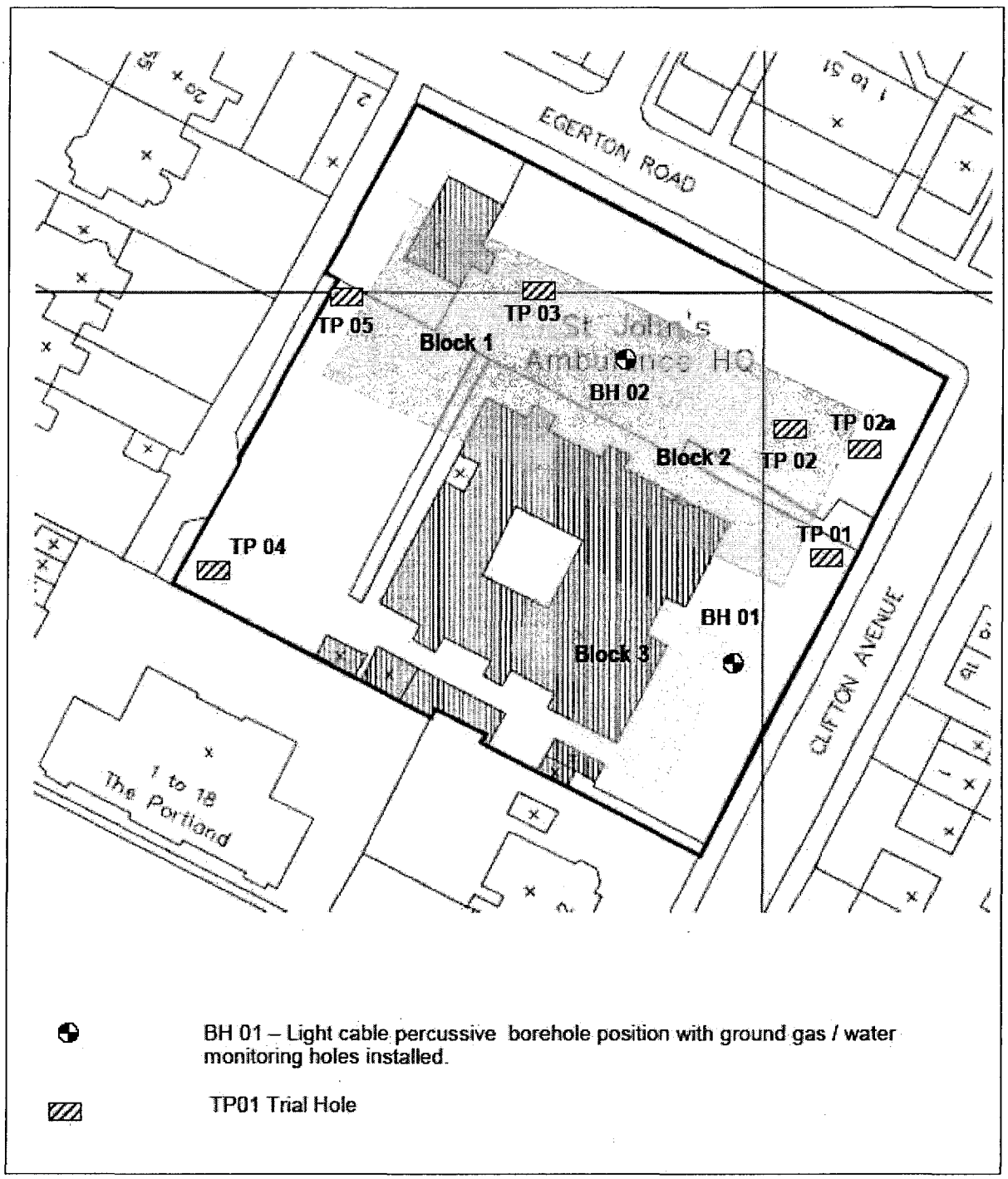
(i) Site Location Plan

(ii) Exploratory Hole Location Plan



Site Location Plan

Egerton Road Fallowfield 0611002



APPENDIX B

(i) Borehole Logs

(ii) Trial Pit Logs

(iii) Environmental Monitoring Results

APPENDIX C

(i) Laboratory Test Results

APPENDIX D

(i) Contamination Test Results

APPENDIX E

(i) Conceptual Model

The report aims to identify land which could potentially be affected by contamination, such that it could affect the value or re-use of the land, or such that mitigation would be required for certain proposed end uses of the land.

The assessment also aims to identify land which would be regarded as 'contaminated land' under the terms of the Environmental Protection Act 1990, Part IIa. This act includes a stricter test for contaminated land than that outlined above. Land is considered to be contaminated if either:

- the land is causing significant harm to people, ecosystems or infrastructure; or
- there is a significant possibility that such harm could be caused; or
- pollution of controlled waters is being, or is likely to be, caused.

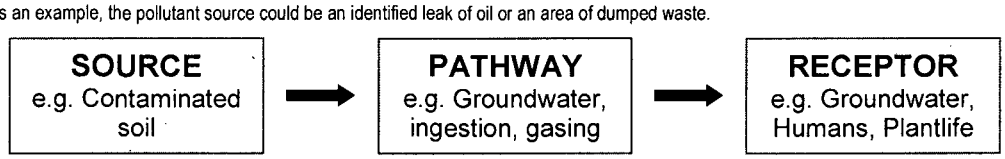
The following situations are defined as being where harm is to be regarded as significant:

- chronic or quite toxic effect, serious injury or death to humans;
- irreversible or other adverse harm to the ecological system;
- substantial damage to or failure of buildings;
- death of, or disease or other physical damage affecting, livestock or crops;
- pollution of controlled waters.

The risk assessment uses a 'Source-Pathway-Receptor' methodology for assessing whether a source of contamination could potentially lead to harmful consequences. This means that there needs to be a pollutant linkage from source to receptor for harm to be caused, this linkage consisting of:

- a source of pollution;
- a pathway for the pollutant to move along;
- a receptor that is affected by the pollutant.

As an example, the pollutant source could be an identified leak of oil or an area of dumped waste.



The pathways could include transport of the contaminant by groundwater, surface water, windblown dust, or vapours, and for human receptors will include the means by which contaminants enter the body, for example skin contact, ingestion and inhalation.

Receptors include people, other living organisms, the built environment and groundwater and surface waters (these latter two also being contaminant pathways).

The source-pathway-receptor methodology relationship allows an assessment of the environmental risk to be determined, based on the nature of the source, the degree of exposure of the receptor to the source and the sensitivity of the receptor.

This section of the report is based on the information set out in the previous sections of the report and should not be read independently of such sections.

Initial Conceptual Model

From the available information the preliminary conceptual model is visualised as follows:

Target (Receptor)	POTENTIAL SOURCE-PATHWAY LINKAGE
Site users / residents	Inhalation of soil gas, odours or dust.
	Ingestion of, and skin contact with, contaminated soil.
	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc.
Construction/ maintenance workers.	Inhalation of soil gas, odours or dust
	Ingestion of, and skin contact with, contaminated soil
Plants	Adverse effects on growth caused by presence of contaminants in soil
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards
	Sulphate attack of foundations
	Hydrocarbons penetrating plastic water supply pipes
Groundwater	Migration of soluble contaminants into groundwater on or off site. Migration of oils into groundwater on or off site.
Surface water	Migration of soluble contaminants and/or direct run-off of contaminants. Migration of oils into groundwater on or off site.

Initial Environmental Risk Assessment

General

It is accepted that an environmental risk assessment can be based on a source-pathway-target model. An examination is carried out as to whether a target will be at risk from a contamination source, that a source exists, and whether there are any pathways (routes of exposure) which might actually link the source to the target.

Environmental risk assessments rely heavily on numerical trigger concentrations or guidelines because exposure of targets to contamination is difficult to quantify directly. Quantification of risk is therefore mainly undertaken for general scenarios in order to derive trigger levels. These are derived for various contaminants for particular targets and routes of exposure. An example of a sensitive target would be users of a domestic back garden, where routes of exposure might be skin contact, dust inhalation, direct ingestion and indirect ingestion via cultivation and consumption of fruit and vegetables.

In March 2002, the first parts of the new CLEA risk assessment guidance were released by DEFRA/Environment Agency.

The risk assessment approach is an extension of the 'fit for use' concept whereby land is cleaned up to a standard fit for the proposed use, that is, so all remaining risks are acceptable. However, as well as being 'fit for use', the environmental risk assessment approach also addresses the soil and water environment so that these are also safeguarded where necessary. For example if a site was contaminated with heavy metals and the development comprised the proposed construction of hard standings and buildings only, the fit-for-use approach might require no remediation for the site. However, consideration of the wider environment needs to address whether groundwater is being contaminated, and if so whether remediation is required for this reason.

The following classification presented by CIRIA has been used in the assessment of risk:

Estimation of risk from consideration of magnitude, consequences and probabilities				
Probability	**Consequences**			
	Severe	**Moderate**	**Mild**	**Minor**
High	Very high	High	Moderate	Moderate / Low
Medium	High	Moderate	Moderate / Low	Low
Low	Moderate	Moderate / Low	Low	Very Low
Unlikely	Moderate / Low	Low	Very Low	Very Low

Reference: Contaminated Land Risk Management; A Guide to Good Practice, CIRIA C552:2001

APPENDIX F

(ii) Notes on Contamination Guidance & Ground Gas

Contamination

In March 2002 DEFRA (Department of the Environment, Food and Rural Affairs) and the Environment Agency released the CLEA (Contaminated Land Exposure Assessment) model and the first tranche of Soil Guideline Values (SGV) covering 10 contaminants. There are currently SGV's for 10 contaminants. It is understood that there will eventually be SGV's for 55 contaminants, but the timescale is not known.

Generally there will be SGV's for each contaminant, for several different uses of land. At the moment the land-uses are limited to residential (with and without plant uptake), allotments and commercial. These standard SGV's are derived in such a way as to be conservative and are tabulated with the results.

There is also an interactive CLEA computer model which is intended to allow the standard values to be adjusted for soil type, pH and organic matter content. At present however, these adjustments tend to be of insignificant magnitude. Therefore it is usually appropriate to assess the results for the site against the standard values, provided that the exposure assumptions used to derive the SGV's are relevant to the site. The interactive model also allows an insight into the process which is followed in order to derive an SGV for a given contaminant and land-use.

The CLEA system also introduces some statistical testing of the test results. In principle, the mean (average) of the results for a given contaminant could be compared with the SGV. However, the measured mean could differ significantly from the true mean if only a limited number of results were available. Therefore in the *mean value test* the upper 95th percentile of the mean measured concentration (US_{95}) is calculated for each contaminant and this is compared to the SGV. This test calculates the upper bound, below which 95% of the results would be expected to lie. If the mean value exceeds the SGV then this may indicate a requirement for remediation or further investigation.

If the mean value lies below the SGV, then remediation is not likely to be required: this may be the case even if some individual results exceed the SGV, as long as the high results fall within the same sample population, as discussed below.

There is also a *maximum value test* and this determines whether results which exceed the SGV fall within the range that can be expected from the sample population, or whether they are indicative of an area of higher contaminant concentrations and hence are called 'outliers'. If outliers are present, then again this may indicate a requirement for remediation or further investigation.

Until recently the assessment of contamination was based upon ICRCL Guidance Note 59/83. In December 2002 DEFRA withdrew ICRCL 59/83 because it was thought that its inconsistency with CLEA would cause confusion. The withdrawal of ICRCL Guidance Note 59/83 prior to the publication of CLEA guidelines for most contaminants has meant that there is at present no UK guidance for some contaminants. In the absence of CLEA guidelines reference has been made to the French contamination guidelines, which in turn also refer to German and Dutch guidelines for some contaminants. For PAH the Dutch guidelines have been referred to, because these (like the USEPA) concentrate on those PAHs which pose significant risk, rather than assessing 'total PAH' which can include many low risk naturally occurring PAHs. The guidelines used are shown in the results tables.

Ground Gas

The Building Regulations and BRE Report 212 state that precautions are not mandatory against carbon dioxide unless 5.0% volume is exceeded. These documents do not give a threshold level for methane, but Baker suggests that this level is 0.1% volume. For methane up to 1.0% volume, and carbon dioxide above 5.0% volume the Building Regulations and BRE Report state that passive measures may be adopted. Above 1.0% methane further specific guidance must be sought.

CIRIA Report 149 gives further guidance on the appropriate precautions for various gas regimes, called characteristic situations in this report. In the DETR Guide for Design by Ove Arup various types of passive measures are assessed for performance with different gas regimes. The assessments used computational fluid dynamic (CFD) modelling.

A gas regime is essentially defined by two parameters:

i) The concentration of the gas (e.g. methane)

ii) The emission rate of the gas from the ground.

The fact that two parameters are used is problematic if the site is to be classified on the basis of Table 28 in CIRIA Report 149. This is because high gas concentrations are often encountered which fall into an onerous gas regime; whereas the low flow rates which are also frequently encountered fall into less onerous gas regimes.

In order to use the Guide for Design to decide if passive measures are suitable, it is necessary to combine the gas concentration and the emission rate.

Using emission rates in $m^3/m^2/s$ as in Table 6 of the Guide for Design, (or $cm^3/m^2/s$ because this gives numbers of a more convenient size), then, for example, the methane concentration might be 20% and the emission rate (total gas emitting from the borehole) might be $1.0x10^{-6}m^3/m^2/s$ (=1 $cm^3/m^2/s$). The emission rate of methane itself will then be one fifth of the total, since only one fifth of the gas is methane that is $0.2x10^{-6}m^3/m^2/s$ or $0.2cm^3/m^2/s$. This enables the gas regimes in Table 6 of the Guide for Design to be expressed as a single parameter which can then be compared with the methane emission rate for the site.

This is done for Table 6 in the table below, with extra columns being added which are shaded.

Gas Regime	Hazardous Gas Concentration (% v/v)	Emission Rate			Borehole flow Velocity m/s	Equivalent characteristic situation (after CIRIA 149)
		Methane	Total Gas			
		$cm^3/m^2/s$	$cm^3/m^2/s$	$m^3/m^2/s$		
A	1	0.01	1.0	0.98×10^{-6}	0.005	2
B	5	0.05	1.0	0.98×10^{-6}	0.005	3
C	5	0.1	2.0	1.96×10^{-6}	0.01	4
D	20	0.2	1.0	0.98×10^{-6}	0.005	4
E	20	0.4	2.0	1.96×10^{-6}	0.01	4
F	20	2	10	9.8×10^{-6}	0.05	5

The passive venting options mentioned in the Guide for Design are tabulated below.

Measure	Maximum Gas Regime (for various building widths)		
	Small up to 7.5m wide	Medium up to 15m wide	Large up to 30m wide
Granular blanket min 300mm deep	B or C	*	A
Granular blanket with drains	*	*	B
Open void min 100mm deep	F	E	E
Polystyrene shuttering (equivalent depth 22mm)	E	*	C
Polystyrene shuttering (equivalent depth 100mm)	E	*	E
Geocomposite blanket (40mm thick, double sided)	E	*	B

* not specified in the Guide for Design.

In the Guide for Design the width of structure is the distance between the opposite sides of the building on which the ventilation points are sited. The report states that side vents are usually placed on at least opposite faces of the venting layer. A membrane is also required.

APPENDIX G

(iii) Off-site Disposal of Surplus Soil Guidance Notes

The disposal of waste (including surplus soils and contaminated soils) to landfill sites is governed by the *Landfill (England & Wales) Regulations 2002*, the *Hazardous Waste Technical Guidance document WM2 (2003)* and associated legislation.

One of the aims of the above legislation is to encourage waste producers (including developers disposing of surplus soils etc) to reduce their waste (and not just discard and disown it). This can be achieved by recycling or reusing the waste. In the case of contaminated sites where leaving contaminated material in-situ poses a risk to a potential receptor such as groundwater resources, further testing and assessment for such risk could reduce the quantities requiring disposal. If there is still unacceptable risk from contaminated soil being left in place, then it may be possible to reduce the risk to an acceptable level (such that the material can be left in place) by in-situ or ex-situ clean up of the soils.

Before waste can be disposed of, the producer of the waste must undertake a number of steps. *'Initial Waste Testing and Characterisation'* is firstly undertaken to determine whether the waste is non-hazardous or hazardous. The exceptions are that some wastes such as coal tars, 'tank bottom sludge's', etc are immediately classed as hazardous, regardless of any testing or threshold concentrations.

Any inert or hazardous waste destined for landfill must undergo *'Compliance Testing'* using the Waste Acceptance Criteria (WAC). There are different inert and hazardous WAC limits relating to landfill sites that are correspondingly licensed to accept inert or hazardous waste.

If the *'Initial Waste Testing and Characterisation'* shows a waste to be hazardous, then it is a requirement that the material be tested against the WAC-hazardous suite of tests. If it *passes* the WAC-hazardous testing, then it can be taken to a hazardous waste landfill site. If the material *fails* the WAC-hazardous testing, then the material must be treated before undergoing re-characterisation, further WAC-hazardous testing and then potential disposal at a hazardous waste disposal site.

If the *'Initial Waste Testing and Characterisation'* shows a waste to be non-hazardous, then it can be taken to a non hazardous waste landfill site, without further testing. The producer may however decide to undertake WAC-inert testing, in an attempt to reclassify the waste as inert, in which case the waste could then go to an inert landfill site.

The volumes of soils associated with potential hotspots on a site (be they hazardous or non hazardous) which might require off-site disposal, could potentially be reduced by further on-site sampling and subsequent testing.

With regard to the *Compliance Testing*, it should be noted that some landfill sites are permitted to increase the standard WAC-hazardous/inert limit concentrations, such that they might accept waste that would normally fail such limits.

We would recommend that the contamination testing results (including the history of the site) be presented to the proposed landfills, to determine if they will accept waste generated at the site and what classification they would impose.

Attention is drawn to the landfill tax and the fact that waste (soils and other materials) arising from the remediation/reclamation of contaminated land is usually exempt from such tax. Exemption must be applied for 30 days before it is intended to start removing remediation waste to landfill (HM Customs and Excise document LFT2 refers. For advice tel. 0845 010 9000).

APPENDIX H

(iv) Validation Report Guidance Notes

Unforeseen Hotspots of Contamination

Given the existence of made ground on the site it would be prudent to maintain vigilance during site clearance and construction, in case any further areas of suspected contamination are encountered.

If areas are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.

Any hotspots encountered during site clearance, not previously encountered in the ground investigation, are to be removed to a suitably licensed landfill site.

A validation report (see below) will be produced on completion of these works. This report will serve to confirm that the works were undertaken in accordance with the relevant legislation, the method statement, specification and planning conditions.

Validation Report Recommendations

It is suggested that the following records will be kept on site to provide a basis for the validation report:

- Daily record sheets of the remediation works to include a summary of the day's activities
- Weather conditions
- Plant, personnel and visitors to the remediation site
- Aspects relating to Health & Safety, environmental control or non-compliance with the specification or the Method Statements.
- All in situ and laboratory testing results.

All requirements of the remediation specification should be complied with; on completion of the remediation a validation report should be provided. This report will comprise the relevant site records and act as certification that the remedial and ground preparation works have been carried out in accordance with the specification.

The validation report will include the following:

- A description of the works undertaken.
- Records of any remediation works, including daily diary sheets.
- Progress photographs.
- Any chemical and geotechnical validation test results.
- As built surveys, including base excavations and top and bottom of capping layer.
- A statement that the works have been undertaken in accordance with the agreed specification

APPENDIX I

(v) Notes on Limitations

The desk study report includes examination and provision of historical maps and an environmental database search covering geology, hydrogeology, historical, land use, water abstractions, groundwater source protection zones, landfill sites, radon, trade directory entries, petrol filling stations and nature reserves for the site and surrounding area. A Coal Authority Report has been obtained as part of the investigation.

This report does not consider ecological impacts (e.g. bats) or botanical risks (e.g. Japanese knotweed). It is recommended that these are considered as part of the assessment of development constraints for the site.

The assessment and judgements given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information. Actual risks can only be assessed following a physical investigation of the site.

The site investigation has been carried out to provide information concerning the type and degree of contamination, and ground and groundwater conditions to allow a reasonable risk assessment to be made. Betts Geo Environmental Ltd undertake to exercise all reasonable skill, care and due diligence in the exercise of the investigation with respect to sampling techniques, sample storage and report interpretation.

The assessments and judgement given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. Data acquisition is subject to the limitations of the methods of investigation used. Exploratory holes undertaken during fieldwork investigate small a small volume of ground in relation to the size of the site and as such can only provide an indication of site conditions. There may be conditions pertaining to the site and the proposed development i.e. localised "hotspots" of contamination, which have not been disclosed by the investigations.

The findings and opinions are relevant to the dates of our site works and should not be relied upon to represent conditions at substantially later dates. Conditions at the site will change over time due to natural variations and anthropogenic activities. Groundwater, surface water and soil gas conditions should be anticipated to change with diurnal, seasonal and meteorological variations.

The opinions expressed in this report regarding any contamination are based on simple statistical analysis and comparison with available guidance values. No liability can be accepted for the retrospective effects of any changes or amendments to these values.

This report was prepared by Betts Geo Environmental Ltd for the sole and exclusive use of Watkin Jones Homes Ltd in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

This document has been prepared for the titled project only and should any third party wish to use or rely upon the contents of the report, written approval from Betts Geo Environmental Ltd must be sought.

Betts Geo Environmental Ltd accepts no responsibility or liability

a) for the consequences of this document being used for the purpose other than that for which it was commissioned and

b) for this document to any other party other than the person by whom it was commissioned.

APPENDIX D - DEFINITION OF SOURCE PROTECTION ZONES AND GROUNDWATER VULNERABILITY ASSESSMENTS

Source Protection Zones

Source Protection Zones (SPZs) are defined by the Environment Agency (for England and Wales), SEPA (Scotland) and the Environment and Heritage Service (Northern Ireland) for groundwater sources such as wells, boreholes and springs that are used for public drinking water supply. The zones show the risk of contamination from activities that might cause groundwater pollution in the area. The size and shape of a zone depends upon subsurface conditions, how the groundwater is removed, and other environmental factors.

SPZs are classified into four categories:

- **Zone 1 (Inner protection zone).** Any pollution that can travel to the abstraction point within 50 days from any point within the zone is classified as being inside Zone 1. This applies at and below the groundwater table. This zone also has a minimum 50 m protection radius around the abstraction point. These criteria are designed to protect against the transmission of toxic chemicals and water-borne disease.

- **Zone 2 (Outer protection zone).** The outer zone covers pollution that takes up to 400 days to travel to the abstraction point, or 25% of the total catchment area, whichever area is the largest. This travel time is the minimum period over which the Environment Agency considers that pollutants need to be diluted, reduced in strength or delayed by the time they reach the abstraction point.

- **Zone 3 (Total catchment).** This is the total area needed to support removal of water from the abstraction point, and to support any discharge from this.

- **Zone of special interest.** This may occasionally be defined as a special case. This is usually where local conditions mean that industrial sites and other potential sources of contamination could affect the groundwater source, even though they are outside the normal catchment area.

Groundwater Vulnerability Assessments

The Environment Agency has issued a series of maps that identify the vulnerability of groundwater in England and Wales to contamination from the overlying soils. The assessment takes account of the physico-chemical characteristics of the overlying soils, the characteristics of the unsaturated strata overlying the aquifer and the properties and the properties of the aquifer itself.

The standard terms used by the Environment Agency are summarised in Tables 1 and 2.

Table 1. Soil Classification.

Classification	Definition
H. Soils of high leaching potential	Soils with little ability to attenuate diffuse source pollutants and in which non-adsorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or shallow groundwater.
H1	Soils which readily transmit liquid discharges because they are either shallow or susceptible to rapid flow direct to rock, gravel or groundwater.
H2	Deep, permeable, coarse textured soils which rapidly transmit a wide range of pollutants because of their rapid drainage and low attenuation potential.
H3	Coarse textured or moderately shallow soils which readily transmit non-adsorbed pollutants and liquid discharges but which have some ability to attenuate adsorbed pollutants due to their clay or organic matter contents.
I. Soils of intermediate leaching potential	Soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-adsorbed diffuse source pollutants and liquid discharges could penetrate the soil layer.
I1	Soils which can possibly transmit a wide range of pollutants.
I2	Soils which can possibly transmit non- or weakly adsorbed pollutants and liquid discharges but are unlikely to transmit adsorbed pollutants.
L. Soils of low leaching potential	Soils in which pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal or they have the ability to attenuate diffuse pollutants.

Table 2. Aquifer Classification ("Geological Classification").

Classification	Definition
Major Aquifers (Highly Permeable)	Highly permeable formations usually with a known or probably presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes.
Minor Aquifers (Variably Permeable)	These may be fractured or potentially fractured rocks that do not have a high primary productivity, or other formations of variable permeability, including unconsolidated deposits. Although these aquifers will seldom produce large quantities of water for abstraction, they are important for local supplies and in supplying base flow to rivers.
Non-Aquifers (Negligibly Permeable)	Formations which are generally regarded as containing insignificant quantities of groundwater. However, some groundwater flow, although imperceptible, does occur through such formations and they need to be considered in assessing the risk posed by persistent pollutants.

APPENDIX E - DEFINITIONS OF TERMS USED IN QUALITATIVE AND QUANTITATIVE RISK ASSESSMENTS

For the qualitative and quantitative assessment of risks posed by potential pollutant linkages to all receptors, a common terminology has been employed throughout this report.

Evaluated significance of pollutant linkage	Definition
Very High	There is a high probability that severe harm or pollution by the identified contaminant could arise at the identified receptor unless appropriate remedial action is taken.
High	It is probable that harm to, or pollution of, the identified receptor by the identified contaminant could occur unless appropriate remedial action is taken.
Moderate	It is possible that harm to, or pollution of, the identified receptor by the identified contaminant could occur unless appropriate remedial action is taken. However, it is relatively unlikely that the consequences would be severe.
Low	It is possible that harm to, or pollution of, the identified receptor by the identified contaminant could occur. However, if any harm is realised it is likely that any effects will be mild.
Negligible	The presence of an identified contaminant will not cause significant harm or pollution to the identified receptor *via* the specified pathway(s).

APPENDIX F - ASSESSMENT CRITERIA APPLIED FOR GROUND GAS

Monitoring for the following is generally performed as part of ground gas assessment:

- Methane (CH_4): an odourless, flammable gas. Mixtures of methane with air containing between 5 and 15% v/v methane are explosive.
- Carbon dioxide (CO_2): an asphyxiant at elevated concentrations. Denser than air, it can accumulate in excavations, and within low points inside buildings
- Oxygen (O_2): important in the assessment of the potential formation of explosive mixtures with methane. Monitoring normally measures both methane and oxygen concentrations in ground gas to derive an indication of the risk of explosive mixture formation, expressed as a percentage of the Lower Explosive Limit (LEL). Low concentrations of oxygen in ground gas can also exacerbate the risk of CO_2 asphyxiation.
- Hydrogen sulphide (H_2S): odorous and toxic, capable of forming flammable mixtures with air.
- Volatile Organic Compounds (VOCs): present as chemical contaminants of soil and sometimes also biologically produced in low concentrations.

Assessment of methane (CH_4) and carbon dioxide (CO_2)

Methane and CO_2 can arise from natural geological sources, mine workings, rotting organic matter (peat, landfilled materials, etc.) and/or contaminant biodegradation. Assessment of ground gas composition and flows is therefore an essential part of site assessment. The need to adequately address potential risks from ground gas on development sites is therefore required under the planning regime.

In order to appropriately assess the site risks, the Construction Industry Research and Information Association (CIRIA) have issued several guidance documents on landfill and ground gas that are intended to provide advice on how to investigate and deal with gas contaminated ground with respect to development. These are:

- Report 149: 'Protecting Development from Methane' (CIRIA, 1995a)
- Report 150: 'Methane Investigation Strategies' (CIRIA, 1995b)
- Report 151: 'Interpreting Measurement of Gas in the Ground' (CIRIA, 1995c)
- Report 152: 'Risk Assessment for Methane and Other Gases from the Ground' (CIRIA, 1995d)

More recent guidance has been published to update the documents detailed above to collaborate and promote industry 'good practice'. These are:

- CIRIA Report 665: 'Assessing risks posed by hazardous ground gases to buildings (CIRIA, 2008)
- NHBC: 'Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present' (NHBC, 2007)

The earlier CIRIA 149 approach is now considered to be too conservative. A more realistic measure of the risk posed by methane and CO_2 in ground gas can be established by determining an appropriate Gas Screening Value (GSV), using the methods described in the NHBC and CIRIA 659 documents. These values are based upon earlier work undertaken by Wilson and Card (1999).

GSVs are calculated by multiplying the borehole flow rate (l/hr) by the percentage (% v/v) concentration in the gas stream of the specific component, i.e.:

GSV = (Concentration / 100) x Flow rate.

A risk-based methodology for deriving GSVs is defined for two situations (designated A and B), which are adequate for the great majority of site cases:

- Situation A: All development types except low rise housing with gardens
- Situation B: Low rise housing with gardens.

Under Situation A, classification of the scope of protection required is determined from the site GSV, summarised in Table 1. For Situation B, GSVs derived are used in a 'Traffic Light' classification (summarised in Table 2) which determines the required level and scope of protection measures. Tables 1 and 2 are summaries only: the details provided in the body text, footnotes and appendices of the above-referenced documents should be read in conjunction with the results to determine the appropriate level of protection.

For conservatism, Tier Consult uses the maximum concentration and gas flow rate of methane detected in any borehole during all of the monitoring visits in deriving recommendations on appropriate protection measures. This represents the worst-case risk of forming an explosive mixtures. For CO_2, steady state concentrations and flow data are applied, as these determine the development of an asphyxiating mixture. All values are selected whether of not they occurred in the same borehole or during the same monitoring event.

Exceedences of the maximum concentrations used in a Tier 1 Gas Risk Assessment can be tolerated, when the conceptual model indicates that it is safe to do so. However, GSV values must never be exceeded - where site-specific circumstances permit the derivation of alternative GSVs according to the defined conceptual model, then the appropriate GSV values should be applied.

Table 1. GSV Categories Defined for Situation A (Summarised from CIRIA Report 659, 2006).

Risk classification	GSV (CH_4 or CO_2; l/hr)	Additional factors	Characteristic situation
Very low	<0.07	Typically methane <=1% and/or CO_2 <=5%, otherwise consider increase to Low Risk.	1
Low	<0.7	Typically borehole ground gas flow rate <=70 l/hr; otherwise consider increase to Moderate Risk.	2
Moderate	<3.5	---	3
Moderate to high	<15	QRA required to evaluate scope of remediation measures.	4
High	<70	---	5
Very high	>70	---	6

Table 2. GSV Categories Defined for Situation B (Summarised from NHBC, 2007).

Methane		CO_2		"Traffic light" classification
Typical max. conc. (% v/v)	GSV (l/hr)	Typical max. conc. (% v/v)	GSV (l/hr)	
				Green
1	0.13	5	0.78	
5	0.63	10	1.60	Amber 1
20	1.60	30	3.10	Amber 2
				Red

Assessment of hydrogen sulphide (H_2S)

H_2S is toxic and highly odorous ("rotten eggs") gas. It is often a minor component within mine gases, in ground gas within or overlying strata rich in pyrites or other sulphide-rich ores, and in most natural gas fields.

H_2S can be generated biologically in significant concentrations by the decomposition by sulphate-reducing bacteria of natural or anthropogenic organic matter under oxygen-free conditions. Its potential generation will be greater in environments containing elevated sulphate concentrations (including sea water). H_2S is therefore common within the gas arising from estuarine and marine sediments, pond sediment, stagnant water bodies, bogs and marshlands and landfilled waste, for example.

It must be noted that H_2S normally occurs together with other potentially hazardous ground gases. The measures adopted for protection against these will prove equally protective against H_2S.

There are no standards by which H_2S concentrations in ground gas can be assessed directly. Therefore, the significance of measured H_2S concentrations in ground gas must be evaluated on a case-by-case basis, taking into account the measured concentrations of other components and the specific conceptual site and exposure models. To assist in this process, the following standards and guidance may be applied.

General protection of land users

There are no UK air quality standards for general exposure to H_2S. The World Health Organisation has derived ambient air quality standards (WHO, 2000) for this gas, which may be used to inform risk assessment and decision-making:

- The 24 hour average exposure guideline value for ambient air: 0.15 mg/m^3 (0.1 ppmv, approx.; this was derived by the application of a 100x safety factor to the LOAEL for long-term exposure).

- This is significantly above the odour threshold, which is typically around 0.01 mg/m^3. To avoid substantial nuisance odour complaints, WHO (2000) recommends that the 30 minute average H_2S concentration in ambient air should not exceed: 0.007 mg/m^3 (0.005 ppmv, approx.).

Occupational exposures

For occupational exposure, the HSE (2005) limits for H_2S are applicable:

- 8 hour time weighted average occupational exposure limit: 5 ppmv (7 mg/m^3).

- Short-term exposure limit (15 minute reference period): 10 ppmv (14 mg/m^3).

Assessment of VOC data

The assessment of VOC concentrations is not covered by above-referenced reports. These data can be used to inform the human health risk assessment for site occupants but should not be relied upon to assess human health risk due to uncertainties in the ground gas flow regime, variability in the (generally low) contaminant concentrations measured and inaccuracies in the concentrations measured by PID instruments.

Data on the VOC concentration in ground gas can also help inform potential occupational exposure risks to construction and similar workers. For this purpose, the measured values can be compared to the relevant occupational exposure limit (OEL) for the contaminant(s) of concern, as given in HSE (2005). In cases of doubt as to the identity of the organic contaminants within the ground gas or when these are present as a complex mixture, then the 8 hour time-weighted average (TWA) exposure limit for benzene (1 ppmv) will be applied for screening purposes. This is a reasonably conservative approach since the OEL for benzene is lower than that for the great majority of organic contaminants commonly encountered in soil and groundwater at contaminated sites

APPENDIX G - HUMAN HEALTH ASSESSMENT CRITERIA

Context

Historically contaminated land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995 ("Part IIA"). Part IIA and its associated guidance. These specify that a "suitable for use" approach is to be applied in the assessment of potentially contaminated land, implemented through a phased programme of site investigation and risk assessment appropriate to the site under consideration. Under the planning regime, the potential for contamination must be considered during the planning process. Regulation and guidance within the planning framework defines an approach that is entirely consistent with that specified in Part IIA.

The assessment of potential risks posed by contaminant land is based upon the assessment of plausible contaminant source - pathway - receptor linkages ("pollutant linkages") for the current and/or proposed future use of the site, as applicable. The assessment must address all potential sources of pollutants that may be present on the site (the "hazards"), all receptors that may be harmed by these (e.g., human health, controlled waters, ecological receptors) and the pathways by which the contamination may be transported from the contaminant source(s) to the receptor(s). This is defined within the conceptual model for the site, which represents the characteristics of the site in a form that shows the possible pollutant linkages. For clarity, the conceptual model is often (but does not have to be) separated into the Conceptual Site Model (which described the physical structure of the site) and the Conceptual Exposure Model (which defines the potential pollutant linkages that may be operating as a result of the circumstances established within the Conceptual Site Model). The conceptual model also helps define necessary site investigation works and the nature of any more detailed risk assessments that may be necessary.

The definition of the appropriate conceptual model(s) depends upon the collection and interpretation of information. As further information becomes available (for example, through site investigation), so the conceptual model will be refined.

For a potentially contaminated site, the first stage of assessment is normally based upon a desk top study of available site information (Also known as "Phase 1" assessment). This enables the definition of the initial conceptual model, the elimination of non-viable pollutant linkages and the identification of potential viable pollutant linkages. The significance of these viable pollutant linkages can also be assessed at this stage through a Preliminary Qualitative Risk Assessment to evaluate those requiring further consideration and scope any intrusive site investigation that may be deemed necessary.

Following completion of the investigation, the findings are used to refine the conceptual model and confirm which pollutant linkages may be operating. The potential significance of these identified linkages can then be evaluated by a generic quantitative risk assessment which involves the comparison of measured site data (sub-divided into zones, if appropriate) with Generic Assessment Criteria (GAC) appropriate for the site conditions, land use and identified receptors.

If the measured contaminant concentrations exceed the screening values applicable to the identified potential pollutant linkages, then it may be appropriate to undertake further site investigation to improve definition and demarcation of the linkage and/or to undertake more sophisticated, site-specific Detailed Quantitative Risk Assessment (DQRA) to establish more reliably whether the linkage poses a risk.

Remedial action can be specified at any phase within this phased assessment process to break the identified pollutant linkage and render the site fit for purpose. In determining whether or not to undertake further assessment or to undertake remediation, the potential cost-savings arising from a more thorough assessment of the pollutant linkages and more tightly defined remedial strategy must be considered against the direct costs involved in the work and the time that this will take to execute and gain regulatory approval.

Some form of DQRA will be essential for those cases where appropriate GAC values cannot be established for the linkages under consideration.

Generic Assessment Criteria for Human Health Risk Assessment

GAC values for a range of common potential contaminants have been compiled for selected standard land uses: residential, allotment and commercial/light industrial. The derived GAC values cover a range of soil types, including pH values and soil organic matter content, where the derived values are sensitive to these.

The GAC values are summarised in Table 1, below.

Where available, UK published and peer reviewed GAC values have been used. These comprise:

- Soil Guideline Values derived by Defra and the Environment Agency;
- Additional GAC values developed by LQM Ltd (2009) on behalf of the Chartered Institute of Environmental Health (CIEH).

The latter GAC criteria do not have official status but are entirely consistent with the policy and guidance prevailing at the time of their issue (2009). They were derived by an expert group for the standard land uses defined in the SGV documents. Criteria for individual chemicals may be superseded if and when SGVs are issued by the Environment Agency and Defra or if guidance is issued that renders the parameters or methods used in their derivation obsolete. Until such time, these represent appropriate scientifically based UK GAC values for the defined land uses.

For those other contaminants for which SGVs have not been issued or GACs presented by LQM (2009) are not published, GAC values were derived by Tier Consult in accordance with current UK guidance using the CLEA v1.06 software:

Although there is no hierarchy of parameters used in the derivation of GACs using CLEA v1.06, where possible, sources from which the parameters were taken agreed with the following:

1. Produced by authoritative bodies in the UK.
2. Produced by committees of the European Commission or by international authoritative bodies, where these have specifically derived TDI values for food and water (for oral intake) or air quality standards (for inhalation).
3. Prepared by other national organisations.
4. Produced by authoritative organisations for other purposes.

Full justification for the derivation of all GAC values derived by Tier Consult can be provided upon request.

For the specific case of asbestos, the presence of fibres has been taken as the applicable GAC.

Table 1. Human Health Generic Assessment Criteria (GAC).

Parameter	Residential (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Source
	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	
Metals/metalloids										
Arsenic	20			20			500			SGV
Beryllium	51			55			420			LQM (2009)
Boron	291			45			192000			LQM (2009)
Cadmium	10			1.8			230			SGV
Chromium III	3000			34600			30400			LQM (2009)
Chromium VI	4.3			2.1			35			LQM (2009)
Copper	2330			524			71700			LQM (2009)
Lead	450			450			750			Tier Consult*
Mercury	8			15			480			SGV
Nickel	50			75			5000			SGV
Selenium	35			260			8000			SGV
Vanadium	75			18			3160			LQM (2009)

Parameter	Residential (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Source
	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	
Zinc	3750			618			665000			LQM (2009)
Other										
pH	<5			<5			<5			
Phenol	420			280			3200			SGV
Total Sulphate	2,400			2,400			2,400			BRE (2005)
Water Soluble Sulphate	0.5 g/l			0.5 g/l			0.5 g/l			BRE (2005)
PAHs										
Acenaphthene	210	480	1000	34	85	200	85000	98000	100000	LQM (2009)
Acenaphthylene	170	400	850	28	69	160	84000	97000	100000	LQM (2009)
Anthracene	2300	4900	9200	380	950	2200	530000	540000	540000	LQM (2009)
Benz(a)anthracene	3.1	4.7	5.9	2.5	5.5	10	90	95	97	LQM (2009)
Benzo(a)pyrene	0.83	094	1	0.6	1.2	2.1	14	14	14	LQM (2009)
Benzo(b)fluoranthene	5.6	6.5	7	3.5	7.4	13	100	100	100	LQM (2009)

Parameter	Residential (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Source
	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	
Benzo(g,h,i)perylene	44	46	47	70	120	160	650	660	660	LQM (2009)
Benzo(k)fluoranthene	8.5	9.6	10	6.8	14	23	140	140	140	LQM (2009)
Chrysene	6	8.0	9.3	2.6	5.8	12	140	140	140	LQM (2009)
Dibenz(a,h)anthracene	0.76	0.86	0.9	0.76	1.5	2.3	13	13	13	LQM (2009)
Fluoranthene	260	460	670	130	130	290	23000	23000	23000	LQM (2009)
Fluorene	160	380	780	160	67	160	64000	69000	71000	LQM (2009)
Indeno(1,2,3-cd)pyrene	3.2	3.9	4.2	7.1	3.8	7.1	60	61	62	LQM (2009)
Naphthalene	1.5	3.7	8.7	4.1	9.9	23	200	480	1100	LQM (2009)
Phenanthrene	92	200	380	16	38	90	22000	22000	23000	LQM (2009)
Pyrene	560	1000	1600	110	270	620	54000	54000	54000	LQM (2009)
BTEX										
Benzene	0.024	0.056	0.11	0.038	0.087	0.168	1.66	3.80	7.34	SGV

Parameter	Residential (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Source
	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	
Toluene	3	7	14	3	8	15	150	350	680	SGV
Ethylbenzene	9	21	41	16	41	80	48000			SGV
Xylene[6]	6.28	15.4	30.4	7.85	19.1	37.8	341	828	1640	SGV
TPH										
Aliphatic EC 5-6	30	55	110	740	1700	3900	3400	62000	13000	LQM (2009)
Aliphatic EC >6-8	73	160	370	2300	5600	13000	8300	18000	42000	LQM (2009)
Aliphatic EC >8-10	19	46	110	320	770	1700	2100	5100	12000	LQM (2009)
Aliphatic EC >10-12	93	230	540	2200	4400	7300	10000	24000	49000	LQM (2009)
Aliphatic EC >12-16	740	1700	3000	11000	13000	13000	61000	83000	91000	LQM (2009)
Aliphatic EC >16-35	45000	64000	76000	260000	270000	270000	1600000	1800000	1800000	LQM (2009)
Aliphatic EC >35-44	45000	64000	76000	260000	270000	270000	1600000	1800000	1800000	LQM (2009)
Aromatic EC 5-7	65	130	280	13	27	57	28000	49000	90000	LQM (2009)
Aromatic EC >7-8	120	270	611	22	51	120	59000	110000	190000	LQM (2009)

Parameter	Residential (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Source
	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	1% SOM	2.5% SOM	6% SOM	
Aromatic EC >8-10	27	65	151	8.6	21	51	3700	8600	18000	LQM (2009)
Aromatic EC >10-12	69	160	346	13	31	74	17000	29000	34500	LQM (2009)
Aromatic EC >12-16	140	310	593	23	57	130	36000	37000	37800	LQM (2009)
Aromatic EC >16-21	250	480	770	46	110	260	28000	28000	28000	LQM (2009)
Aromatic EC >21-35	890	1100	1230	370	820	1600	28000	28000	28000	LQM (2009)
Aromatic EC >35-44	890	1100	1230	370	820	1600	28000	28000	28000	LQM (2009)
Aromatic EC >44-75	1200	1300	1300	1200	2100	3000	28000	28000	28000	LQM (2009)

*Tier Consult in-house calculation using CLEA v1.06
SGV refers to the relevant Soil Guideline Values published by Defra and Environment Agency (2009).
GAC published by LQM Ltd (2009), developed in association with the CIEH.

APPENDIX H - GENERIC ASSESSMENT CRITERIA FOR LEACHATE AND CONTROLLED WATERS

Introduction

The appropriate GAC for controlled waters receptors values presented within the main report has been determined from the conceptual model for the site (specifically, the receptor(s) that may be impacted) and the type of data being evaluated (water samples or leachate).

Different standards apply for salt water and fresh water and, in some cases, there may be different screening values applied where the receiving water may be a drinking water source. Some parameters vary by the hardness of the receiving water, which should be measured if possible. Consequently, there may be multiple assessment criteria applied for an individual site

Interpretation of leachate data

Where leachate data are available, they are compared directly to the appropriate GAC value. The conceptual model will indicate whether leachable contaminants may pose a risk to:

(i) an aquifer;

(ii) a surface water body (e.g., river, stream, pond, lake, estuary, coastal water);

(iii) both an aquifer and a surface water body.

If (i), then the Fresh Water GAC values apply.

The appropriate end-use GAC to be applied for the receiving water body should then be determined for the site: it may be drinking water, environmental quality or both. In some cases, there are different GAC criteria for the different uses and the appropriate one selected. In cases of doubt, the most conservative *relevant* GAC values are applied.

Where the GAC values are sensitive to water hardness, then they may be adjusted for the measured hardness in the receiving water in accordance with prevailing Environment Agency and other regulatory guidance. In the absence of hardness data for the receiving water, then the lowest GAC must be applied.

If (ii), then either or both the Fresh Water and the Salt Water GAC values will apply, depending upon the receptor(s).

For Salt Water bodies (sea water, estuaries) specific GAC values are provided. For Fresh Water bodies, the approach outlined above under (i) applies.

If (iii), then the above procedures are applied for each receptor type.

Interpretation of groundwater and surface water data

Data are compared directly to the appropriate GAC value. The conceptual model will determine which GAC values apply. There may be multiple pollutant linkages to consider and more than one set of values may be used for the different potential pollutant linkages identified at a site.

The approach outlined above for leachate data is then applied.

Special considerations

Fresh water fisheries

The appropriate regulator should be consulted to determine whether a receiving fresh water body is classified as Cyprinid or Salmonid, since different hardness-sensitive GAC value apply to each. If unknown, then the lowest GAC are applied as a conservative measure.

Ammonia and ammonium

The total concentration of ammonia in soil and water is made up of both un-ionised ammonia (NH_3; sometimes called free ammonia) and ionised ammonia (ammonium ions; NH^{4+}):

[Total ammonia] = [Un-ionised ammonia (NH_3)] + [Ionised ammonia (NH_4^+)]

The proportion of ionisation is a function of pH and temperature.

Most analytical laboratories report total ammonia and express this as "ammoniacal nitrogen" (shortened to either NH_3-N or NH_4-N). Ammoniacal nitrogen is simply a way of standardising the measured concentration independent of the proportion ionised. However, some laboratories may express their results in a different way ("total ammoniacal nitrogen as NH_4^+" is the most common alternative). The form in which ammonia/ammonium data are presented in this report is clearly identified in the analytical data sheets and within summary data tables.

GAC values differ in how the ammonia/ammonium concentration is expressed. Those based on drinking water standards are expressed on the basis of the total concentration of NH_4^+. The method by which different types of laboratory data are compared to these GAC values is presented in Table 1.

Table 1. Comparison of laboratory ammonia/ammonium data to GAC values based on drinking water standards.

Lab result units	How to compare the result to the GAC
Total nitrogen as NH_4^+	Compare directly.
Ammoniacal nitrogen (NH_3-N or NH_4-N)	Convert from the reported concentration (*X*) to NH_4^+ by[1]: $[NH_4^+] = (X/14)18$ And then compare the calculated NH_4^+ concentration to the standard.

GAC values based on Environmental Quality Standards are expressed as the concentration of un-ionised ammonia (as N; i.e. NH_3-N), as this is the form that has the toxic effect on the biota. The method by which different types of laboratory data are compared to these GAC values is presented in Table 2.

Table 2. Comparison of laboratory ammonia/ammonium data to GAC values based on environmental quality standards.

Lab result units	How to compare the result to the GAC
Total nitrogen as NH_4^+	1. Convert the reported concentration (*Y*) to NH_4-N by[1]: $[NH_4\text{-}N] = (Y/18)14$ 2. Now calculate the proportion of un-ionised ammonia[2]:

	Un-ionised ammonia (as N) = $[NH_4\text{-}N] / (1.0+10.0^{(10.055-(0.0324T)-pH)})$ Where T is the temperature (Celsius)[3] and pH is the measured pH of the receiving water. 3. Compare the calculated concentration of un-ionized ammonia (as N) to the GAC.
Ammoniacal nitrogen (NH_3-N or NH_4-N)	1. Calculate the proportion of un-ionised ammonia using the reported NH_4-N value[2]: Un-ionised ammonia (as N) = $[NH_4\text{-}N] / (1.0+10.0^{(10.055-(0.0324T)-pH)})$ Where T is the temperature (Celsius)[3] and pH is the measured pH of the receiving water. 2. Compare the calculated concentration of un-ionised ammonia (as N) to the GAC.

1 The molecular mass of nitrogen is 14 and that of NH4+ is 18.

2 This calculation is a good basis for the approximating screening of un-ionised ammonia (http://www.environment-agency.gov.uk/commondata/103599/river_e1.doc). Precise concentrations of un-ionized ammonia will be affected by salinity and the exact temperature.

3 Temperature of surface waters will be seasonally variable. For screening purposes, a temperature of 10oC is a reasonable assumption of the "average" temperature, except in rare cases.

APPENDIX I - ENGINEER'S FIELD TESTING

Samples for field testing were selected by a representative of Tier Consult during the site investigation works in accordance with the sampling specification presented elsewhere in this report.

Field testing for geotechnical parameters

In situ Standard Penetration Tests (SPTs) were also carried out throughout the full depth of the cable percussive boreholes using either a split spoon sampler or a 60° solid cone. These tests assess the relative density of granular soils encountered and indicate the undrained shear strength of cohesive soils or the strength of rock. The results of these tests are shown as 'N' values and can be found adjacent to the appropriate sample level on the exploratory hole records in Appendix N.

Hand shear vane testing was also undertaken, where possible, to establish the undrained shear strength of cohesive soils within trial pits Testing was performed, when safe to do so, at shallow depth (<1.0 m) within the trial pit or upon intact samples collected within the digger bucket. Where possible a set of at least 3 No. tests was performed at each depth.

In order for stratum descriptions to comply with BS EN ISO 14688 and 14689, the Engineer performs the following assessment of soil properties in the field.

- Determination of consistency (BS EN ISO 14688 Part 1 Section 5.14);
- Assessment of dry strength (BS EN ISO 14688 Part 1 Section 5.6);
- Shear strength (BS EN ISO 14688 Part 2 Section 5.3);
- Plasticity (BS EN ISO 14688 Part 1 Section 5.8);
- Assessment of particle shape (BS EN ISO 14688 Part 1 Section 5.2).

APPENDIX J - CHEMICAL AND GEOTECHNICAL TEST SAMPLING

Samples were selected by a representative of Tier Consult during the site investigation works in accordance with the sampling approach described elsewhere in this report.

Samples for geotechnical and related testing

Bulk samples were placed within robust heavy duty plastic bags and sealed, together with small disturbed samples, within airtight 1 litre plastic containers.

100 mm diameter 'undisturbed' samples ("U100 samples") were obtained where possible from cable percussive and large diameter window sample boreholes within cohesive materials.

Samples for chemical analysis

All samples for chemical analysis were placed into clean new containers as summarised in Table 1. Unless explicitly stated elsewhere in this report, no preservatives were used to eliminate the risk that preservatives cause contaminant dissolution or analytical interference. Containers for VOC analysis were fully filled to exclude headspace.

Soil samples were dispensed as soon as possible after collection using reusable stainless steel spatulas, trowels or similar implements.

Ground water samples were collected from boreholes using single-use Teflon bailers or dedicated Waterra tubing with foot valves, except as otherwise noted within this report. Caution was taken to avoid excessive agitation during collection

New disposable gloves were used by the engineer for the collection of each sample.

Reusable equipment was washed down with distilled or deionised water between samples, except where tarry or similarly sticky materials were present. In such cases specific cleaning procedures were adopted as specifically described elsewhere in this report.

All sub-samples taken for chemical analysis were placed into refrigerators or cool boxes containing frozen ice packs immediately after aliquoting. All samples were transferred in cool boxes containing frozen ice packs to the relevant UKAS/MCERTS accredited laboratory as soon as possible. Recommended maximum holding times before analysis are summarised in Table 1.

Table 1. Sample containers and holding times.

Analysis	Container/special requirements	Max. holding time at 4°C before analysis
Soil and sediment samples		
VOCs	30-60 g brown or green glass jar with VOC-resistant cap and inert cap liner. *Must be fully filled.*	14 days
TPHCWG	30-60 g brown or green glass jar with VOC-resistant cap and inert cap liner **PLUS** 250-500 g brown or green glass jar with unwaxed cap liner.[1] *The former must be fully filled.*	14 days
All other organics	250-500 g brown or green glass jar with unwaxed cap liner.	7 days
Inorganics	Air-tight 0.5-2.0 kg plastic container (250-500 g brown or green glass jar may also be used).	14 days[2]
Water samples		
VOCs	40-50 ml glass vial with VOC resistant screw cap and inert liner. *Must be fully filled.*	14 days
TPHCWG	40-50 ml glass vial with VOC resistant screw cap and inert liner **PLUS** 500-1000 ml brown or green glass bottle with screw cap and unwaxed liner.[1] *The former must be fully filled, the latter should be filled if possible.*	14 days
All other organics	500-1000 ml brown or green glass bottle with screw cap. *Fill if possible.*	7 days

Inorganics	500-1000 ml translucent or opaque screw cap plastic *or* brown or green glass bottles. *Fill if possible.*	14 days[3]

[1] The smaller vessel is used for analysis of the volatile components within the TPH mixture and the larger one is for the non-volatile components.

[2] 14 days is set as a reasonable limit for all routine analyses of soil for those inorganic components vulnerable to chemical and/or biological breakdown. Samples for sulphate analysis are vulnerable to biological sulphate-reduction but can be held for up to 28 days. For total metals, a holding period of up to 6 months is acceptable.

[3] 14 days applies for all routine analyses of most inorganic components that may be vulnerable to chemical and/or biological reactions. In the specific cases of sulphide, nitrite, nitrate and phosphate analyses, storage time must not exceed 48 hours. For total metals, a holding time of up to 6 months is acceptable.

Tier Consult standard analytical suites

The analyses included with Tier Consult' standard analytical suites for soil, soil leachate and water samples are presented in Table 2. Other individual analyses were specified as described within this report.

Table 2. Tier Consult Standard Analytical Suites.

Parameter	**Sample type**					
	Soil		**Leachate**[1]		**Water**	
		LoD[2] **(mg/kg or as stated)**		**LoD (µg/l or as stated)**		**LoD (µg/l or as stated)**
Metals and metalloids						
Arsenic	✓	1	✓	10	✓	10
Cadmium	✓	1	✓	5	✓	5
Chromium	✓	1	✓	5	✓	5
Mercury	✓	1	✓	1	✓	1
Lead	✓	1	✓	4	✓	4
Selenium	✓	2	✓	10	✓	10
Copper	✓	1	✓	1	✓	1

Nickel	✓	1	✓	50	✓	50
Zinc	✓	1	✓	8	✓	8
Other inorganics						
Ammonia (as NH_4-N)					✓	15
Total sulphate	✓	100			✓	50 mg/l
Water-soluble sulphate	✓	0.1 g/l				
Hardness (as $CaCO_3$)					✓	1 mg/l
Organics						
Monohydric phenol	✓	1	✓	0.5	✓	0.5
Speciated PAHs (USEPA 16)	✓	0.1	✓	0.01	✓	0.01
Total Organic Carbon	✓	0.1 wt%				
Others						
Electrical conductivity					✓	NA
Ph	✓	NA	✓	NA	✓	NA

NA - Not applicable

1 Leachate preparation according to NRA (1994), 10:1 liquid to solid ratio.

2 The table presents the desired limit of detection for the analysis. Higher LoDs may be reported on analytical data sheets due to interference between analytes within specific samples or if the laboratory needed to dilute samples to achieve results within the calibrated range for that instrument.

APPENDIX K - RESULTS OF LABORATORY CHEMICAL ANALYSES

Derwentside Environmental Testing Services

Interim Report of Analysis

2139

Date: 02/02/2011

Certificate Number: 11-46078

Client:	Tier Consult Elm Farm House Saighton Chester CH3 6EN
Our Reference:	11-46078
Client Reference:	T/10/917
Contract Title:	Egerton Road
Description:	3 water samples
Date Received:	31/01/2011
Date Started:	31/01/2011
Date Completed:	/ /
Test Procedures:	Identified by prefix DETSn, details available upon request.
Notes:	Observations and interpretations are outside the scope of UKAS accreditation * denotes test not included in laboratory scope of accreditation # denotes test that holds MCERT 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 DETSM denotes tests carried out by DETS Midlands laboratory Solid samples will be disposed 1 month and liquids 2 weeks after the date of issue of this test certificate Asbestos subsamples will be kept for 6 months

Results contained in an interim test report are subject to change and should not be used for decision making purposes. Interim reports are issued on a guidance only basis, the use of which shall be at the customers own risk

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

Summary of Chemical Analysis
Water Samples

Our Ref: 11-46078
Client Ref: T/10/917
Contract Title: Egerton Road

		Lab No.	308037	308038	308039
		Sample ID	WS1	WS6	WS7
		Depth			
		Sample Ref			
		Sample Type			
Test	**Units**	**DETSxx**			
Cadmium Dissolved	ug/l	DETS 042	< 2	< 2	< 2
Chromium Dissolved	ug/l	DETS 042	< 5	< 5	< 5
Copper Dissolved	ug/l	DETS 042	< 2	< 2	< 2
Lead Dissolved	ug/l	DETS 042	< 4	< 4	< 4
Nickel Dissolved	ug/l	DETS 042	< 10	< 10	< 10
Selenium Dissolved	ug/l	DETS 017	< 3	< 3	< 3
Zinc Dissolved	ug/l	DETS 042	< 1	< 1	2
Sulphate as SO4	mg/l	DETS 055	25	78	33
Hardness	mg/l	DETS 043*	289	382	294
Ammoniacal Nitrogen as N	mg/l	DETSC2207	2.3	6	1.9
pH		DETS 008	6.3	6.5	6.4
Acenaphthene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01
Acenaphthylene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01
Anthracene	ug/l	DETS 074*	< 0.01	0.01	< 0.01
Benzo(a)anthracene	ug/l	DETS 074*	< 0.01	0.02	0.03
Benzo(a)pyrene	ug/l	DETS 074*	< 0.01	0.02	0.03
Benzo(b)fluoranthene	ug/l	DETS 074*	< 0.01	0.04	0.05
Benzo(k)fluoranthene	ug/l	DETS 074*	< 0.01	0.01	0.01
Benzo(g,h,i)perylene	ug/l	DETS 074*	< 0.01	0.03	0.03
Chrysene	ug/l	DETS 074*	< 0.01	0.04	0.02
Dibenzo(a,h)anthracene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01
Fluoranthene	ug/l	DETS 074*	0.02	0.06	0.06
Fluorene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-c,d)pyrene	ug/l	DETS 074*	< 0.01	0.02	0.03
Naphthalene	ug/l	DETS 074*	< 0.01	< 0.01	< 0.01
Phenanthrene	ug/l	DETS 074*	0.02	0.03	0.03
Pyrene	ug/l	DETS 074*	0.11	0.29	0.29
PAH	ug/l	DETS 074*	< 0.20	0.57	0.57
DRO (C10-C24)	ug/l	DETS 051	55	230	290
Mineral Oils	ug/l	DETS 051	140	420	500
Phenol	ug/l	DETS 079*	< 0.50	< 0.50	< 0.50

ALcontrol Geochem Analytical Services
Sample Descriptions

Job Number: 06/21409/02/01
Client: Structural Soils Ltd
Client Ref : 67142

Grain sizes

<0.063mm	Very Fine
0.1mm - 0.063mm	Fine
0.1mm - 2mm	Medium
2mm - 10mm	Coarse
>10mm	Very Coarse

Sample Identity	Depth (m)	Colour	Grain Size	Description	Batch
BH01 7D	2.10-2.60	Brown	<0.063mm	Clay with some Stones	1
BH02 3B	1.20-1.70	Dark Brown	0.1mm - 0.063mm	Silty Clay with some Stones	1
BH02 7D	4.30-4.80	Brown	<0.063mm	Clay	1

* These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials-whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.
Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
[1] Sample Description supplied by client

Validated ☑
Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 06/21409/02/01 **Matrix:** SOLID
Client: Structural Soils Ltd **Location:** FALLOWFIELD
Client Ref. No.: 67142 **Client Contact:** Mark Athorne

Sample Identity	BH01 7D	BH02 3B	BH02 7D							Method Code	LoD/Units
Depth (m)	2.10-2.60	1.20-1.70	4.30-4.80								
Sample Type	SOLID	SOLID	SOLID								
Sampled Date											
Sample Received Date	01.12.06	01.12.06	01.12.06								
Batch	1	1	1								
Sample Number(s)	1	2	3								
Cadmium Low	-	0.6	-							TM129#	<0.2 mg/kg
Arsenic	-	26	-							TM129#M	<3.0 mg/kg
Chromium	-	91.9	-							TM129#M	<4.5 mg/kg
Copper	-	78	-							TM129#M	<6 mg/kg
Lead	-	774	-							TM129#M	<2 mg/kg
Mercury	-	1.2	-							TM129#M	<0.6 mg/kg
Nickel	-	23.6	-							TM129#M	<0.9 mg/kg
Selenium	-	<3	-							TM129#M	<3 mg/kg
Zinc	-	148.5	-							TM129#M	<2.5 mg/kg
Water Soluble Sulphate as SO4 2:1 Extract	0.060	-	0.014							TM098#M	<0.003 g/l
pH Value	7.04	7.54	7.78							TM133#M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	-	0.062	-							TM098#	<0.003 g/l
Total Organic Matter	-	15.56	-							TM050#	<0.01 %
TPH C6-40	-	503	-							TM154#	<10 mg/kg
PAH by GC-FID											
Naphthalene	-	0.60	-							TM142	<0.05 mg/kg
Acenaphthylene	-	0.19	-							TM142	<0.05 mg/kg
Acenaphthene	-	0.32	-							TM142	<0.05 mg/kg
Fluorene	-	0.25	-							TM142	<0.05 mg/kg
Phenanthrene	-	3.55	-							TM142	<0.05 mg/kg
Anthracene	-	0.67	-							TM142	<0.05 mg/kg
Fluoranthene	-	4.17	-							TM142	<0.05 mg/kg
Pyrene	-	3.99	-							TM142	<0.05 mg/kg
Benz(a)anthracene	-	2.26	-							TM142	<0.05 mg/kg
Chrysene	-	2.45	-							TM142	<0.05 mg/kg
Benzo(b)fluoranthene	-	2.04	-							TM142	<0.05 mg/kg
Benzo(k)fluoranthene	-	0.72	-							TM142	<0.05 mg/kg
Benzo(a)pyrene	-	2.10	-							TM142	<0.05 mg/kg
Indeno(123cd)pyrene	-	1.59	-							TM142	<0.05 mg/kg
Dibenzo(ah)anthracene	-	0.39	-							TM142	<0.05 mg/kg

All results expressed on a dry weight basis.

Date 08.12.2006

Validated ☑
Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 06/21409/02/01 **Matrix:** SOLID
Client: Structural Soils Ltd **Location:** FALLOWFIELD
Client Ref. No.: 67142 **Client Contact:** Mark Athorne

Sample Identity	BH01 7D	BH02 3B	BH02 7D							Method Code	LoD/Units
Depth (m)	2.10-2.60	1.20-1.70	4.30-4.80								
Sample Type	SOLID	SOLID	SOLID								
Sampled Date											
Sample Received Date	01.12.06	01.12.06	01.12.06								
Batch	1	1	1								
Sample Number(s)	1	2	3								
PAH by GC-FID (cont)											
Benzo(ghi)perylene	-	1.51	-							TM142	<0.05 mg/kg
PAH 16 Total	-	26.80	-							TM142	<0.05 mg/kg

All results expressed on a dry weight basis.

Date 08.12.2006

ALcontrol Geochem Analytical Services
Table Of Results - Appendix

Job Number: 06/21409/02/01
Client: Structural Soils Ltd
Client Ref. No.: 67142

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP	No Determination Possible	*	Subcontracted test
NFD	No Fibres Detected	»	Result previously reported (Incremental reports only)
#	ISO 17025 accredited	M	MCERTS Accredited
PFD	Possible Fibres Detected	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample [1]	Surrogate Corrected
TM050	Method 5310B, AWWA/APHA, 20th Ed., 1999 / DIN EN 13137	Total Organic Carbon determination by combustion method	✓		DRY	
TM098	Method 4500E, AWWA/APHA, 20th Ed., 1999	Determination of Sulphate using the Kone Analyser	✓		DRY	
TM098	Method 4500E, AWWA/APHA, 20th Ed., 1999	Determination of Sulphate using the Kone Analyser	✓	✓	DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓		DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓	DRY	
TM133	BS 1377: Part 3 1990	Determination of pH in Soil and Water using the GLpH pH Meter	✓	✓	WET	
TM142	In house method	Analysis of Polynuclear Aromatic Hydrocarbons (PAH) by GC-FID			DRY	
TM154	In - house Method	Determination of Petroleum Hydrocarbons by EZ Flash GC-FID in the Carbon range C6- C40	✓		WET	

[1] Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Geochem Analytical Services
Table Of Results - Appendix

Job Number: 06/21409/02/01
Client: Structural Soils Ltd
Client Ref. No.: 67142

Summary of Coolbox temperatures

Batch No.	Coolbox Temperature (°C)
1	6.6

ALcontrol Geochem Analytical Services
Sample Descriptions

Job Number: 06/20806/02/01
Client: Betts Associates
Client Ref : 0611002

Grain sizes

<0.063mm	Very Fine
0.1mm - 0.063mm	Fine
0.1mm - 2mm	Medium
2mm - 10mm	Coarse
>10mm	Very Coarse

Sample Identity	Depth (m)	Colour	Grain Size	Description	Batch
TP1	0.7	Dark Brown	0.1mm - 0.063mm	Sandy Clay with some Stones	1
TP2	1.0	Dark Brown	0.1mm - 0.063mm	Silty Clay with some Stones	1
TP3	0.3	Brown	0.1mm - 0.063mm	Silty Clay with some Stones	1
TP3	1.5	Brown	0.1mm - 0.063mm	Silty Clay with some Stones	1
TP4	0.6	Brown	0.1mm - 0.063mm	Sandy Clay with some Stones	1
TP5	0.5	Brown	0.1mm - 0.063mm	Sandy Clay with some Stones	1

* These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials-whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.
Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
[1] Sample Description supplied by client

Validated ☑
Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 06/20806/02/01 **Matrix:** SOLID
Client: Betts Associates **Location:** EGERTON ROAD
Client Ref. No.: 0611002 **Client Contact:** Marc Fawcett

Sample Identity	TP1	TP2	TP3	TP3	TP4	TP5				Method Code	LoD/Units
Depth (m)	0.7	1.0	0.3	1.5	0.6	0.5					
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID					
Sampled Date	21.11.06	21.11.06	21.11.06	21.11.06	21.11.06	21.11.06					
Sample Received Date	22.11.06	22.11.06	22.11.06	22.11.06	22.11.06	22.11.06					
Batch	1	1	1	1	1	1					
Sample Number(s)	2	3	4	5	6	7					
Cadmium Low	0.8	1.2	0.4	<0.2	0.8	0.4				TM129#	<0.2 mg/kg
Arsenic	14	20	16	4	13	13				TM129#M	<3.0 mg/kg
Chromium	12.6	147.2	24.3	25.0	21.9	23.8				TM129#M	<4.5 mg/kg
Copper	10200	141	36	23	267	75				TM129#M	<6 mg/kg
Lead	294	233	98	12	186	6442				TM129#M	<2 mg/kg
Mercury	1.1	<0.6	<0.6	<0.6	<0.6	1.1				TM129#M	<0.6 mg/kg
Nickel	16.0	16.4	12.5	15.1	13.1	16.2				TM129#M	<0.9 mg/kg
Selenium	<3	<3	<3	<3	<3	<3				TM129#M	<3 mg/kg
Zinc	740.2	371.7	72.9	43.5	406.8	122.2				TM129#M	<2.5 mg/kg
pH Value	8.01	7.64	7.35	5.89	7.81	8.17				TM133#M	<1.00 pH Units
Soluble Sulphate 2:1 Extract as SO4 BRE	0.030	0.027	0.003	0.025	0.088	0.096				TM098#	<0.003 g/l
Total Organic Matter	4.69	10.64	5.67	0.97	3.34	6.84				TM050#	<0.01 %
TPH C6-40	1497	866	518	<10	242	1119				TM154#	<10 mg/kg
PAH by GC-FID											
Naphthalene	5.99	7.59	9.46	8.20	2.87	6.00				TM142	<0.05 mg/kg
Acenaphthylene	0.21	3.40	0.74	<0.05	0.19	1.31				TM142	<0.05 mg/kg
Acenaphthene	0.30	6.76	0.82	<0.05	0.43	2.03				TM142	<0.05 mg/kg
Fluorene	0.21	4.36	0.67	<0.05	0.35	2.28				TM142	<0.05 mg/kg
Phenanthrene	2.66	37.00	5.74	<0.05	3.96	25.84				TM142	<0.05 mg/kg
Anthracene	0.86	9.09	1.37	<0.05	1.02	6.79				TM142	<0.05 mg/kg
Fluoranthene	3.94	42.20	9.14	<0.05	7.50	31.07				TM142	<0.05 mg/kg
Pyrene	3.76	35.88	8.97	<0.05	7.33	29.27				TM142	<0.05 mg/kg
Benz(a)anthracene	2.32	17.26	4.64	<0.05	3.39	13.60				TM142	<0.05 mg/kg
Chrysene	2.47	18.08	5.26	<0.05	4.07	14.48				TM142	<0.05 mg/kg
Benzo(b)fluoranthene	2.13	14.20	5.59	<0.05	3.05	12.37				TM142	<0.05 mg/kg
Benzo(k)fluoranthene	0.72	4.82	1.89	<0.05	1.08	4.23				TM142	<0.05 mg/kg
Benzo(a)pyrene	2.19	14.67	5.77	<0.05	3.15	12.80				TM142	<0.05 mg/kg
Indeno(123cd)pyrene	1.81	9.45	2.89	<0.05	2.21	7.59				TM142	<0.05 mg/kg
Dibenzo(ah)anthracene	0.45	2.32	0.70	<0.05	0.56	1.94				TM142	<0.05 mg/kg
Benzo(ghi)perylene	1.76	9.12	2.75	<0.05	2.13	7.38				TM142	<0.05 mg/kg

All results expressed on a dry weight basis.

Date 08.12.2006

Validated ☑
Preliminary ☐

ALcontrol Geochem Analytical Services
Table Of Results

ISO 17025 accredited
M MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 06/20806/02/01 **Matrix:** SOLID
Client: Betts Associates **Location:** EGERTON ROAD
Client Ref. No.: 0611002 **Client Contact:** Marc Fawcett

Sample Identity	TP1	TP2	TP3	TP3	TP4	TP5				Method Code	LoD/Units
Depth (m)	0.7	1.0	0.3	1.5	0.6	0.5					
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID					
Sampled Date	21.11.06	21.11.06	21.11.06	21.11.06	21.11.06	21.11.06					
Sample Received Date	22.11.06	22.11.06	22.11.06	22.11.06	22.11.06	22.11.06					
Batch	1	1	1	1	1	1					
Sample Number(s)	2	3	4	5	6	7					
PAH by GC-FID (cont)											
PAH 16 Total	31.78	236.20	66.40	8.20	43.29	178.98				TM142	<0.05 mg/kg

All results expressed on a dry weight basis.

Date 08.12.2006

ALcontrol Geochem Analytical Services
Table Of Results - Appendix

Job Number: 06/20806/02/01
Client: Betts Associates
Client Ref. No.: 611002

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP	No Determination Possible	*	Subcontracted test
NFD	No Fibres Detected	»	Result previously reported (Incremental reports only)
#	ISO 17025 accredited	M	MCERTS Accredited
PFD	Possible Fibres Detected	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample [1]	Surrogate Corrected
TM050	Method 5310B, AWWA/APHA, 20th Ed., 1999 / DIN EN 13137	Total Organic Carbon determination by combustion method	✓		DRY	
TM098	Method 4500E, AWWA/APHA, 20th Ed., 1999	Determination of Sulphate using the Kone Analyser	✓		DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓		DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓	DRY	
TM133	BS 1377: Part 3 1990	Determination of pH in Soil and Water using the GLpH pH Meter	✓	✓	WET	
TM142	In house method	Analysis of Polynuclear Aromatic Hydrocarbons (PAH) by GC-FID			DRY	
TM154	In - house Method	Determination of Petroleum Hydrocarbons by EZ Flash GC-FID in the Carbon range C6- C40	✓		WET	

[1] Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Geochem Analytical Services
Table Of Results - Appendix

Job Number: 06/20806/02/01
Client: Betts Associates
Client Ref. No.: 611002

Summary of Coolbox temperatures

Batch No.	Coolbox Temperature (°C)
1	12

APPENDIX L - EXPLORATORY HOLE LOGS

Tier Consult

Tier Consult Ltd
Tel: 01244 333 080
www.tierconsult.co.uk

Borehole No
WS1
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 99.67 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.50	ES					MADE GROUND: Dark brown black very clayey slightly gravelly sand. Gravel is subangular to rounded fine to coarse of sandstone brick and limestone. Rare clinker fragments. (MADE GROUND)
		1.20	SPT	N=4 (2,2/ 0,2,1,1)	1.30	98.37		
		1.50	ES					MADE GROUND: Very low strength soft consistency brown very sandy slightly gravelly clay. Gravel is subangular to rounded fine to coarse of mudstone and sandstone. Possible reworked ground. (MADE GROUND)
		2.00	SPT	N=0 (0,0/ -,-,-,-)				
	▽	2.50	D		2.40	97.27		Very low strength soft consistency light brown very sandy CLAY. (GLACIAL TILL)
		3.00	SPT	N=5 (0,0/ 0,0,2,3)				
		3.50	D		3.30	96.37		High strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is rounded fine to coarse of sandstone limestone and mudstone. (GLACIAL TILL)
		4.00	SPT	N=34 (6,7/ 7,7,10,10)				
					4.45	95.22		End of Borehole at 4.45 m
			Type	Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Groundwater strike at 2.50m bgl.
3) Terminated in competent strata.

AGS

HoleBASE 3.1 (Bld 418.6) Standard Borehole Log v2 dated 27th Nov 03

Tier Consult

Tier Consult Ltd
Tel: 01244 333 080
www.tierconsult.co.uk

Borehole No
WS2
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 99.30 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.30	D					MADE GROUND: Dense light grey slightly clayey slightly sandy angular fine to coarse gravel of limestone. (MADE GROUND)
		1.20 1.30	SPT D	N=12 (3,2/ 2,3,4,3)	1.10	98.20		High strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone mudstone and limestone. (GLACIAL TILL)
		2.00	SPT	N=28 (4,4/ 5,6,8,9)				
					2.45	96.85		End of Borehole at 2.45 m
		Type		Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Borhole dry.
3) Borehole stable.
4) Terminated in competent strata.

AGS

HoleBASE 3.1 (Bld 418.4)/Standard Borehole Log v2.dsid 27th Nov 03

Tier Consult

Tier Consult Ltd
Tel: 01244 333 080
www.tierconsult.co.uk

Borehole No
WS3
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 99.99 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.20	D		0.40	99.59		MADE GROUND: Dark grey slightly clayey slightly sandy angular fine to coarse gravel of limestone. (MADE GROUND)
		0.80	D					Medium strength firm consistency grey mottled brown sandy CLAY. (GLACIAL TILL)
		1.20	SPT	N=10 (1,2/ 2,3,2,3)	1.00	98.99		High strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone mudstone and limestone. (GLACIAL TILL)
		1.80	D					
		2.00	SPT	N=23 (2,3/ 4,6,6,7)				
					2.45	97.54		End of Borehole at 2.45 m

Type	Results

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Borehole stable.
3) Borehole dry.
4) Terminated in competent strata.

AGS

HoleBASE 3.1 (Bld 418.4) Standard Borehole Log v2 dated 27th Nov 03

Tier Consult

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Borehole No
WS4
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 100.14 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.20	D		0.40	99.74		MADE GROUND: Dark grey slightly clayey slightly sandy angular fine to coarse gravel of limestone. (MADE GROUND)
		0.80	D		0.80	99.34		Firm consistency grey mottled brown sandy CLAY. (GLACIAL TILL)
		1.20	SPT	N=10 (1,2/ 2,3,2,3)				High strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone mudstone limestone and coal. (GLACIAL TILL)
		1.80	D					
		2.00	SPT	N=23 (2,3/ 4,6,6,7)				
					2.45	97.69		End of Borehole at 2.45 m

Type	Results

Remarks:
1) Hand dug pit to 1.20m bgl.
2) Borehole stable.
3) Borehole dry.
4) Terminated in competent strata.

AGS

HoleBASE 3.1 (Bld 418.4) Standard Borehole Log v2.tdsad 27th Nov 03

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Borehole No
WS5
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 99.95 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.50	ES					MADE GROUND: Firm dark brown sandy gravelly CLAY. Gravel is angular to rounded fine to coarse of brick sandstone clinker and coal. (MADE GROUND)
		1.20	SPT	N=3 (0,0/ 0,0,2,1)				
		1.50	D		1.40	98.55		High strength firm becoming stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone mudstone limestone and coal. (GLACIAL TILL)
		2.00	SPT	N=20 (2,3/ 4,4,5,7)				
					2.45	97.50		End of Borehole at 2.45 m
			Type	Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Borehole damp 1.30m to 1.40m bgl.
3) Borehole stable.
4) Located west of a possible boiler.
5) Terminated in competent strata.

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HoleBASE 3.1 (Bld 418.4) Standard Borehole Log v2 dated 27th Nov 03

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Borehole No **WS6** Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 99.94 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.70	ES					MADE GROUND: Soft consistency black very sandy slightly gravelly clay. Gravel is angular fine to coarse of coal clinker and brick. (MADE GROUND)
		1.20	SPT	N=3 (1,1/ 0,1,1,1)				
		1.70	ES		1.60	98.34		MADE GROUND: Very soft consistency brown mottled black slightly sandy clay. (MADE GROUND)
		2.00	SPT	N=0 (0,0/ -,-,-,-)				
		2.20	ES		2.10	97.84		MADE GROUND: Very low strength soft consistency grey very gravelly clay. Gravel is angular fine to coarse of brick and clinker. (MADE GROUND)
		2.50	D		2.30	97.64		Soft consistency grey mottled brown sandy CLAY. (GLACIAL TILL)
		3.00	SPT	N=27 (3,4/ 5,6,7,9)	2.80	97.14		High strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone limestone and mudstone. (GLACIAL SANDS AND GRAVELS)
		3.00	D		3.45	96.49		End of Borehole at 3.45 m
			Type	Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Borehole stable.
3) Borehole damp 1.50m to 2.30m bgl.
4) Terminated in competent strata.

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HoleBASE 5.1 (Bld 418.4) Standard Borehole Log v2 dated 27th Nov 03

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Borehole No
WS7
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 99.43 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.40	ES					MADE GROUND: Dark brown black slightly clayey slightly gravelly sand. Gravel is angular to subrounded fine to coarse of clinker ceramics brick and limestone. (MADE GROUND)
					0.80	98.63		
	▽	1.00	D					Very low strength soft consistency grey mottled brown slightly sandy CLAY. (GLACIAL TILL)
		1.20	SPT	N=3 (0,0/ 0,0,0,3)				
	▼	2.00	SPT	N=21 (5,3/ 3,5,6,7)	1.90	97.53		High strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone coal and mudstone. (GLACIAL TILL)
		2.00	D		2.45	96.98		End of Borehole at 2.45 m
			Type	Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Borehole stable.
3) Groundwater strike at 1.20m bgl, rose to 2.00m bgl after 20 minutes.
4) Terminated in competent strata.

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HoleBASE 3.1 (Bld 418.4) Standard Borehole Log v2 dated 27th Nov 03

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Borehole No
WS8
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		WS
Location: Egerton Road, Fallowfield, Manchester		Level: 98.65 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 08/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.60	ES		0.80	97.85		MADE GROUND: Very dark brown very clayey slightly gravelly sand. (MADE GROUND)
		1.20	SPT	N=4 (1,0/ 1,0,1,2)				MADE GROUND: Firm consistency dark brown very sandy slightly gravelly clay. Gravel is angular fine to coarse of brick and sandstone. (MADE GROUND)
		1.60	ES		1.80	96.85		RELICT TOPSOIL: Firm consistency dark brown slightly sandy CLAY.
		2.00	SPT	N=6	2.10	96.55		Low strength soft consistency grey mottled brown slightly sandy CLAY. (GLACIAL TILL)
		2.00	D	(1,1/ 1,1,2,2)	2.30	96.35		Medium to high strength very stiff consistency brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone and mudstone. (GLACIAL TILL)
		2.20	D					
		2.90	D					
		3.00	SPT	N=14 (3,2/ 3,3,3,5)	3.45	95.20		End of Borehole at 3.45 m
			Type	Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Borehole stable.
3) Borehole dry.
4) Terminated in competent strata.

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HoleBASE 3.1 (Bld 418.4) Standard Borehole Log V2 dated 27th Nov 03

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Borehole No
BH102
Sheet 1 of 2

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		Cable
Location: Egerton Road, Fallowfield, Manchester		Level: 99.67 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 16/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.25	99.42		CONCRETE: Layer of reinforced concrete. (MADE GROUND)
		0.50	D					MADE GROUND: Light brown slightly clayey slightly gravelly sand. Gravel is angular fine to coarse of concrete and flint. (MADE GROUND)
		1.20	SPT	N=15 (1,1/ 2,1,5,7)				
		1.50	D		1.40	98.27		MADE GROUND: Dark brown sandy gravelly clay. Gravel is angular to rounded fine to coarse of brick concrete and flint. (MADE GROUND)
		2.00	SPT	N=8 (1,1/ 2,1,2,3)				
		2.30	D		2.30	97.37		Low strength firm consistency black mottled grey sandy CLAY. (GLACIAL TILL)
					3.00	96.67		Medium strength firm to stiff consistency brown mottled grey slightly sandy CLAY. (GLACIAL TILL)
		3.00-3.45	U	22				
		3.50	D					
		4.00	SPT	N=15 (2,2/ 5,3,3,4)				
		4.50	D					
					4.80	94.87		High strength stiff to very stiff consistency grey mottled brown slightly sandy CLAY. (GLACIAL TILL)
		5.00-5.45	U	112				
		5.50	D					
		6.50	SPT	N=18 (2,2/ 3,5,5,5)				
		8.00-8.45	U	84				
		8.50	D					
			Type	Results				Continued next sheet

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Terminated in competent strata.
3) Borehole stable.
4) Borehole dry.

AGS

HoleBASE 3.1 (Bld 418.A) Standard Borehole Log v2 dated 27th Nov 03

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Borehole No
BH102
Sheet 2 of 2

Project Name	Project No.	Co-ords: -	Hole Type
EGERTON ROAD	T/10/917		Cable
Location: Egerton Road, Fallowfield, Manchester		Level: 99.67 m AOD	Scale 1:50
Client: Watkin Jones		Dates: 16/12/2010	Logged By JB

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		10.00 10.00	SPT D	N=32 (5,6/ 7,6,10,9)	10.45	89.22		High strength stiff to very stiff consistency grey mottled brown slightly sandy CLAY. (GLACIAL TILL) End of Borehole at 10.45 m
			Type	Results				

Remarks: 1) Hand dug pit to 1.20m bgl.
2) Terminated in competent strata.
3) Borehole stable.
4) Borehole dry.

AGS

HoleBASE 3.1 (Bld 418.4) Standard Borehole Log v2 dated 27th Nov 03

APPENDIX M - GAS AND GROUNDWATER MONITORING RESULTS

JOB DETAILS:

Client:	Watkin Jones Group	**Job No:**	T/10/917
Site:	Egerton Road, Manchester	**Visit No:**	1 **of** 6
Date:	28.12.10	**Operator:**	JRB

	GAS CONCENTRATIONS												FLOW DATA		WELL AND WATER DATA		
Monitoring Point	**Methane (%v/v)**		**%LEL**		**Carbon dioxide (%v/v)**		**Carbon monoxide (ppm)**		**Hydrogen sulphide (ppm)**		**Oxygen (%v/v)**		**Flow rate (l/hr)**		**Water level (mbgl)**	**Depth of well (m)**	**Response Zone**
	Peak	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Lowest**	**Steady**	**Peak**	**Steady**			
WS5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20.00	20.00	ND	ND	1.55	1.55	Made Ground
WS6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20.10	20.10	ND	ND	1.40	2.20	Made Ground
WS7	ND	ND	ND	ND	0.60	ND	ND	ND	ND	ND	19.90	20.40	ND	ND	1.50	2.30	Made Ground
WS1	ND	ND	ND	ND	3.40	3.40	ND	ND	ND	ND	17.60	17.60	ND	ND	1.40	3.70	Made Ground

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground:		Dry		Moist	X	Wet		Snow		Frozen
Wind:		Calm	X	Light		Moderate		Strong		
Cloud cover:		None		Slight	X	Cloudy		Overcast		
Preciptation:		None	X	Slight		Moderate		Heavy		
Barometric pressure (mbar):			1002	Before			1002	After		
Pressure trend:				Falling		Steady	X	Rising		

Ground gas meter: GA2000

Ambient

Gas concentration: CH_4 ND CO_2 ND O_2 20.4

JOB DETAILS:

Client:	Watkin Jones Group	**Job No:**	T/10/917
Site:	Egerton Road, Manchester	**Visit No:**	2 of 6
Date:	06.01.11	**Operator:**	JRB

Monitoring Point	GAS CONCENTRATIONS												FLOW DATA		WELL AND WATER DATA			Comments
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppm)		Hydrogen sulphide (ppm)		Oxygen (%v/v)		Flow rate (l/hr)		Water level (mbgl)	Depth of well (m)	Response Zone	
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Lowest	Steady	Peak	Steady				
WS5	ND	ND	ND	ND	1.20	1.20	ND	ND	ND	ND	19.20	19.20	5.70	ND	1.55	1.55	Made Ground	DRY
WS6	ND	ND	ND	ND	3.10	3.10	ND	ND	ND	ND	17.20	17.20	ND	ND	1.40	2.20	Made Ground	
WS7	ND	ND	ND	ND	2.80	2.80	ND	ND	ND	ND	17.50	17.50	ND	ND	1.00	2.30	Made Ground	
WS1	ND	ND	ND	ND	5.40	5.40	ND	ND	ND	ND	15.00	15.00	ND	ND	1.10	3.70	Made Ground	

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground:		Dry	X	Moist		Wet		Snow		Frozen
Wind:		Calm	X	Light		Moderate		Strong		
Cloud cover:		None	X	Slight		Cloudy		Overcast		
Preciptation:	X	None		Slight		Moderate		Heavy		
Barometric pressure (mbar):			996	Before			996	After		
Pressure trend:			X	Falling		Steady		Rising		

Ground gas meter: GA2000

Ambient

Gas concentration: CH_4 ND CO_2 ND O_2 20.1

Ground Gas and Groundwater Monitoring Record Sheet

JOB DETAILS:

Client: Watkin Jones Group
Site: Egerton Road, Manchester
Date: 27/01/2011

Job No: T/10/917
Visit No: 3 **of** 6
Operator: HS

Monitoring Point	GAS CONCENTRATIONS												FLOW DATA		WELL AND WATER DATA			Comments
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppm)		Hydrogen sulphide (ppm)		Oxygen (%v/v)		Flow rate (l/hr)		Water level (mbgl)	Depth of well (m)	Response Zone	
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Lowest	Steady	Peak	Steady				
WS5	ND	ND	0.00	0.00	0.30	0.30	ND	ND	ND	ND	21.10	21.10	0.30	ND	1.54	1.55	Made Ground	Damp at base
WS6	ND	ND	0.00	0.00	0.40	0.30	ND	ND	ND	ND	20.70	20.70	ND	ND	1.10	2.20	Made Ground	Sample Taken
WS7	ND	ND	0.00	0.00	0.80	0.20	ND	ND	ND	ND	20.70	20.70	ND	ND	1.20	2.30	Made Ground	Sample Taken
WS1	ND	ND	1.00	1.00	4.80	4.80	ND	ND	ND	ND	16.20	16.20	ND	ND	1.30	3.70	Made Ground	Sample Taken

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground:		Dry	X	Moist		Wet		Snow		Frozen
Wind:		Calm		Light	X	Moderate		Strong		
Cloud cover:		None		Slight		Cloudy	X	Overcast		
Preciptation:	X	None		Slight		Moderate		Heavy		
Barometric pressure (mbar):			1020	Before			1020	After		
Pressure trend:			X	Falling		Steady		Rising		

Ground gas meter: GA2000
Ambient
Gas concentration: **CH_4** 0.1 **CO_2** 0.1 **O_2** 21.2