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By Email

Our ref: 20-340.01L

Shoaib Mahmood
Faum Architecture
Studio 2, First Floor
610 Leeds Rd
Bradford
West Yorkshire
BD3 9TY

12th June 2021

Dear Shoaib,

Re: Land Adjacent to Scar Mill, Lockwood Scar, Huddersfield, HD4 6BL – Hazardous Ground Gas Risk Assessment Addendum Report

This letter report is an addendum to the Phase 2: Ground Investigation Report (GIR) (Project No. 20-153, April 2021) undertaken for the proposed development at the above location.

Please find enclosed:

- ARC Environmental Ground Gas & Groundwater Monitoring Certificate

Monitoring was undertaken using a Gas Data GFM 430, 435 & LMSxi infra-red gas analysers with integral flow meters, and an electronic dipmeter.

Based on the findings of the Phase 1: DTS report and the results of the intrusive ground investigation works, in accordance with CIRIA Report C665, November 2007, NHBC 'Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present', Report Edition No. 4, March 2007, BS8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, and BS8576:2013: Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds, the risk assessment for this site has been based on the following limiting factors:

- The Residential development has been considered as **high sensitivity** (Table 5.5 – Typical/Idealised frequency and period of monitoring, after Wilson et al, 2005).
- The risk associated with the generation potential of a source is considered as **very low**, (assessment based on the environmental setting) as well as observations noted during the fieldworks.
- Monitoring over a **minimum** of **three months** with **six recorded** readings (Table 5.5 – Typical /idealised frequency and period of monitoring after Wilson et al, 2005).
- **Negligible** flow rates have been recorded (Table 8.5 – Modified Wilson & Card classification).

Historically, site visits to undertake gas monitoring are typically carried out at regular intervals (i.e. weekly, fortnightly, monthly, etc.), however this does not always correlate with 'worst case' scenarios for falling atmospheric conditions.

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Re: Land Adjacent to Scar Mill, Lockwood Scar, Huddersfield, HD4 6BL – Hazardous Ground Gas Risk Assessment Addendum Report (Cont'd)

Within CIRIA C665 it is suggested that a 'worst case' scenario for ground gas emissions is more likely to occur during rapid falls in atmospheric pressure, in particular from c.1020mb and c.1010mb. In addition, it has also been suggested that low atmospheric pressures (i.e. c.1000mb and below) can give rise to greater emission potential for lighter gases, in particular methane.

As such for this monitoring, a targeted and phased programme of gas monitoring has been completed which has obtained gas monitoring readings during varying atmospheric conditions and which also covers the 'worst case' scenarios. The monitoring visits correlate to worst case conditions with falling atmospheric pressure trends, and atmospheric pressures below 1000mb and the monitoring results for all 6 no. visits undertaken can be seen attached with this report.

As can be seen from the attached results, no concentrations of Methane (CH₄) were recorded within any of the boreholes. However, detectable levels of Carbon Dioxide (CO₂) were recorded, up to a maximum level of 2.8% v/v, with associated depleted oxygen (O₂) concentrations (minimum 18.3% v/v). In addition, negligible flow rates of <0.1/hr have been recorded during all the monitoring visits.

Based upon the results recorded, in accordance with CIRIA Report C665, the risk to the site from ground gases has been assessed by converting the attached results to gas screening values (GSV's), calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates (after Wilson & Card). As no levels of Methane have been recorded, the GSV for CO₂ only has been calculated, using the maximum recorded value of 2.8% v/v, with a maximum flow rate of <0.1/hr. The GSV has been calculated as follows:

$$\text{Carbon Dioxide GSV} = 0.028 (2.8\%) \times 0.1 = 0.0028 \text{ l/hr}$$

When considering these results, in accordance with CIRIA C665, and considering the NHBC Traffic light system (low rise housing with ventilated underfloor void), the GSV value for CO₂ is below the assessment GSV of 0.78 l/hr (Green classification), resulting in no gas protection measures being required. Alternatively, if the proposed development were to comprise ground bearing floor slabs within the structure, in accordance with CIRIA C665, the GSV for CO₂ would also fall below the lower target concentration of 0.07l/hr and would equate to a Characteristic Situation 1 site classification, resulting in no gas protective measures being required for the proposed development.

We trust the information we have provided to you is to your satisfaction. However, if you require any further information or clarification, please do not hesitate to contact us.

Yours sincerely,



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For and on behalf of Arc Environmental Ltd
Darren McGrath *MIEnvSc FGS Tech IOSH*
Director

Arc Environmental Ground Gas & Groundwater Monitoring Certificate



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|---------------------------------------|
| Site: Scar Mills, Huddersfield |
| Ref: 20-153 |

| Visit | Date | Time | Equipment | Weather | Initials | Comments | Borehole | Gas Flow (l/hr) | Atmospheric Pressure (mb) | Trend | Methane (% v/v) | | Methane (% LEL) | | Carbon Dioxide (% v/v) | | Oxygen (% v/v) | | Hydrocarbons (GFM 435 only) | | Other Gases (PPM) | | | Depth to Water (m bgl) |
|-------|-------------|---------|-----------|-------------------|----------|----------|----------|-----------------|---------------------------|---------------------|-----------------|--------|-----------------|--------|------------------------|--------|----------------|--------|-----------------------------|--------|-------------------|------------------|-----|------------------------|
| | | | | | | | | | | | Initial | Steady | Initial | Steady | Initial | Steady | Initial | Steady | Hex % | PID Cf | PID (Isobutylene) | H ₂ S | CO | |
| 1 | 25/02/2021 | 12.10PM | GFM435 | Mostly Sunny | KC | | 1 | <0.1 | 1003 | Rising (1012-1035) | | 0.0 | | 0.0 | | 2.8 | | 18.3 | | | | 0.0 | 0.0 | 1.57 |
| | | | | | | | 2 | <0.1 | 1003 | Rising (1012-1035) | | 0.0 | | 0.0 | | 0.5 | | 19.6 | | | | 0.0 | 0.0 | 1.47 |
| | | | | | | | 3 | <0.1 | 1003 | Rising (1012-1035) | | 0.0 | | 0.0 | | 0.5 | | 19.3 | | | | 0.0 | 0.0 | 4.49 |
| 2 | 11/03/2021 | 11.20AM | GFM435 | Sunny Spells | KC | | 1 | <0.1 | 973 | Falling (1008-992) | | 0.0 | | 0.0 | | 0.2 | | 19.5 | | | | 0.0 | 0.0 | 1.16 |
| | | | | | | | 2 | <0.1 | 973 | Falling (1008-992) | | 0.0 | | 0.0 | | 0.7 | | 19.3 | | | | 0.0 | 0.0 | 1.57 |
| | | | | | | | 3 | <0.1 | 973 | Falling (1008-992) | | 0.0 | | 0.0 | | 0.4 | | 19.8 | | | | 0.0 | 0.0 | 4.76 |
| 3 | 25/03/2021 | 9.45AM | GFM435 | Slightly Overcast | KC | | 1 | <0.1 | 1010 | Rising (1002-1020) | | 0.0 | | 0.0 | | 0.6 | | 19.4 | | | | 0.0 | 0.0 | 1.22 |
| | | | | | | | 2 | <0.1 | 1010 | Rising (1002-1020) | | 0.0 | | 0.0 | | 0.3 | | 19.8 | | | | 0.0 | 0.0 | 1.60 |
| | | | | | | | 3 | <0.1 | 1010 | Rising (1002-1020) | | 0.0 | | 0.0 | | 0.4 | | 19.6 | | | | 0.0 | 0.0 | 4.52 |
| 4 | 28/04/2021 | 12.50PM | GFM435 | Overcast | JW | | 1 | <0.1 | 993 | Falling (1030-1008) | | 0.0 | | 0.0 | | 2.5 | | 19.8 | | | | 0.0 | 0.0 | 2.00 |
| | | | | | | | 2 | <0.1 | 993 | Falling (1030-1008) | | 0.0 | | 0.0 | | 2.4 | | 20.0 | | | | 0.0 | 0.0 | 1.50 |
| | | | | | | | 3 | <0.1 | 993 | Falling (1030-1008) | | 0.0 | | 0.0 | | 0.7 | | 21.0 | | | | 0.0 | 0.0 | 4.80 |
| 5 | 14/05/2021 | 9.30AM | GFM435 | Overcast | KC | | 1 | <0.1 | 1006 | Falling (1010-997) | | 0.0 | | 0.0 | | 1.1 | | 19.2 | | | | 0.0 | 0.0 | 1.85 |
| | | | | | | | 2 | <0.1 | 1006 | Falling (1010-997) | | 0.0 | | 0.0 | | 0.9 | | 19.5 | | | | 0.0 | 0.0 | 1.42 |
| | | | | | | | 3 | <0.1 | 1006 | Falling (1010-997) | | 0.0 | | 0.0 | | 0.3 | | 19.9 | | | | 0.0 | 0.0 | 4.62 |
| 6 | 02./06/2021 | 11.45AM | GFM435 | Sunny | KC | | 1 | <0.1 | 1012 | Steady (1018-1019) | | 0.0 | | 0.0 | | 1.6 | | 18.8 | | | | 0.0 | 0.0 | 1.92 |
| | | | | | | | 2 | <0.1 | 1012 | Steady (1018-1019) | | 0.0 | | 0.0 | | 1.1 | | 19.3 | | | | 0.0 | 0.0 | 1.49 |
| | | | | | | | 3 | <0.1 | 1012 | Steady (1018-1019) | | 0.0 | | 0.0 | | 0.9 | | 19.5 | | | | 0.0 | 0.0 | 4.65 |

Notes:
 Detection limits - Methane = 0.0%, Carbon Dioxide = 0.0%, LEL = 0.0%, Oxygen = 0.0%, Flow = 0.1l/hr
 Monitoring order is from **Left to Right** across table
 Monitoring should be for **Not Less** than 3 minutes. However, if high concentrations of gases initially recorded, monitoring should be for up to 10 minutes
 N/A = Not applicable = Off the scale

Cf = PID compensation Factor (1-10) - Must be used to multiply the PID reading to give an accurate measure of the total hydrocarbons in the borehole when methane is present
 Hex = Hexane (Valid and in range up to 2.000%) - Recorded when abnormally high methane is present.
 PID = Photo Ionisation Detector (Calibrated to Isobutylene)