Site Investigations
♣
Geologists
♣
Environmental & Geotechnical Engineers

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Date: 17th May 2024

GROUND GAS RISK ASSESSMENT

Mill Lane, Batley
S240106/GAS

INTRODUCTION

Authorisation

The site investigation described in this report was carried out by Solmek to the instructions of Mandale Construction North Ltd, on land located at Mill Lane, Batley, West Yorkshire, WF17 6EN. Figure 1, appended to this report, shows the outlined site boundaries.
Sources of information, including previous work undertaken at the site, are detailed below:

- *Solmek Phase One Desk Study Report (S240106/DS, February 2024)*
- *Solmek Phase Two Site Investigation (S240106/SI, February 2024)*

Reference should be made to the above reports for details of the site's history, environmental setting, mining assessment and underlying geological conditions.

Scope of Works

The site is expected to be developed with 19no residential properties with soft landscaped gardens and hardstanding in the form car parking and access road, along with Public Open Space (POS) to the north east, including a playground. Figure 2, appended to this report, shows the boreholes locations.

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

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

GROUND GAS ASSESSMENT

Given the proposed development of the site the ground gas results have been compared to the NHBC Traffic Light System, shown in Table 1.

Ground gases such as carbon dioxide (CO_2) and methane (CH_4) can be classed as a form of contamination where there is a potential risk to human health. As a result, six visits have been carried out between January 2024 and May 2024 to assess the potential risks posed by ground gases to date.

The gas was monitored by measuring emissions from monitoring points installed into BH01, BH03, BH04 and BH06 during the fieldwork. The results are attached.The monitoring was generally carried out in accordance with current guidance provided within CIRIA C665:2007.

bsi. ISO 9001:2015 Quality Management
bsi. ISO 14001:2015 Environmental Management
bsi. ISO 45001 Occupational Health and Safety Management
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Ground Gas Results

The atmospheric pressure has an impact on the concentrations of gas released. The atmospheric pressure was between 997 and 1015 millibars during the surveys. Times of rising and falling atmospheric pressure regional trends were noted during each survey. This is considered to be a very good range of conditions for the time of year as the worst-case conditions have been captured i.e. <1000mB and falling pressure.

Carbon dioxide concentrations were recorded between 0.0% and 4.8% volume, and oxygen levels were between 14.7% and 20.4%. Methane was not detected in any of the boreholes during the survey and very low flow rates were recorded.

Ground Gas Analysis

The results obtained have been compared with relevant guidance that includes the following:

- BRE/Environment Agency BR414 (2001) - Protective Measures for housing on gas-contaminated land
- Wilson & Card (1999) - Reliability and Risk in Gas Protection Design
- CIRIA 149 (1995) - Protecting Development from Methane
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings.

The Building Regulations set action levels for both methane and carbon dioxide from which an initial assessment can be made. The action threshold for methane is 1% while for carbon dioxide an initial consideration should be undertaken if gas concentrations exceed 1.5%.

Action might be required if carbon dioxide concentrations exceed 5%. If these thresholds are exceeded, reference should be made to specific documentation to determine the nature and extent of the gas control measures required.

The GSV and risk classification define the characteristic situation, which are comparable to the tables below, taken from CIRIA C665, and derived from CIRIA R149.

TABLE 1: NHBC TRAFFIC LIGHT SYSTEM (FROM CIRIA C665)

Traffic light classification	Methane		Carbon dioxide	
	Typical max concentration (% v/v)	Gas screening value (litres/hr)	Typical max concentration (% v/v)	Gas screening value (litres/hr)
Green				
	1	0.16	5	0.78
Amber 1				
	5	0.63	10	1.56
Amber 2				
	20	1.56	30	3.13
Red				

The gas concentrations from the monitoring visits to date would place the site in **NHBC GREEN.** A list of gas protection required are given in Table 2 below. The worst case GSV can be taken from the highest flow rate recorded over the visits (0.1l/hr) along with the greatest volume of CO_2 (4.8%). Based on these figures the worst GSV has been calculated as 0.0048 (l/hr).

TABLE 2: NHBC PROTECTION MEASURES

Traffic light classification	Protection measures required
Green	Gas protection measures not considered necessary.
Amber 1	Gas resistant membrane & ventilated sub-floor void to create permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as per BRE Report 414.
Amber 2	As Amber 1 but membrane should be installed by a specialist contractor; certification of correct installation is also required. Installation & certification 'package' is the ideal way to do this.
Red	Standard residential housing would be unacceptable without further risk assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

The site is in an Intermediate probability Radon Affected Area, as between 3 to 5% of properties are estimated to be at or above the Action Level.
In accordance with the procedure described in BRE Publication BR211 Radon: Guidance on Protective Measures for New Dwellings, **basic radon protective measures are necessary** in the construction of new dwellings or extensions.

Yours sincerely,

Lauren Oxley

Ground Gas Technician
On behalf of Solmek Ltd.

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GAS MONITORING RESULTS

Project number	S240106
Project name	Mill Lane, Batley
Client	Mandale
Visit no	1
Date	24/01/2024
Equipment	GFM 435 Gas Analyser
Operator	LO

Weather Conditions	Cloudy
Ground Conditions	Wet
Ambient Atmospheric Pressure	1011
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH01	0.1	1011	0.0	0.0000	0.8	0.0008	20.0	0.0	0.0	0.50	1.40	
BH03	1.0	1011	0.0	0.0000	0.9	0.0090	20.0	0.0	0.0	0.47	2.00	
BH04	0.1	1011	0.0	0.0000	0.0	0.0000	20.4	0.0	0.0	0.25	1.45	
BH06	0.1	1011	0.0	0.0000	0.1	0.0001	20.4	0.0	0.0	0.40	1.00	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S240106
Project name	Mill Lane, Batley
Client	Mandale
Visit no	2
Date	06/03/2024
Equipment	GFM 435 Gas Analyser
Operator	LO

Weather Conditions	Cloudy
Ground Conditions	Wet
Ambient Atmospheric Pressure	1012
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH01	0.1	1012	0.0	0.0000	2.2	0.0022	18.5	0.0	0.0	0.64	1.40	
BH03	0.1	1012	0.0	0.0000	0.8	0.0008	19.1	0.0	0.0	0.57	2.00	
BH04	0.1	1012	0.0	0.0000	0.1	0.0001	20.1	0.0	0.0	0.00	1.45	
BH06	0.1	1012	0.0	0.0000	0.3	0.0003	20.0	0.0	0.0	0.40	1.00	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S240106
Project name	Mill Lane, Batley
Client	Mandale
Visit no	3
Date	20/03/2024
Equipment	GFM 435 Gas Analyser
Operator	LO

Weather Conditions	Cloudy
Ground Conditions	Wet
Ambient Atmospheric Pressure	1011
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH01	0.1	1011	0.0	0.0000	3.6	0.0036	15.8	0.0	0.0	0.60	1.40	
BH03	0.1	1011	0.0	0.0000	0.6	0.0006	19.1	0.0	0.0	0.52	2.00	
BH04	0.1	1011	0.0	0.0000	0.0	0.0000	20.4	0.0	0.0	0.00	1.45	
BH06	0.1	1011	0.0	0.0000	0.3	0.0003	20.1	0.0	0.0	0.42	1.00	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S240106
Project name	Mill Lane, Batley
Client	Mandale
Visit no	4
Date	12/04/2024
Equipment	GFM 435 Gas Analyser
Operator	LO

Weather Conditions	Cloudy
Ground Conditions	Damp
Ambient Atmospheric Pressure	1015
Regional Pressure Trend	Falling

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH01	0.1	1015	0.0	0.0000	4.3	0.0043	15.2	0.0	0.0	0.54	1.40	
BH03	0.1	1015	0.0	0.0000	0.7	0.0007	18.8	0.0	0.0	0.40	2.00	
BH04	0.1	1015	0.0	0.0000	0.1	0.0001	20.3	0.0	0.0	0.00	1.45	
BH06	0.1	1015	0.0	0.0000	0.5	0.0005	20.2	0.0	0.0	0.41	1.00	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S240106
Project name	Mill Lane, Batley
Client	Mandale
Visit no	5
Date	26/04/2024
Equipment	GFM 435 Gas Analyser
Operator	LO

Weather Conditions	Cloudy
Ground Conditions	Damp
Ambient Atmospheric Pressure	997
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH01	0.1	997	0.0	0.0000	4.4	0.0044	16.8	0.0	0.0	0.67	1.40	
BH03	0.1	997	0.0	0.0000	0.4	0.0004	19.9	0.0	0.0	0.65	2.00	
BH04	0.1	997	0.0	0.0000	0.2	0.0002	20.2	0.0	0.0	0.14	1.45	
BH06	0.1	997	0.0	0.0000	2.1	0.0021	18.2	0.0	0.0	0.50	1.00	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S240106
Project name	Mill Lane, Batley
Client	Mandale
Visit no	6
Date	10/05/2024
Equipment	GFM 435 Gas Analyser
Operator	LO

Weather Conditions	Sunny
Ground Conditions	Dry
Ambient Atmospheric Pressure	1015
Regional Pressure Trend	Steady

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH01	0.1	1015	0.0	0.0000	4.6	0.0046	16.9	0.0	0.0	0.88	1.40	
BH03	0.1	1015	0.0	0.0000	0.3	0.0003	20.3	0.0	0.0	0.40	2.00	
BH04	0.1	1015	0.0	0.0000	0.1	0.0001	20.4	0.0	0.0	0.10	1.45	
BH06	0.1	1015	0.0	0.0000	4.8	0.0048	14.7	0.0	0.0	0.62	1.00	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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Figure Title

Site Location Plan

Project Number

S240106

Project Name

Mill Lane, Batley

Client

Mandale

Date

January 2024

DRG Number

Figure 1

Scale

1:5000 @ A4 [DO NOT SCALE]

Legend Key

- Locations By Type - Empty
- Locations By Type - BH
- Locations By Type - TP
- Project Bounds - Project Bounds

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Figure Title

Exploratory Location Plan

Project Number

S240106

Project Name

Mill Lane, Batley

Client

Mandale

Date

January 2024

DRG Number

Figure 2

Scale

1:1200 @ A4 [DO NOT SCALE]

Legend Key

- Locations By Type - Empty
- Locations By Type - BH
- Locations By Type - TP
- Project Bounds - Project Bounds

Gas Protection Measures – Residential Development

Characteristic Situation	Membrane	Floor Slab	Sub-floor ventilation	External ventilation	Additional measures to reduce gas concentrations in the ground
1	No special precautions				
2 (equivalent to basic radon)	Waterproof DPM (see note below)	Well constructed suspended floor or raft foundation	Beam & block floors; open void min. 150mm depth Suspended in-situ concrete floor: proprietary void former: • Expanded polystyrene shuttering with equivalent clear void depth of 22mm or • Geocomposite drainage blanket Or 20mm single size gravel blanket (min. 300mm thick) Rafts: granular blanket min. 300mm thick (not suitable on sites with high water table)	Area of side ventilation >2,000mm^2/m run of wall Vents on at least 2 opposite sides of ventilation layer (usually via air bricks)	None required
3 (Equivalent to full radon)	Gas resistant membrane (basic)				None required
4	Gas resistant membrane (with aluminium foil)	Well constructed suspended floor (raft foundation unsuitable)	Beam & block floors; open void min. 150mm depth Suspended in-situ concrete floor: proprietary void former: • Expanded polystyrene shuttering with equivalent clear void depth of 22mm (structures <7.5m wide only) or • Expanded polystyrene shuttering with equivalent clear void depth of 100mm (structures >7.5m wide only) or • Geocomposite drainage blanket (structures <7.5m wide only)	Area of side ventilation >4,500mm^2/m run of wall Vents on at least 2 opposite sides of ventilation layer (usually via air bricks) Design of ventilation layer should be checked by calculation	In-ground barrier / in ground venting layer / trenches / wells (see CIRIA 149)
5			Beam & block floors; open void min. 150mm depth		In-ground barrier / in ground venting layer / trenches / wells (see CIRIA 149) Probabilistic QRA required.

Note: DPM should be 2000 g where beam & block floors are used; 1200 g is suitable for cast *in situ* floor slabs

♣Solmek conditions of offer, notes on limitations & basis for contract (ref: version1/2024)

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

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

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

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

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2011 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

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

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

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

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