

Our Ref C4260/24/E/6523
5th June 2024

Mr Matthew Young
PO BOX 634
Barnsley
S70 9GG



For the attention of Mr Matthew Young

Dear Matthew

Ref: Gas Monitoring at Goldthorpe Housing Project, Victoria Street, Goldthorpe, Rotherham, S63 9HN

Further to our report on a geo-environmental investigation (C4260/24/E/6523) which was presented in May 2024, we have now completed four rounds of gas monitoring and present our findings.

Monitoring

Gas monitoring standpipes were installed between 1.0m and 2.0m depth in boreholes BH02, BH04, BH05 and BH08. The installation details are shown on the appropriate borehole records and the locations are provided on the site plan presented as Appendix 1 of the geo-environmental report. Visits were made to the site between the 9th May and the 3rd June 2024. The results of this work are tabulated below.

| Table 1: Gas Monitoring | | | | | | | | |
|-------------------------|------------|---------------------|---------------------|--------------------|-------------|--------------------------|-----------------|---------------------|
| Location | Date | CH ₄ (%) | CO ₂ (%) | O ₂ (%) | Flow (l/hr) | Barometric Pressure (mb) | Water Level (m) | Standpipe Depth (m) |
| BH02 | 09.05.2024 | 0.1 | 3.3 | 18.0 | 2.7 | 1022 → | 1.39 | 2.00 |
| | 16.05.2024 | 0.1 | 2.7 | 18.6 | 1.7 | 1002 → | 1.06 | |
| | 23.05.2024 | 0.1 | 1.8 | 19.4 | 3.0 | 1004 → | 0.98 | |
| | 03.06.2024 | 0.1 | 1.3 | 19.5 | 0.6 | 1016 → | 0.80 | |
| BH04 | 09.05.2024 | 0.0 | 0.6 | 20.0 | 0.0 | 1023 → | 1.00 | 1.80 |
| | 16.05.2024 | 0.0 | 0.6 | 20.6 | 1.6 | 1003 → | 0.88 | |
| | 23.05.2024 | 0.1 | 0.9 | 20.1 | 0.2 | 1005 → | 0.69 | |
| | 03.06.2024 | 0.0 | 1.0 | 20.2 | 0.0 | 1017 → | 1.49 | |

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| | | | | | | | | |
|------|------------|-----|-----|------|-----|--------|------|------|
| BH05 | 09.05.2024 | 0.0 | 0.5 | 19.8 | 0.0 | 1023 → | 1.85 | 2.00 |
| | 16.05.2024 | 0.0 | 1.1 | 20.6 | 0.0 | 1003 → | 1.85 | |
| | 23.05.2024 | 0.0 | 0.8 | 20.7 | 0.0 | 1004 → | 1.74 | |
| | 03.06.2024 | 0.0 | 0.8 | 20.2 | 0.1 | 1016 → | 1.89 | |
| BH08 | 09.05.2024 | 0.0 | 0.3 | 20.0 | 0.0 | 1023 → | – | 1.00 |
| | 16.05.2024 | 0.0 | 0.5 | 20.5 | 0.0 | 1003 → | – | |
| | 23.05.2024 | 0.0 | 0.4 | 20.7 | 0.0 | 1004 → | 0.81 | |
| | 03.06.2024 | 0.0 | 0.7 | 20.0 | 0.0 | 1016 → | – | |

↑ rising pressure

↓ falling pressure

→ steady pressure

The monitoring visits were undertaken using a Geotechnical Instruments (UK) Ltd. GA5000 (serial No G503524) which was last calibrated on the 20th April 2024.

Gas Concentrations

With respect to ground gas, the results of the monitoring visits indicated maximum 0.1% methane, with concentrations of carbon dioxide ranging between 0.3% and 3.3%, in association with oxygen levels of between 18.0% and 20.9%. It should be appreciated that on non contaminated sites there is generally about 20% by volume of oxygen, associated with low levels of carbon dioxide. In addition, a maximum flow rate of 3.0 litres per hour was recorded and will be employed in the following calculations.

The principal driving force for initiating the movement of gas in the ground is a change in atmospheric gas condition on a site is usually observed on days of low atmospheric pressure, preferably below 1000mb. It has been noted that during high pressure conditions may be of lesser value. At this site the readings undertaken to date were at atmospheric pressures of between 1004mb and 1023mb.



Risk Assessment

In order to establish the gas screening value (GSV) for carbon dioxide or methane, the maximum gas concentration (expressed as a decimal) is multiplied by the borehole flow rate (l/hr). In this case 0.1% (0.001) methane was recorded along with 3.3% (0.033) carbon dioxide, in association with a maximum flow rate of 3.0 l/hr. This results in a GSV of 0.003 l/hr for methane and a GSV of 0.099 l/hr for carbon dioxide.

In accordance with Table 8.5, Modified Wilson and Card classification of the CIRIA report C665, Assessing risks posed by ground gasses to building, the site may be characterised as Characteristic Situation Level 2. It is therefore considered that some remediation measures are required in accordance to Table 8.6, Typical scope of gas protection measures, of CIRIA report C665.

With regard to the number of monitoring visits required reference is made to Tables 5.5a and 5.5b of CIRIA report C665 (2007)¹. Accepting that the proposed development is of high sensitivity (residential with gardens), these tables suggest that 6 readings could be undertaken over a period of 3 months. However, in this case a total of four monitoring visits were undertaken over a four week time period, at which point monitoring was terminated because it was considered that the site could be fully classified as Characteristic Situation Level 2. Therefore, some remediation will be required.

In this context, it should be noted that the gas screening value threshold for Characteristic Situation level 3, is <0.7 l/hr. Assuming the flow rate remains constant at 3.0l/hr the gas concentration would need to increase to 23.3% to move into the next risk band, a seven fold increase. Moreover, by keeping the concentration constant, the flow rate would need to increase to 21.2 l/hr which represents a seven fold increase. It is considered that these increases are not feasible given the flow rates and gas concentrations encountered.

Updated Conceptual Ground Model and Risk Assessment

Table 2: Conceptual Site Model and Site Specific Risk Assessment [Made Ground]

| Pathways | Receptor | Linkage Present | Risk Rating | Notes |
|--|------------|--|-------------|--|
| Migration of hazardous gases via permeable strata or shallow mining activity | Operative | Yes – some levels of carbon dioxide revealed and site is being considered as Characteristic Situation Level 2. | High | Precautionary measures will be required during the construction in order to protect site operatives and the end users. |
| | End User | Yes – some levels of carbon dioxide revealed and site is being considered as Characteristic Situation Level 2. | High | |
| | Neighbours | Yes – however, as no adjoining structures are present, it is considered that ground gasses will vent directly to atmosphere. | Low | |

For definitions of the risk ratings, see section 10.2.2 of the geo-environmental report.

¹ Adapted from tables 5.5a and 5.5b of CIRIA C665, 2007, *Assessing risks posed by hazardous ground gas to buildings*, p60.



Remediation Strategy for Ground Gas

For this site, the remediation strategy presented within the geo-environmental report (section 10.3) has been updated to include the following elements:

Ground-works

The risks to site personnel highlighted within the contractor's Health and Safety Plan and Site Specific Method Statements should include making site operatives aware of the hazards of working in an environment where accumulations of carbon dioxide could occur.

Gas Protection Measures

In order to assess the protection measures required BS8485: 2015 +A1: 2019: *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* has been employed. In accordance with Table 3, *Building types*, of the code, the development may be considered to conform to Type A. Therefore, on the basis of Table 4 *Gas protection score by CS and type of building*, the minimum gas protection score (points) is 3.5. The gas protection system should consist of at least two different elements. The elements work independently and collaboratively, and a single element should not be used because there would be no redundancy to allow for defects in the component.

In order to achieve this score the following shall be undertaken.

| Reference | Protection Element | Score |
|----------------------|--|------------------------------|
| Table 5 | Precast suspended segmental sub-floor (i.e. beam and block). | 0 |
| | Cast insitu ground-bearing floor slab (with only nominal mesh reinforcement). | 0.5 |
| | Reinforced ground bearing raft or reinforced slab with minimal penetrations. | 1.0 or 1.5 ² |
| Table 6 ³ | Pressure relief pathway ⁴ (usually formed of low fines gravel with a thin geocomposite blanket or strips terminating in a gravel trench external to the building) | 0.5 |
| | Passive sub-floor dispersal layer (Note 1): | |
| | Good Performance | 1.5 |
| | Very good performance | 2.5 |
| Table 7 | Gas resistant membrane complying with the requirements given in Table 7 (Note 2) | 2 |
| Total Score | | Min: 3.5 Max: 4.5 |

² To achieve a score of 1.5, the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in.

³ For details on the criteria for good and very good performance see Annex B of BS8485: 2015.

⁴ If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is zero.



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Note 1:

Dispersal layers could include:

- Clear void.
- Polystyrene void former blanket.
- Geocomposite void former blanket.
- No-fines gravel layer with gas drains.
- No-fines gravel layer.

Note 2:

The gas resistant membrane shall meet the following criteria (from Table 7, BS 8485: 2015):

- Sufficiently impervious (methane gas transmission rate $<40.0\text{ml/day/m}^2/\text{atm}$ (average) BS ISO 15105-1 manometric method).
- Sufficiently durable and strong to remain serviceable for the anticipated life of the building, to withstand in-service stresses and installation process.
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas.
- Verified in accordance with CIRIA C735: 2014: *Good practice on the testing and verification of protection systems of buildings against hazardous ground gasses.*
- Chemically resistant to degradation by other contamination that might be present.

It should be appreciated that if the membrane installed does not meet all the criteria above, then the score for the membrane is considered to be zero.

In addition to the above, the following points shall be considered.

- Technical drawings of the incorporation of the gas protection measures into the sub-structure will be provided by a suitably qualified engineer/architect and produced in accordance with the guidance given in BRE 414.
- The sequence of construction indicating when the gas protection system will be installed shall be provided with the remediation statement. Where possible the installation shall take place as a unique activity on site and shall not be completed until sub-structure construction is complete.
- At the time of installation of the membrane, all parties in attendance at the site shall be made aware that a gas protection system is to be employed within the construction. Such communications should include, but not be limited to, the CDM documentation for the site and site inductions.
- The installation of the membrane shall be carried out only by suitable personnel and the qualifications or experience/training will be included as part of the remediation statement. The suitability of personnel will be assessed in accordance with Annex 1 of CIRIA C735.
- The installation shall be in strict accordance with manufacturer specifications and recommendations, which shall also be included as part of the remediation statement.
- The membrane system employed will not be an ensemble (i.e. a system comprising a mixture of products from different manufacturers will not be employed).
- Membranes shall be supplied to site on a single wound roll, creased product will not be accepted or employed.



- Whilst membranes are exposed, signage will be provided to indicate the access to the installation area is prohibited unless authorised. Footwear will be checked prior to accessing the membrane surface to ensure no sharp objects are apparent, such as stones caught in treads. The use of sharp objects or hot-works around the exposed membrane will be strictly prohibited unless the risk of damaging the membrane has been full assessed and mitigated.
- Non-conformance of manufacturer recommendations shall be discussed and agreed as acceptable, in writing, with a suitably qualified person from the manufacturer.

References

- British Standards Institution (2013), BS 8576 Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds.
- British Standards Institution (2015 +A1:2019) BS8485: *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*, B.S.I., London.
- CIRIA Report C665, *Assessing risks posed by ground gasses to building*.

We trust that this information is of interest and should you have any other requirements do not hesitate to contact us.

For Rogers Geotechnical Services Ltd,

Yours Faithfully



James Finch BSc FGS
Graduate Engineer



CERTIFICATION OF CALIBRATION



No. 66916



Certificate Number: G503524_2/35282

Date Of Calibration: 20-Apr-2024

Issued by: QED Environmental Systems Inc.

Customer: QED ENVIRONMENTAL SYSTEMS LIMITED

QED ENVIRONMENTAL SYSTEMS LTD CYAN PARK - UNIT 3 JIMMY HILL WAY COVENTRY, WEST MIDLA CV2 4QP GB

Description:

Model: GA5000

Serial Number: G503524

Accredited Results:

Methane (CH4)

| Certified Gas (%) | Instrument Reading (%) | Uncertainty (%) |
|-------------------|------------------------|-----------------|
| 5.1 | 5.0 | 0.42 |
| 15.0 | 14.9 | 0.66 |
| 60.0 | 59.7 | 1.03 |

Carbon Dioxide (CO2)

| Certified Gas (%) | Instrument Reading (%) | Uncertainty (%) |
|-------------------|------------------------|-----------------|
| 5.0 | 5.0 | 0.43 |
| 15.0 | 15.0 | 0.71 |
| 40.0 | 40.0 | 1.19 |

Oxygen (O2)

| Certified Gas (%) | Instrument Reading (%) | Uncertainty (%) |
|-------------------|------------------------|-----------------|
| 20.9 | 21.0 | 0.25 |

Gas cylinders are traceable and details can be provided if requested.

CH4, CO2 readings recorded at: 31.2 °C/88.1 °F

O2 readings recorded at: 22.1 °C/71.7 °F

Barometric Pressure: 0987 mbar/29.15 "Hg

Method of Test : The analyzer is calibrated in a temperature controlled chamber using a series of reference gases, in compliance with procedure ISP17.

Instrument has passed calibration as the measurement result is within the specification limit. The specification limit takes into account the measurement uncertainty.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with NIST requirements.

The calibration results published in this certificate were obtained using equipment capable of producing results that are traceable through NIST to the International System of Units (SI). Certification only applies to results shown. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Calibration Instance: 118

IGC Instance: 118

www.qedenv.com (800) 624-2026 info@qedenv.com

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QED Environmental Systems Inc. 2355 Bishop Circle West, Dexter, MI 48130

CERTIFICATION OF CALIBRATION



Date Of Calibration: 20-Apr-2024

No. 66916

Certificate Number: G503524_2/35282

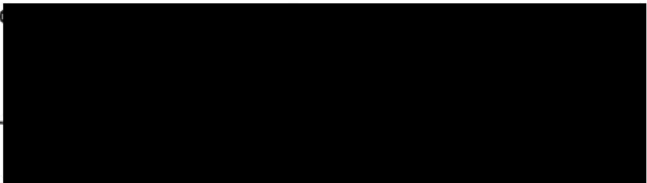
Issued by: QED Environmental Systems Inc.

Non Accredited results:

| Pressure Transducers (inches of water column) | | | | | |
|---|-----------------|---------------|------------------|----------------|----------|
| Transducer | Certified (Low) | Reading (Low) | Certified (High) | Reading (High) | Accuracy |
| Relative | 0" | 0" | 40" | 40.33" | 2.0" |

| Barometer (mbar) | |
|-----------------------|-----------------------|
| Reference | Instrument Reading |
| 0987 mbar / 29.15 "Hg | 0987 mbar / 29.16 "Hg |

As received gas check readings are only recorded if the instrument is received in good condition. Where the instrument is received damaged no reading can be taken.



Date of Issue : 24 Apr 2024

Approved By Signatory

Laboratory Inspection

The calibration results published in this certificate were obtained using equipment capable of producing results that are traceable through NIST to the International System of Units (SI). Certification only applies to results shown. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Calibration Instance: 118

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Notes:

Investigation positions approximated from site operative's notes.



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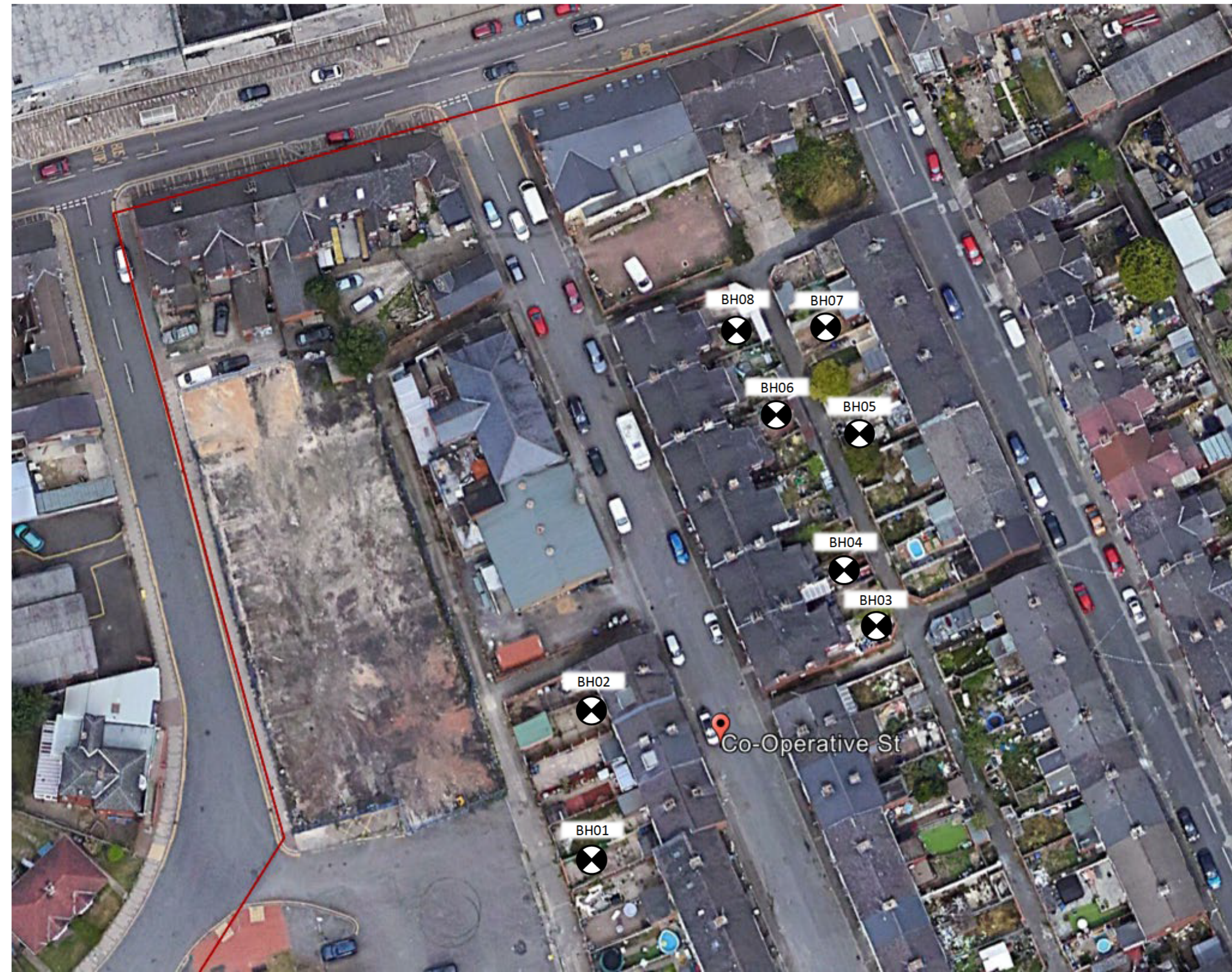
Job Number:

C/4260/24/E/6523

Project Details:

Goldthorpe Housing Estate

Scale: Not to scale - reference only





Notes:
Investigation positions approximated from site operative's notes.



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Client:
Barnsley Council

Job Number:
C/4260/24/E/6523

Project Details:
Goldthorpe Housing Estate

Scale: Not to scale - reference only

