GROUND INVESTIGATION REPORT

FORMER SCHOOL, ADJACENT TO ULLSWATER AVENUE, CARR MILL, ST. HELENS

Date: May 2008

Job Ref: 6560

Urban Vision Partnership Ltd
Environment – 3rd Floor
Emerson House
Albert Street
Eccles
Manchester
M30 0TE

Tel: 0161 604 7772
Fax: 0161 779 6003

Client:

St Helens Council
4th Floor Wesley House
Corporation Street
St Helens
WA10 1HF

urbanvision

GROUND INVESTIGATION REPORT FORMER SCHOOL, ADJACENT TO ULLSWATER AVENUE	
Job no.	**Issue Status**
6560	Final

	Name	Position	Signature	Date
Prepared By:	Gail Sanderson	Contaminated Land Officer	G. Sanderson	May 08
Checked & Approved By:	Matt Uttley	Environment Manager	M Uttley	May 08

GROUND INVESTIGATION REPORT
FORMER SCHOOL,
ADJACENT TO ULLSWATER AVENUE, CARR MILL, ST. HELENS

Executive Summary

Urban Vision Partnership Ltd have been commissioned by St Helens Council to carry out a ground investigation on the site at Former school, adjacent to Ullswater Avenue, Carr Mill, St. Helens.

The investigation was required to provide advice on the nature and condition of ground conditions of the site prior to the land being sold and redeveloped. The future development of the site is described as residential.

The intrusive investigation was carried out between 17th and 19th of March 2008. The ground investigation comprised the following elements:

- 14 trial pits (TP801 TO TP814)
- 3 rotary boreholes (BH801 to BH803)

The soil risk assessment identified a low risk to human health presented by elevated levels of arsenic, nickel and BaP in the shallow soils at TP803 and TP808. Appropriate pipe material will need to be selected to protect potable water pipes from corrosion and toxic contaminants (arsenic).

The gas risk assessment identified a low risk to buildings and human health. Although the results do indicate CS1 measures being suitable, future budgeting should allow for CS2 measures to be required if further ground gas monitoring is not undertaken.

GROUND INVESTIGATION REPORT
FORMER SCHOOL,
ADJACENT TO ULLSWATER AVENUE, CARR MILL, ST. HELENS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

GROUND INVESTIGATION REPORT
FORMER SCHOOL,
ADJACENT TO ULLSWATER AVENUE, CARR MILL, ST. HELENS

1.0 Introduction

Urban Vision Partnership Ltd have been commissioned by St Helens Council to carry out a ground investigation on the site at Former school, adjacent to Ullswater Avenue, Carr Mill, St. Helens.

The investigation was required to provide advice on the nature and condition of ground conditions of the site prior to the land being sold and redeveloped. The future development of the site is described as residential.

This report describes the near surface ground investigation undertaken to provide a quantitative assessment of soil and gas contamination risks associated with the two proposed end uses.

2.0 Site Characteristics and Preliminary Conceptual Model

2.1 Site Description

Site location	Former school site adjacent to Ullswater Avenue off Eskdale Avenue, Carr Mill, St Helens (Location Plan Figure 1, Appendix A)
National Grid Reference	351732, 397582
Site area	1.95 hectares
Elevation	43mAOD (above ordnance datum)
Current land use	Site: No potentially contaminative land uses. Surrounding area: historically a building yard, Two sand pits, one excavation and one potential excavation within 250m of the site.
Invasive plants	None noted on site.

Table 1: Site description

2.2 Site History

The prior land use of this site was a primary school which had been demolished prior to undertaking the site investigation.

Potentially Contaminative Past Uses	**Map Date**	
	From	**To**
None	NA	NA

Table 2: On site history

Surrounding area: Potentially Contaminative Past Uses	**Map Date**	
	From	**To**
Sand Pit 72m south of site. Infilled by 1928	1907	1926
Sand Pit 217m south of site. Infilled by 1937. Houses on site in 1937	1926	1928
Excavation approx 70m east of site. Infilled by 1937	1926	1926
Lime Pit in Builder's Yard 245m southeast of site. Removed / infilled by 1975	1959	1959
Possible excavation 195m west of site. Infilled by 1949. Houses on site in 1949	1926	1938

Table 3: Off site history

2.3 Environmental Setting

A summary of the environmental settings is provided below.

Artificial Geology	None
Drift Geology	None on site. Shirdley Hill Sand Formation 3m SE of site
Solid Geology	Pennine Lower Coal Measures (Mudstone, Siltstone & Sandstone) & Old Lawrence Rock (Sandstone). One inferred coal seam 10m east of site
Hydrogeology	Minor Aquifer (High Leaching Potential)
Hydrology	Small stream approx 250m N of site & Rainford Brook 462m SW of site
Env. Designations	None
Radon	The site is in a radon affected area, as between 1% and 3% of properties are above the action level. However, no radon protective measures are necessary.
Landfills	There are no known registered landfills within 250m but there are five potentially infilled areas (Table 3 refers).
Mining and Minerals	The study site is located within the specified search distance of an identified mining area (Shafts located 943m to the southeast of the site). The hazard of subsidence relating to shallow mining under the site is low to moderate. The Coal Authority Report (Appendix B) states that the property is not within a zone of physical influence from underground workings.

Table 4: Environmental setting

2.4 Preliminary Conceptual Model

A summary of the preliminary conceptual model is as follows:

- Soil contamination considered low risk due to former land use being a school.
- Landfill gas associated with the former coal workings and seams and potentially infilled areas, particularly from the infilled sand pit 72m south of the site, the infilled excavation 70m east of the site.

3.0 Ground Investigation

3.1 Method

3.1.1 Intrusive Investigation

The intrusive investigation was carried out on between the 17th and 19th of March 2008. The intrusive investigation included trial pitting and rotary boreholes (Figure 2 Appendix A).

Fourteen trial pits were excavated to a maximum depth of 4m below ground level (bgl.) using a JCB, the material was logged and samples taken. The trial pits were then backfilled with arisings.

Three rotary boreholes were drilled to a maximum depth of 5m bgl and fitted with gas monitoring installations.

Photographs of the trial pits and the logs prepared in accordance with BS EN ISO 14655-1:2002[1] are in Appendix C. The rotary logs have been prepared in accordance with BS 5930:1999[2] and are in Appendix D. Photo Ionisation Detector (PID) testing was undertaken on all the samples with only one elevated reading of 3.5ppm being noted in sample TP812 CS1 at a depth of 0.3m bgl.

The trial pit locations were non-targeted to provide full coverage across the site. The boreholes however, were targeted to ensure any gas migration from the south and east where the nearest infilled areas of land were identified was monitored.

All rotary boreholes were fitted with gas monitoring equipment in accordance with BS10175:2001[3]. Monitoring standpipe was screened across natural ground due to the limited depth of made ground present on site. BH801 however, screened both made ground and natural.

---

[1] British Standards (2002) Geotechnical investigation and testing – Identification and classification of Soil. Part 1: Identification and description. *BS EN ISO 14688-1:2002*

[2] British Standards (1999) Code of Practice for Site Investigations. *BS 5930:1999*

[3] British Standards (2001) Investigation of potentially contaminated sites - Code of Practice. *BS 10175:2001*

3.1.2 Onsite Monitoring

The borehole installations were allowed to stabilise for two weeks before monitoring occurred. A total of four monitoring visits were conducted over a two week period from the 2nd of April to the 14th April 2008.

For each monitoring visit weather, barometric pressure and ground conditions were recorded. A GA2000 infrared gas analyser was used to measure gas flow rates and gas concentrations (methane, carbon dioxide and oxygen) by volume.

Groundwater levels were recorded upon completion of each gas monitoring visit.

3.1.3 Sampling Strategy

Disturbed soil samples were taken from the trial pits only. They were collected from the top 0.5m bgl and then every change in strata. One sample was taken at the made ground-natural interface.

Shallow soil samples from the trial pits were screened on site using a PhoCheck+ 1000Ex PID to test for total volatile organic compounds (TVOC).

3.1.4 Laboratory Testing

Chemical testing was carried out by i2 Analytical of Watford, Hertfordshire. The laboratory is UKAS accredited in accordance with ISO17025 and is also MCERTS accredited for selected soil testing.

The majority of the samples tested were from the top 0.5mbgl with one sample taken from greater depth (1.50m bgl. TP806). All samples tested were from the made ground.

Ten representative soil samples were tested for a standard suite of contaminants which included metals, metalloids, inorganic compounds, phenols, speciated polycyclic aromatic hydrocarbons (PAHs) and fraction of organic carbon.

One sample was tested for volatile and semi volatile organic compounds due to an elevated PID reading of 3.5ppm (TP812, CS1 0.3m bgl.).

Soil contamination results are presented in Appendix E.

3.2 Ground Conditions

3.2.1 Geology

The generalised sequence encountered across the site has been summarised below:

- Made ground was identified in each trial pit. The made ground mainly consisted of either Sand or Clay. Gravel is fine to coarse, angular to subrounded comprising of glass, ceramics, brick, coal and ash. TP802 and TP804 are the exceptions to this rule with made ground consisting of Silt and TP803 with gravel.

- Natural deposits were in the majority of trial pits and consisted of either Sands or Clays. Where gravel is present it comprises of sandstone and mudstone.
- Bedrock was encountered in 11 trial holes and comprised of either sandstone or mudstone, with the shallowest depth at which bedrock was encountered being 0.45m bgl (TP812).

3.2.2 Gas Monitoring Results

Gas monitoring was carried out in varying weather conditions and included two visit at falling atmospheric pressure (<1000mb).

The full records from each monitoring visit are presented in Appendix F and are summarised in Table 5 below.

Monitoring locations	**No. visits**	**Concentration (% v/v)**						**Volume flow (l/hr)**	
		Methane		**Carbon dioxide**		**Oxygen**			
		Min	Max	Min	Max	Min	Max	Min	Max
BH801	4	0	0	0	0	19.5	20.7	-0.3	0.0
BH802	4	0	0	1.8	4.1	19	20.4	-4.2	11.30
BH803	4	0	0	3.8	5.3	8	12.1	-0.3	0.2

Table 5: Summary of gas monitoring results

No methane concentrations were recorded on the site. The highest carbon dioxide concentrations were recorded in BH803 with the maximum recording being (5.3%v/v) which is located in the south eastern section of the site.

Varying levels of oxygen concentrations have been recorded in each borehole. BH803 recorded the lowest oxygen concentrations with a minimum value of 8% v/v and a maximum value of 12% v/v. These depleted oxygen concentrations correspond with the highest carbon dioxide concentrations recorded for the site.

Low flow rates were recorded for the majority of the wells. There is however, an exception with BH802 recording a flow rate of 11.3l/hr on one occasion. After a period of two minutes this flow had decreased to 0.l/hr. If this result is omitted the next maximum flow rate is 0.5 l/hr.

It is likely that the 11.3l/hr is an anomaly reading resulting from a build up of pressure which is rapidly released when the borehole has been initially opened for monitoring. The water level recorded at the time of this high flow was at its shallowest depth at 1.20m bgl and may have influenced the flow recorded.

3.2.2 Soil Waste Classification

The soil contamination results have been assessed using Cat-Waste Soil (a web based model produced by McArdle and Atkins to determine the likely classification of waste should surplus soils be removed from site during construction).

The Cat-Waste Soil report in Appendix G indicates that the soils on site are not likely to be classed as hazardous waste. However, should surplus soils be removed, reference should also be made to the latest Environment Agency guidance for treating non-hazardous wastes for landfill.

NB: The soil classification should not be considered definitive as there may be other factors that may influence whether the waste is hazardous. Full details of the soils and contamination results should be made available to a specialist disposal contractor to confirm the nature of the waste prior to removal.

3.2.4 Other Observations

Groundwater monitoring was not undertaken at the site. No seepages of water were recorded in the trial pits. Table 6 below indicates the variations in the water levels recorded in the three boreholes across the site.

BH	**Shallowest Water Level (m bgl)**	**Deepest Water Level (m bgl.)**	**Range (m)**
BH801	1.44	2.11	0.67
BH802	1.20	1.69	0.49
BH803	1.49	2.28	0.79

Table 6: Summary of variations in water levels across the site.

The table indicates water levels of site have changed rapidly during the two weeks of monitoring. This indicates that shallow groundwater levels have the potential to respond relatively quickly to precipitation events. Monitoring results also suggest that groundwater fluctuations are not consistent across the site. This is likely to be a result of local variations in strata and fracturing within the rock mass.

4.0 Generic Quantitative Risk Assessment

Current good practice requires that the findings from a site investigation be evaluated on a site-specific basis, using a risk-based approach. Risk assessment involves identification and assessment of the hazards presented by the concentrations of contaminants measured. This is followed by estimation of risk resulting from each hazard, and an evaluation of whether each risk is acceptable.

Risk estimation is based on consideration of magnitude, probability and consequence of a contaminant-pathway-receptor linkage occurring, using a matrix recommended by Defra. The rationale behind the estimation of risk in this investigation is presented in Appendix H. This is in line with guidance described in CLR11[4]. Risk assessment requires an evaluation of the contaminant-pathway-receptor linkage model and can be qualitative or quantitative.

[4] Department for Environment, Food and Rural Affairs and the Environment Agency (2004). Model procedures for the management of land contamination. *R&D Publication CLR11*.

4.1 Soil

4.1.1 Human Health Receptor

Current UK guidance recommends that soil samples are assessed against the Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGVs). The UK's risk assessment model CLEA UK assumes that land-use falls into one of the following three categories (the first having two sub-categories): residential with and without plant uptake; allotments and; commercial / industrial use. In this case it is appropriate to use the SGVs for residential with plant uptake.

For contaminants without a CLEA derived SGV, results have been compared against equivalent Generic Assessment Criteria (GAC) derived by the Chartered Institute of Environmental Health (CIEH) and Land Quality Management Ltd (LQM)[5] for the four land use scenarios. The GACs have been derived using CLEA UK (beta) and as such are relevant in the UK context.

GACs have been selected based on a soil organic matter (SOM) value of 2.5% which is based on the fraction of organic carbon (FOC) values derived from made ground samples tested.

The soil test results have been compared to the assessment criteria and this comparison is presented in full in Appendix I.

A number of contaminants were found when to have exceeded the assessment criteria for residential with plant uptake use. A summary is provided in Table 7 below.

Contaminant	Units	No. of samples	Max. result	Assessment Criteria	Source of Criteria	No. exceeded
Arsenic	mg/kg	10	68	20	CLEA SGV	3
Benzo(a)pyrene	mg/kg	10	1.5	1.08	LQM GAC	1
Nickel	mg/kg	10	110	50	CLEA SGV	1
Copper	mg/kg	10	180	111	LQM GAC	3

Table 7: Summary of soil results

The average soil organic matter (SOM) is 2.15% therefore; the soil organic matter value used to assess the site is 2.5%. The pH across the site ranged from 6.5 to 8.2.

[5] Nathanail, C.P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillett, A., Hooker, P., and Ogden, R.C. (2007) *Generic Assessment Criteria for Human Health Risk Assessment*. Land Quality Press, Nottingham.

When compared to residential with plant uptake SGVs and GACs, three soil samples were found to contain elevated arsenic and copper (maximum 68mg/kg and 180mg/kg respectively in sample TP808 at a depth of 0.2m bgl). An elevated concentration was also recorded for benzo(a)pyrene (BaP) with 1.5mg/kg in TP803 and nickel with 110mg/kg in TP808.

In order to assess the risk presented by the made ground across the site, CLR7[6] recommends comparing the dataset to the assessment criteria using the mean value and maximum value tests.

The mean value test identifies the 95% confidence limits of the measured mean of the dataset and compares the upper 95th percentile with the SGV / GAC.

The maximum value test identifies whether the maximum values should be classified as outliers. These outliers may indicate localised areas of contamination.

The statistical output sheets for this analysis are presented in Appendix J.

The statistical analysis undertaken indicates there to be outliers present for arsenic and nickel (TP808), and benzo(a)pyrene (TP803).

A summary table of the statistical analysis is provided in Table 8 below.

Contaminant	Maximum concentration mg/kg	No. outliers	Mean, mg/kg	Upper 95th Percentile mg/kg	Residential with Screening Values, mg/kg
First Statistical Test					
Arsenic	68	1	20.31	28.75	20
Nickel	110	1	25.60	42.92	50
BaP	1.5	1	0.45	0.67	1.08
Copper	180	0	82.70	113.00	111
Second Statistical Test without maximum value					
Arsenic	27	0	12.77	17.45	20
Nickel	22	0	16.22	18.66	50
BaP	0.53	0	0.33	0.38	1.08

Table 8: Statistical Summary.

When the outliers are removed from the data the mean value is reduced to below the assessment criteria in each case. This suggest that contamination localised around TP808 (arsenic and nickel) and TP803 (BaP). These elevated concentrations are likely to be due to the clinker, ash, bituminous materials and coal recorded within the made ground.

The statistical results for copper indicate a US95 above the GAC, which is indicative of a more widespread issue. Copper however, is not considered a risk to human health but is phyotototoxic. The site was formerly a school with the buildings having been demolished and

[6] Department for Environment, Food and Rural Affairs and the Environment Agency (2002). Assessment of risks to human health from land contamination: an overview of the development of soil guideline values and related research. R&D Publication CLR7.

the site left to become slightly overgrown. There was no indication of vegetation die back or areas that appear to have been adversely affected.

4.2 Buildings, Building Materials or Services Receptor

Soil contamination results have been compared to the material selection 'threshold' levels recommended in the Water Regulations Advisory Scheme (WRAS) guidance on the selection of materials for water supply pipes to be laid in contaminated land[7]. This comparison is presented in Appendix K.

The concentrations of the corrosive contaminant pH and toxic contaminant arsenic exceed the material selection 'threshold' level of pH8 and 10mg/kg respectively recommended in the Water Regulations Advisory Scheme (WRAS) guidance on the selection of materials for water supply pipes to be laid in contaminated land[8]. Appropriate pipe materials will therefore need to be selected unless the remediation removes / reduces the concentration of the contaminant.

4.3 Ground Gas

The following ground gas risk assessment has been carried out in accordance with recommendations made in CIRIA C665[9] guidance for assessing risk posed by hazardous ground gases to buildings.

Gas Screening Values (GSVs) have been calculated using the following equation:

GSV (l of gas per hour) = borehole flow rate (l/h) x gas concentration (%)

GSVs have been used (with consideration of additional factors) to determine appropriate characteristic situations based on the modified Wilson and Card classification system. Gas monitoring results are presented as GSVs in Appendix L.

Maximum GSVs for CH_4 and CO_2 represent the peak concentration and the flow measured in that borehole on the same visit. Worst case GSVs for each borehole use the maximum concentration of gas and the maximum flow measured in that borehole (on any occasion). A summary of GSVs is presented in Table 8 below.

Borehole Ref.	No. visits	Maximum GSV for CH_4	Maximum GSV for CO_2	Worst case GSV
BH801	3	0	0	0
BH802	3	0	0.31	0.4633
BH803	3	0	0.01	0.0106

With highest flow of 11.3l/hr

[7] Water Regulations Advisory Scheme (2002) The selection of materials for water supply pipes to be laid in contaminated land. *Information and Guidance Note No 9-04-03, Issue 1.*
[8] Water Regulations Advisory Scheme (2002) The selection of materials for water supply pipes to be laid in contaminated land. *Information and Guidance Note No 9-04-03, Issue 1.*
[9] Construction Industry Research and Information Association (2007) Assessing risks posed by hazardous ground gases to buildings. *CIRIA Report C665.*

Borehole Ref.	No. visits	Maximum GSV for CH_4	Maximum GSV for CO_2	Worst case GSV
BH801	3	0	0	0
BH802	3	0	0.01	0.0205
BH803	3	0	0.01	0.0106

Without highest flow of 11.3l/hr.

Key:

Very Low Risk – Characteristic Situation 1
Low Risk – Characteristic Situation 2
Moderate Risk – Characteristic Situation 3
Moderate to High Risk – Characteristic Situation 4

Table 8: Summary gas monitoring as GSVs

The GSVs generated above conclude that if the 11.3l/hr flow reading is utilised it could be concluded that CS2 protection measures are appropriate for future development. However, if this anomalous reading is removed from the calculations, CS1 measures can be considered.

Although the CS1 is indicated by the results for budgeting purposes CS2 measures should be considered pending further monitoring which will be required to support future planning applications for the site.

If the proposed residential development fits the criteria for Situation B of CIRIA C655 i.e. low rise housing with ventilated underfloor void, the NHBC traffic light system could be utilised. In this situation either Green (which would require additional monitoring) or Amber 1 measures would need to be utilised.

4.4 Conceptual Model

A preliminary risk assessment for this site has been discussed along in Section 2 of this report. Following the intrusive site investigation, the preliminary risk assessment has been re-evaluated and specific linkages examined based on the testing and monitoring results and the proposed end use of the site. The contaminant-pathway-receptor linkage model for this site has been revised and summarised as a CM in tabulated form in Table 10.

Potential Source	Potential Contaminant	Potential Pathway	Potential Receptor	Probability	Consequence	Risk
Made Ground	Soils metals – arsenic, nickel	• Ingestion of soil and indoor dust • Consumption of home grown vegetables	• On site future users • Construction workers	Low	Moderate	**Low**
	Soils (BaP)	• Ingestion of soil and indoor dust • Consumption of home grown vegetables • Indoor and outdoor dermal contact	• On site future users • Construction workers	Low	Moderate	**Low**
Ground Gas	Methane	• Migration through variably permeable strata and service ducts.	• Site users • Buildings	Low	Severe	**Low**
	Carbon Dioxide	• Migration through variably permeable strata and service ducts. • Inhalation	• Site users • Buildings	Low	Severe	**Low**

Table 10: Revised Conceptual Model for residential with plant uptake

5.0 Conclusions and Recommendations

The soil risk assessment identified a low risk to human health presented by elevated levels of arsenic, nickel and BaP in the shallow soils at TP803 and TP808. Appropriate pipe material will need to be selected to protect potable water pipes from corrosion and toxic contaminants (arsenic)

The gas risk assessment identified a low risk to buildings and human health. Although the results do indicate CS1 measures being suitable, future budgeting should allow for CS2 measures to be required if further ground gas monitoring is not undertaken.

6.0 Limitations

Urban Vision Partnership Ltd has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the content of the report, written approval must be sought from Urban Vision Partnership Ltd; a charge may be levied against such approval.

Urban Vision Partnership Ltd accepts no responsibility for the consequences of this document being used for any purpose or project other than for which it was commissioned or for consequences arising from this document’s use by any third party with whom an agreement has not been executed.

The investigation of the site has been carried out to provide sufficient information concerning the type and degree of contamination, to provide a reasonable assessment of the human risks.

The exploratory holes excavated, which investigate only a small volume of the ground in relation to the size of the site, can only provide a general indication of the site conditions. The opinions provided and recommendations given in this report are based on the ground conditions apparent within each of these holes. Therefore, there may be unexpected ground conditions elsewhere on the site which have not been disclosed by this investigation, and which may not have been taken into account in this report.

The risk assessment and opinions provided, *inter alia*, take into consideration currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.