



A GROUND GAS VERIFICATION PLAN FOR SYMMETRY PARK, HUYTON, MERSEYSIDE

ISSUE 1.1

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Prepared for:

Tritax Symmetry Ltd

Prepared by: Alex Preston

Tier Environmental Ltd

Chadwick House,
Birchwood Park, Warrington,
WA3 6AE

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1. INTRODUCTION

Tier Environmental was commissioned by Tritax Symmetry Ltd to undertake a Ground Gas Verification Plan for the Symmetry Park development located off Fox's Bank Lane, Cronton, L3 5SU. The redevelopment is to comprise multiple industrial warehouses each with associated car parking areas, surface water attenuation ponds and areas of soft landscaping. In the south and eastern areas of the Site it is proposed that the site will be redeveloped into a country park, comprising woodland, ephemeral lakes and footpaths. A large scale earthworks exercise (approximately 450,000m³ of cut/fill) is proposed to provide the appropriate development platforms and highway gradients.

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

- To propose ground gas mitigation measures in line with current British Standards and best practice; and,
- To produce a Ground Gas Verification Plan in accordance with CIRIA C735.

This report, which was designed to meet the requirements of all relevant current guidance including Land Contamination: Risk Management on the www.gov.uk website, presents the factual information available during this appraisal, interpretation of the data obtained and recommendations relevant to the defined objectives.

The comments and opinions presented in this report are based on the findings of the desk study, ground conditions encountered during intrusive investigation works and the results the ground gas monitoring. 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 Tritax Symmetry Ltd. 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.

This report does not include for assessment of risks to construction workers as any redevelopment and construction work should be conducted in accordance with HS(G)66. Similarly, nuisance health effects are not considered within this report. The Statutory Nuisance Act considers olfactory impacts from odours and allows comparison of enclosed space air concentrations with odour threshold concentrations.



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2. SITE DETAILS AND DESCRIPTION

Table 2-1. Current Site Overview.

Site name	Former Cronton Colliery
Site address	Halsneads Farm Livery Stables, Fox's Bank Lane, Cronton, L353SU. A site location plan is included as Drawing No. TE1163GIR1 within Appendix A.
National Grid Reference	SJ 47493 89537
Location description	The Site is located south of the M62 in a predominantly agricultural area. The closest town is Whiston which is 2.3 km North of the Site.
Approximate Site area	28.96ha
Site shape	Irregular with the longest axis in the east to west direction and the shortest axis being in the north to south direction.
General topography and ground levels	The Site is generally undulating with ground levels in the north of the site ranging from 44m AOD in the east to 24m AOD in the west. The southern area of the site is a plateau at 34m AOD with a steep slope towards the south to 25m AOD. Ground levels in the eastern area of the site generally decrease from 48m AOD in the centre to 40m AOD in the west and 34m AOD in the east and south.
Current land use	The Site is currently unoccupied with no above ground structures. The northern area of the Site is currently occupied by grazing and agricultural land. The southern and eastern areas of the Site are currently occupied by immature woodland on the regraded colliery spoil slopes. The area of the southern access road is covered with concrete hardstanding with bridge/embankment structure.
Existing structures	There are 3 No. methane vent pipes located within the centre of the site overlying the 3 No. old mine shafts used by the former colliery
Site ground surfaces	The northern agricultural section of the site is covered by arable land. The central and southerly sections are comprised of scrubland with exposed colliery spoil surficial gravelled expanses.
Sub-surface structures	Relict structures associated with historic site use as a colliery may be present in the southern area of the site. A total of 2 No. septic tanks are located within the site boundary, one south of Halsnead Lane and one north of Park Villas in the south of the Site. Additional unrecorded services should be anticipated.
Invasive plant species	Localised Himalayan balsam and Japanese knotweed have been recorded across the site. Further details can be found from the invasive plant survey undertaken.



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3. THE GROUND GAS REGIME

A Ground Investigation Report was undertaken for the Site including a ground gas risk assessment (Tier Environmental, A Ground Investigation Report for the Former Cronton Colliery, Slade Lane. Reference No. TE1163GIR, dated 23rd October 2020. As such, reference should be made to this report with regards to the detail behind the ground gas risk assessment undertaken.

3.1. Ground Gas Monitoring and Risk Assessment

Ground gas monitoring installations were constructed in locations RB102, WS101, WS103, WS104, WS105, WS106, WS107, WS108, WS110, WS111, CP101, CP103, CP102, CP104, CP108, CP105, CP106 and CP107 with response zones in the Made Ground (RB102, WS101, WS106, WS110, WS111), Till deposits (WS103, WS104, WS105), Till deposits and Pennine Middle Coal Measures (CP101 to CP108). Individual standpipes were used exclusively except within CP105, CP106 and CP107 where nested standpipes were used.

Monitoring comprised measurement of pressure, methane (CH₄), , percent of lower explosive limit (LEL), carbon dioxide (CO₂), oxygen (O₂), hydrogen sulphide (H₂S), gas flow rate.

The ground gas monitoring presented in this report was performed on 3 No. occasions between the period 2nd August 2019 and the 30th August 2019 and 4 No. occasions during the period 2nd September 2020 to 14th October 2020. The rationale behind this monitoring period is to determine the hazardous ground gas concentrations from a moderate risk source for a proposed commercial land use in accordance with CIRIA C665. The full ground gas monitoring results from the installations are presented in Appendix N.

The total atmospheric pressure range of the ground gas monitoring data included in this report was from 1001mbar to 1019mbar. This range covers moderate to high atmospheric pressures. Monitoring events included periods of stable, rising and falling atmospheric pressure

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 G. The conclusion of the assessment is that across the site a worst case maximum peak and steady concentration of carbon dioxide of 15.6% v/v was reported at WS8 with a corresponding lowest peak and steady oxygen concentration of 0.2% v/v at WS9 during the second monitoring visit. A maximum peak concentration of methane of 1.4% v/v and a steady concentration of 0.4% v/v was reported at the Site. A maximum carbon monoxide level of 18ppm, which is below the workplace long term exposure limit (30ppm) and a maximum hydrogen sulphide level of 1ppm was recorded during the third monitoring visit which is below the long-term UK Workplace Exposure Limit (WEL) limit of 5ppm and the short term WEL of 10ppm. A maximum peak positive flow rate of 9.1l/hr has been reported at WS10, with a maximum steady flow rate of 2.1l/hr also reported at WS10. A maximum negative flow rate of -0.6 l/hr has been reported at the Site.

Further assessment of the maximum reported flow rates has been undertaken. This assessment has focussed on the elevated peak flow rates observed in excess of 5.0 l/hr. Peak flow rates in excess of 5.0 l/hr were recorded in 2 No. of the wells with a maximum recorded peak flow rate of 9.1 l/hr (WS10). It is considered that the flow rate data from well WS12 may be reasonably discounted whilst determining the gas screening value because the water level within this borehole was resting within the plain section of the standpipe. It has been observed that the flow rate is a function of 'groundwater pumping' where the shallow groundwater fluctuations artificially create pressure changes in the plain section of the monitoring pipe that in turn generates artificial flow rates.

The peak flow rate of 9.1 l/hr observed at WS10 was observed during the first monitoring visit whilst the well was still stabilising from installation, furthermore this peak flow rate dropped to a steady rate of 2.1l/h. BS8485:2015 states 'Adopting a GSV calculated from peak flow measurements might result in a disproportionately high gas hazard prediction and assignment of an over-precautionary CS'. It also states when performing a worst



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case check scenario any peak instantaneous flows and negative flows which have been judged to be unrepresentative should be discounted. The elevated peak instantaneous flow rates encountered are considered to be unrepresentative as they were observed to rapidly reduce. Therefore the steady flow rate of 2.1l/hr has been used in the GSV calculations.

In accordance with CIRIA C665, the assessment of these results obtained to date produced a maximum Gas Screening Value of 0.3276l/hr, derived using the maximum recorded carbon dioxide concentration of 15.6%v/v and the maximum peak flow rate of 2.1l/hr. Assessment of this gas screening value alone places the Site in a Characteristic Situation 2. A low risk scenario in accordance with CIRIA C665 for which ground gas protection measures will be required in areas where colliery spoil is to be retained/relocated to or areas in the vicinity of the shallow coal seam.

At the time of writing the final development layout for the site is not confirmed, as such where different material types are to be relocated around the site cannot be confidently discerned. Under each of the current proposed units is an area where ground levels need to be increased. To do this may use any material type found within the site. It is therefore considered prudent to utilise a worst case scenario from across the entire Site, as undertaken above to adequately protect future end users.

Tier Environmental have also considered the risk from the outcropping coal seam and faulting system that underlies the Site, targeting multiple boreholes above these features. After a thorough review of the conceptual site model, gas data to date and development plans Tier Environmental are satisfied that a CS2 scenario across the Site, will adequately protect the Proposed Development from ground gas.

It is also noted that gas levels have been monitored from the 3 No. mine shafts present on Site every two months for the last ten years. A Mine Gas Emission Report was procured from the Coal Authority. Elevated methane and carbon dioxide levels were noted between 2005 and 2014. These were observed to drop below 5% in all 3 No. shafts with no concentrations recorded in 2 No. shafts. It is considered the elevated levels of ground gas observed initially may have been caused by the mines flooding and rising groundwater levels forcing gases upwards following the cessation of groundwater pumping with the closing of the colliery. This has since stabilised as groundwater levels have returned to natural levels.



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4. GROUND GAS REGIME PROTECTION MEASURES

4.1. Remedial Objectives

The remediation objectives are to break the potentially active linkage between bulk ground gas from beneath the Site and the buildings or future Site users associated with the proposed development.

4.2. Radon

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

4.3. Foundation and Floor Slab Design

Guidance document BS8485:2015 states that “*The construction and use of the building, together with the control of future structural changes to the building and its maintenance (the building’s management) should be assessed, since potential risks posed by ground gases are strongly influenced by these factors. The assessment should lead to the categorization of the building as a whole, or each different part of the building, into one of four building types: Type A, Type B, Type C or Type D.*”

The ground gas monitoring data, taken from across the Site, has categorised the ground gas regime prevailing beneath the Site as Characteristic Situation 2 – Low Risk in accordance with CIRIA C665.

It is therefore considered likely that the **ground floor** office areas of the proposed units will fall under a Type C scenario and the remainder of the warehouses would likely fall under a Type D scenario.

Type D building: *industrial style building having large volume internal space(s) that are well ventilated. Corporate ownership with building management controls on alterations to the ground floor and basement areas of the building and on maintenance of ground gas protective measures. Probably civil engineering construction. Examples are retail park sales buildings, factory shop floor areas, warehouses.*

Type C building: *commercial building with central building management control of any alterations to the building or its uses and central building management control of the maintenance of the building, including the gas protection measures. Single occupancy of ground floor and basement areas. Small to large size rooms with active ventilation or good passive ventilation of all rooms and other internal spaces throughout ground floor and basement areas. Probably civil engineering construction. Examples include offices, some retail premises, and parts of some public buildings (such as schools, hospitals, leisure centres and parts of hotels).*

In accordance with Table 4 of BS8485:2015, a low hazard potential would require a points score of 1.5; however, there is a requirement to ensure at least two types of protection measures should be implemented. This is based on a Type D building as defined in Table 3 of the aforementioned British Standard. For the office areas (Type C building), a point score of 2.5 would be required.

For a Characteristic Situation 2 – Low Risk scenario:

A points score of 2.5 (which would satisfy both office and warehouse areas) may be attained thusly:

- Gas resistant membrane which satisfies specification of Table 7 of BS5930:2015, lapped and sealed – **2 points** and;



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- Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)– **0.5 points**.

Or:

- Gas resistant membrane which satisfies specification of Table 7 of BS5930:2015, lapped and sealed – **2 points** and;
- Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations. – **1 or 1.5 points** (To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations).

Or:

- Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations. – **1 or 1.5 points** (To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations) and;
- Passive sub floor dispersal layer. Very good performance – **2.5 points**. Good Performance - **1.5 points**. Performance criteria for methane and carbon dioxide within passive sub floor dispersal layers are shown in Figure B.6 and Figure B.7, of BS5930:2015, respectively.

The gas resistant membrane should meet the following criteria in order to achieve the necessary 2 points in accordance with Table 7 of BS8485:2015:

- Sufficiently impervious to the gases with a methane gas transmission rate $<40.0 \text{ ml/day/m}^2/\text{atm}$ (average) for sheets and joints (tested in accordance with BS ISO 15105-1 manometric method);
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools etc);
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- Verified in accordance with CIRIA C735

It is considered that the combination of gas protection measures specified above would provide a sufficient 3.5 points of protection required in accordance with BS8485:2015.

The ground gas membrane installer and detailed specification for the ground gas protection measures will be confirmed in an updated version of this report.

The gas resistant membrane will conform to guidance document BS8485:2015, Table 7.

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 CO_2 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



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published information defining safe occupational exposure levels for CO₂ and the latest guidance must be consulted to determine whether the ground gas regime necessitates specific precautions during site works.

- Methane concentrations in ground gas. The measured methane concentrations in ground gas reported are significantly elevated and could give rise to explosive mixtures in confined spaces. Safe working methods should be adopted to mitigate this risk

It is understood that the proposed floor slabs will be mesh reinforced and the membrane will be protected via 'mars bar' baffles beneath the steel-work. The slabs should be poured via pumped cement where possible (to avoid vehicular movements across the slab). In addition, plywood boards should be used to protect the membrane where required and the cement should be laser levelled again to reduce the interaction between floor slab construction and the membrane and reduce the risk of damage to the membrane.



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5. GROUND GAS VERIFICATION PLAN

5.1. General

An informed and risk-based approach has been taken as part of the verification plan, which has been produced to determine the following:

1. Decide which stakeholders are deemed suitable to undertake the necessary verification procedures;
2. How many site inspections should be undertaken; and,
3. The need for, and scope of, any integrity testing.

This risk-based system has taken into account the various factors that have influenced the scope of verification activities (including the possibility of integrity testing), which have included:

- Site-specific gas regime;
- Number of buildings to be inspected and the period over which this will take place;
- Complexity of the design and installation; and,
- Qualifications and experience of the workforce.

Figure 5.1 has been modified from CIRIA C735, with the red dots showing the relative placement of the site.

5.2. Contractor and Materials Information

The installation contractor is not known at this stage and will be confirmed in an updated version of this report.

Any at any point the confirmed contractor changes, this will be subject to an updated version of this report being prepared.

It is proposed that the gas membrane used, should be defined as being BS8485: 2015 +A1: 2019 compliant as a carbon dioxide and methane barrier.



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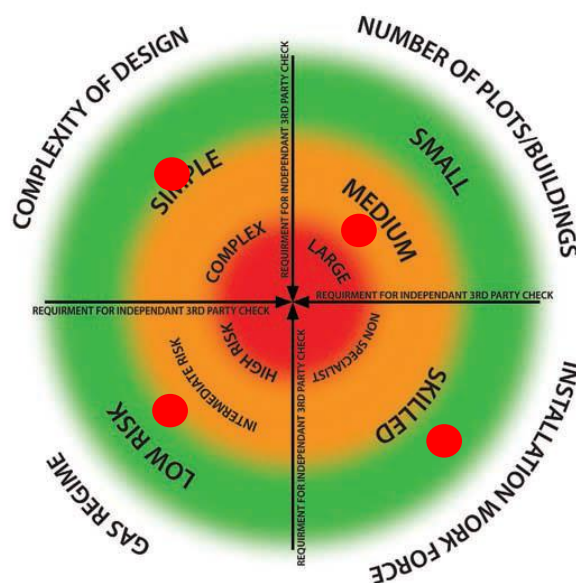


Figure 5.1 Analysis of the variables which have influenced the scope of the verification plan for this site.

5.3. Independence and Competence

In respect to the level of competence required in general ground remediation, the Environment Agency recommends that conflicts of interest in verification should be avoided. A contractor or gas membrane supplier certifying their own work or product is considered to be a conflict of interest and is therefore not good practice. If verification is carried out by the same company (or related company) that carried out the installation then the process, the results and report should be audited by an independent consultant.

The verification will be undertaken by Tier Environmental.

5.4. The Inspection Regime

The gas membrane installation should be subject to a visual verification inspection to establish the adequacy of the ground preparation and, subsequently, possible damage to the installed gas membrane. The inspection visits should fall generally in line with the following:

1. The verifier should be a suitably qualified engineer with sufficient training and experience.
2. The contractor should determine whether an area to be covered in a ground gas membrane is ready for inspection by initiating contact with verifier;
3. The verifier would then inspect all areas of interest (including sub floor ventilation) with the site manager or groundworks supervisor;
4. The inspection will cover:
 - The ground prepared for the gas membrane which should be clean and free from stones etc;
 - The installation of the membrane to an acceptable standard, and;



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- The membrane itself.
5. The verifier should also inspect the gas membrane itself over the whole floor area, paying particular attention to laps, edges and the sealing of service entries and penetrations such as vent pipes;
 6. The visual inspection should be recorded on the Gas Protection Verification Pro Forma, as presented in Appendix G of this report;
 7. Any discrepancies with the installation method recommended by the gas membrane supplier should be highlighted. These may include small or large holes and rips, tears and punctures, absence of tape (double sided or single sided tape) on the lapped areas, loose or unstuck tape, inadequate corner details, and unbounded seams such as loose edges and 'fish mouths' in the gas membrane;
 8. Tapes used to join gas membranes should be inspected to make sure they are compatible with the gas membrane being joined and are as specified by the gas membrane supplier or specifier; non-proprietary gas resistant tape should never be used to seal a gas membrane. Where welded joints are used, the verifier should ensure they are correctly tested;
 9. Repairs should be instructed and observed on the same day as the site visit or inspected at a later date. This will be documented on the Gas Protection Verification Pro Forma for that visit. The frequency and intensity of inspections should increase to reflect any lower level of competence of the workers installing the gas protection system;
 10. As the membrane may be located below reinforced slabs, inspections should take place after the installation of the membrane and also before concreting. The concrete should then be poured as soon as possible after the gas membrane has been signed off, in order to ensure that follow-on trades do not damage a gas membrane that has been signed off; and,
 11. All follow-on trades should be made aware of the presence and purpose of the gas membrane, and who they should contact if they believe their actions have had the potential to compromise it.

The final verification report will include plot specific photographs as supporting evidence. A pro forma should be completed for each inspection visit. All pro formas should be retained for inclusion within the final verification report in order to demonstrate the involvement of the verifier throughout the process and provide evidence of the appropriate installation of the gas protection measures. An example pro forma which highlights all aspects to inspect is provided in Appendix G of this report.

5.5. Inspection Timing and Frequency

There is currently no absolute guidance relating to the number and frequency of visits; however, for the purposes of this verification plan, reference has been made to Table A1 within Annex 1 of CIRIA C735. Whilst at this stage it is not possible to give specific dates for inspection visits, the following rules should be adhered to when attending site to make the required visual inspection (relative to the site specific risks shown in Figure 5.1).

If skilled (defined by CIRIA C735 as holding NVQ Level 2 qualification in gas protection installation). installers are the verifier is to conduct a thorough verification (visual) inspection of the membrane and installation prior to between 25 and 50 per cent of concrete pours with inspections undertaken just prior to a concrete pour event. If unskilled (no NVQ qualification) installers are the verifier is to conduct a thorough verification (visual) inspection of the membrane and installation prior to between 50 and 75 per cent of concrete pours with inspections undertaken just prior to a concrete pour event. It is proposed that inspections will be conducted on all of the 4 No. proposed units at the Site.

Inspection will be predominantly visual but may include the mechanical point stress test (this involves running a blunt instrument (e.g. a screwdriver) along the edge of the seam to identify any unbounded seams).



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The installer to supply sign off sheets (verification evidence) including photographs to the verifier.

After all inspections are completed it is advised that the membranes are protected using insulation and/or other adequate measures to prevent any damage before the concrete pour. It is also advised that signs are displayed around the Site advising all site users of the presence of the gas membrane and noting measures to avoid damage to the membrane.

5.6. Integrity Testing

Consideration has been made to the use of integrity testing as part of the verification of the gas protection measures. In determining the requirement for integrity testing, reference has also been made to the diagram in Figure 5.1 and Table A1 of Annex 1 of CIRIA C735:

- The Site is a Characteristic Situation 2 - Low Risk scenario;
- The membrane is being inspected by a qualified geoenvironmental engineer; and,
- The absence of a sub floor void in some instances precludes the use of most integrity testing techniques.

As such integrity testing is not currently recommended in this verification plan. It should be noted; however, that this is dependent upon the results of the initial verification visits. If, following these initial visits, it is deemed by the verifier that the installation is of a questionable standard, the use of integrity testing may be added to this verification plan. The results of any integrity testing must therefore be included in any final verification report.

5.7. Non-Conformances

Non-conformances to this verification plan will be recorded and noted to the contractors. Works will be then undertaken to rectify any non-conformance either under the supervision of Tier Environmental Ltd or a subsequent inspection will be undertaken post remedial works to verify that the non-conformance has been adequately rectified. An assessment will be made, depending on the scale, nature and extent of the non-conformance as to whether the Contaminated Land Officer (or equivalent) shall be notified including agreement of any measures to be taken to rectify the situation.



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6. VERIFICATION REPORT

The reporting of verification activities and integrity testing of gas barriers will be in general accordance with the relevant guidance (Environment Agency, 2010a and b). The reporting requirements will reflect the type and level of verification activity and integrity testing (if deemed to be required by the verifier) carried out at this site.

The final report will inform all the relevant stakeholders (regulators, site owners, funders, the local community etc) of the verification activities/integrity testing undertaken and will provide a logical framework to demonstrate confidence in the installation of the ground gas protection measures.

The SE will maintain records of the works to ensure the Verification Report will include the following:

- Site details and reasons for carrying out remediation;
- Planning Application details;
- Details of the various parties involved in the project, i.e. client, consultant, contractor, installer, verifier;
- A summary of the original site conditions and ground gas risk assessment carried out;
- The CSM for remediation identifying each pollutant linkage to be addressed by remedial activities, and the lines of evidence to test whether the linkages are broken;
- A description of the ground gas protection measures put in place, with reference to detailed design drawings;
- A clear description of this verification plan, including the methods used for data collection and interpretation;
- A description of the inspection regime (who carried out the inspections, their competence to do so, over what period, at what frequency and supported by a written record, e.g. completed pro formas and captioned photographs presented in the appendices);
- Presentation of the manufacturer's material(s) specifications(s) for all elements of the gas protection system, including warranty information;
- A summary of progress data, such as completed pro formas and monitoring results;
- Details of non-conformances and how they were rectified;
- Where necessary, details of further works and/or long-term management (if required);
- Details of all communications held with regulatory bodies during implementation; and,
- A clear statement, based on the presentation of 'lines of evidence' and review of the CSM, of the extent to which the remedial objectives and criteria have been achieved and the presence, extent and nature of any residual hazards.



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HUYTON, MERSEYSIDE**

Project No:	TE1163GVP1.1
Page No:	13 of 15
Engineer:	Alex Preston
Date:	29/03/2023

7. 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 organisations for 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.



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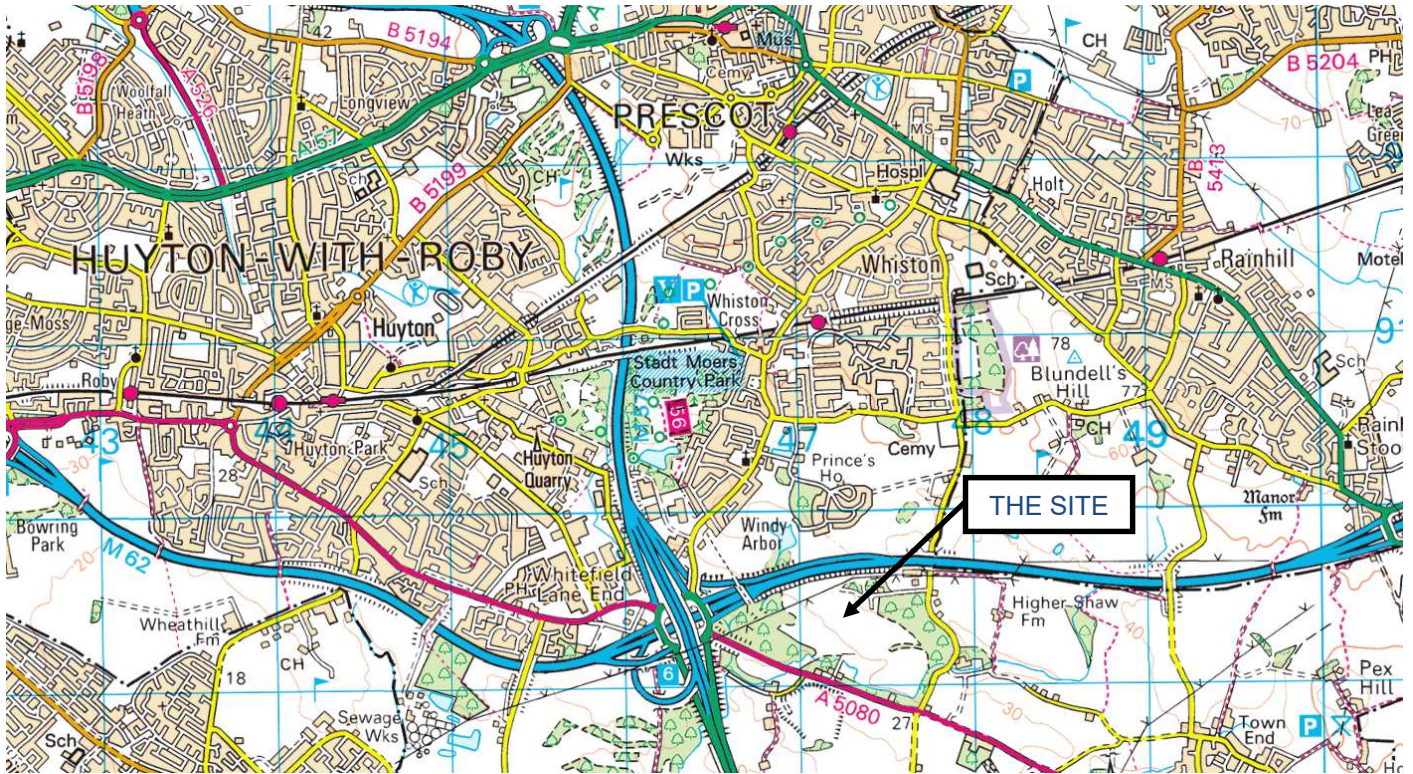
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APPENDIX A – FIGURES AND DRAWINGS



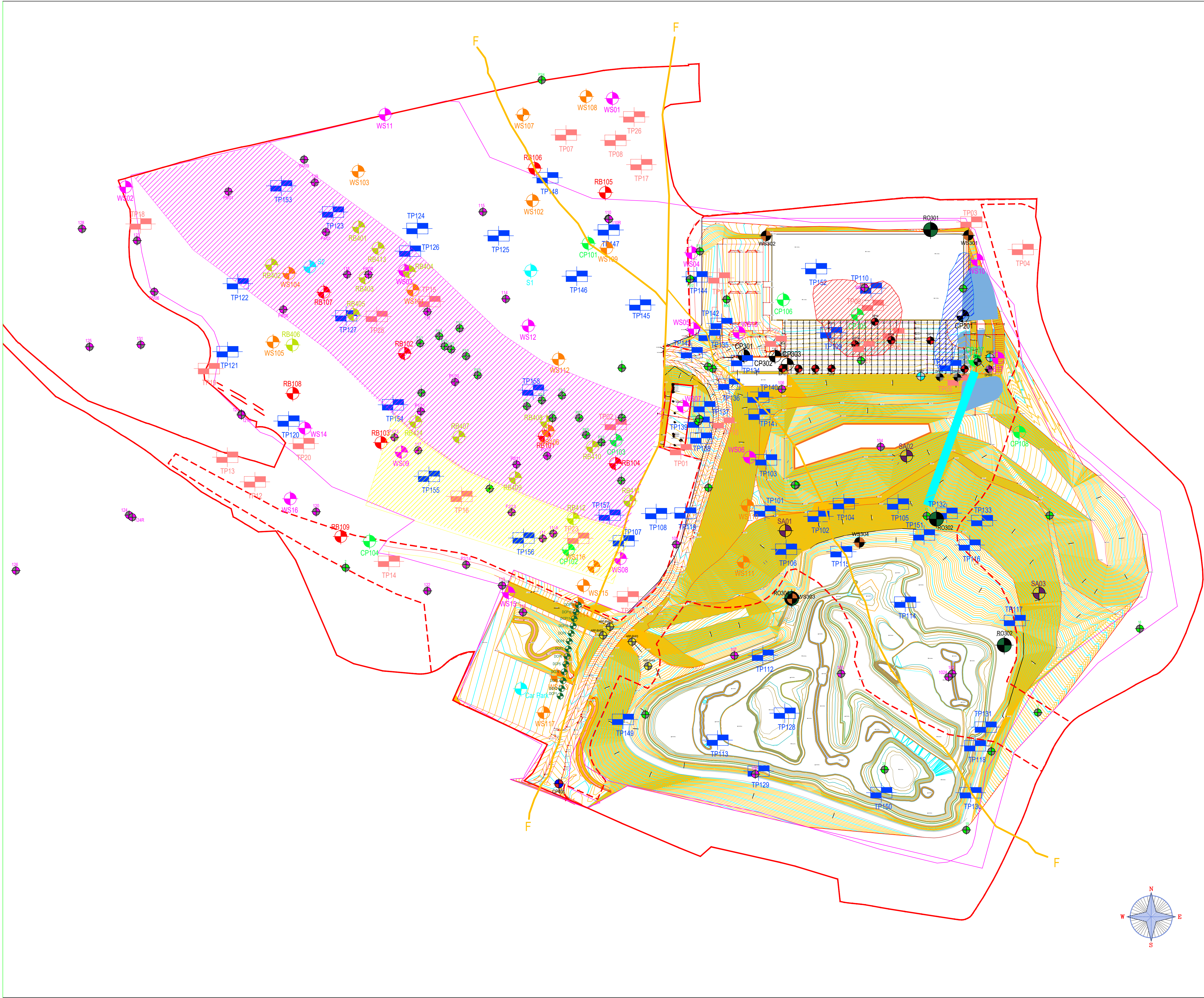
Site Location Plan

Contract Number	TE1163
Contract	Former Cronton Colliery Site
Client	Tritax Symmetry Limited



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Scale	NTS	
Drawn by	JS	Approved SL
Drawing Number	TE1163PRA1	



DO NOT SCALE

TIER

NOTES

1999 LOCATIONS:

PARHAM ROTARY CORE LOCATIONS

2003 LOCATIONS:

SOIL MECHANICS ROTARY CORE LOCATIONS

2019 LOCATIONS:

WINDOW SAMPLE LOCATION

TRIAL PIT LOCATION

2020 LOCATIONS:

TRIAL PIT LOCATION

ROTARY BOREHOLE LOCATION

WINDOW SAMPLE LOCATION

CABLE PERCUSSIVE LOCATION

SAMPLE LOCATION

DOP LOCATIONS

2022 LOCATIONS:

CABLE BOREHOLE LOCATION

DP LOCATION

WINDOW SAMPLE LOCATION

CABLE PERCUSSIVE LOCATION

ROTARY OPENHOLE LOCATION

2023 LOCATIONS:

DP LOCATION

WINDOW SAMPLE LOCATION

CABLE PERCUSSIVE LOCATION

ARIP LOCATION

ROTARY BOREHOLE LOCATION

HISTORIC COLLIERY SETTLEMENT LAGOON

SILT REMOVED

SILT REMOVED

APPROXIMATE AREA THAT REQUIRES DRILL AND GROUTING

REQUIRED CONFIRMATORY BOREHOLES TO ESTABLISH ADEQUATE COVER IS PRESENT

DRAINAGE RUN

FAULT - APPROXIMATE LOCATION

WORSLEY FOUR FEET COAL SEAM

UNNAMED INFERRED COAL SEAM

P1

03/08/2023

CS

ISSUED FOR INFORMATION

AP

AP

REV

DATE

BY

DESCRIPTION

CHK

APD

DRAWING STATUS:

PRELIMINARY

TIER

CONSULT

Tier Environmental Ltd.

Chadwick House

Warrington Road

Birchwood

Warrington | WA3 6AE

t: 01925 818388

CLIENT:

DB SYMMETRY

PROJECT:

FORMER CRONTON COLLIERY

TITLE:

SITE WIDE PLAN

SCALE: SIZE:

NTS

CHECKED:

AP

APPROVED:

AP

CAD FILE:

-

DESIGN/DRAWN:

CS

DATE:

03.08.2023

PROJECT No:

TE1163

DRAWING No:

TE1163-TE-00-XX-DR-GE-019-V01

REV:

P1

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 or 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 the CIEH Guidance) 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 the CIEH Guidance) 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
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	95 th percentile estimate of the true mean value of a data population (also known as 95%UCL).
VOC	Volatile Organic Compound

APPENDIX C – DEFINITIONS OF TERMS USED IN QUALITATIVE AND QUANTITATIVE RISK ASSESSMENTS

For the qualitative and quantitative assessment of risks posed by potential pollutant linkages have been undertaken using the risk matrix adapted from CIRIA C552 and outlined in the table below.

	Category	Definition
Potential severity	Severe	Acute (short term) risk to human health, Major pollution of sensitive controlled waters, ecosystems or habitat. Catastrophic damage to buildings or property or crops.
	Medium	Chronic (Medium / long term) risk to human health Pollution of sensitive controlled waters, ecosystems or species, Significant damage to crops, buildings or structures
	Mild	Easily preventable permanent health effects on humans. Pollution of non-sensitive controlled waters. Minor damage to buildings or structures.
	Minor	Easily preventable non-permanent health effects on humans, or no effects. Minor, low level and localised contamination of on-site soil. Easily repairable damage to buildings or structures.
Probability of risk	High Likelihood	Pollutant linkage may be present and the risk is almost certain to occur, or there is evidence of harm already occurring.
	Likely	Pollutant linkage may be present and it is probable that the risk will occur over the long term.
	Low Likelihood	Pollutant linkages may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
	Unlikely	Pollutant linkage may be present but the circumstances under which harm would occur are improbable.

		Potential Severity			
		Severe	Medium	Mild	Minor
Probability of risk	High Likelihood	Very high	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/Low	Low	Negligible
	Unlikely	Moderate/Low	Low	Negligible	Negligible

APPENDIX D – ASSESSMENT CRITERIA APPLIED FOR GROUND GAS

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

- Methane (CH₄): an odourless, flammable gas. Mixtures of methane with air containing between 5 and 15% v/v methane are explosive.
- Carbon dioxide (CO₂): an asphyxiant at elevated concentrations. Denser than air, it can accumulate in excavations, and within low points inside buildings
- Oxygen (O₂): 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 CO₂ asphyxiation.
- Hydrogen sulphide (H₂S): 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 (CH₄) and carbon dioxide (CO₂)

Methane and CO₂ 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) and others 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)
- BS8485: Code of Practice for the characterisation and remediation from ground gas in affected developments (BSI Group, 2007)

The earlier CIRIA 149 approach is now considered to be too conservative. A more realistic measure of the risk posed by methane and CO₂ 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.:

$$\text{GSV} = (\text{Concentration} / 100) \times \text{Flow rate.}$$

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 Environmental 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 CO₂, steady state concentrations and flow data are applied, as these determine the development of an asphyxiating mixture. All values are selected whether or 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 665).

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	Amber 1
5	0.63	10	1.60	
20	1.60	30	3.10	Amber 2
				Red

Assessment of hydrogen sulphide (H₂S)

H₂S 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.

H₂S 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). H₂S 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 H₂S normally occurs together with other potentially hazardous ground gases. The measures adopted for protection against these will prove equally protective against H₂S.

There are no standards by which H₂S concentrations in ground gas can be assessed directly. Therefore, the significance of measured H₂S 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 H₂S. 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/m³ (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/m³. To avoid substantial nuisance odour complaints, WHO (2000) recommends that the 30 minute average H₂S concentration in ambient air should not exceed: 0.007 mg/m³ (0.005 ppmv, approx.).

Occupational exposures

For occupational exposure, the HSE (2005) limits for H₂S are applicable:

- 8 hour time weighted average occupational exposure limit: 5 ppmv (7 mg/m³).
- Short-term exposure limit (15 minute reference period): 10 ppmv (14 mg/m³).

APPENDIX E – GROUND GAS MITIGATION MEASURES INSPECTION PROFORMA



VISUAL INSPECTION OF GAS PROTECTION MEASURES

VISIT: 1 of X

Site name:	[Keywords]	Gas characteristic situation:	[Category]
Job number:	[Company]	Type of development and building:	[Company Address]
Date:		Building description:	[Manager]
Visit by:		Foundation type:	[Status]
Weather:		Gas protection type:	[Subject]

No.	Item	Comments
1	<i>Gas membrane</i>	
1.1	Condition of sub-grade and/or underside of gas membrane	
1.2	Gas membrane type	
1.3	Gas membrane condition	
1.4	Joining tape product	
1.5	Lapping design	
1.6	Laps, welds and joint seals	
1.7	Service entries seals	
1.8	Other features	
2	<i>Passive venting</i>	
2.1	Sub-floor void	
2.2	External wall airbricks	
2.3	Internal sleeper walls	
2.4	External vent trenches/ducts	
3	<i>Active venting</i>	
3.1	System details	
Additional notes:		

Photographs

No.	Description
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Photo 1

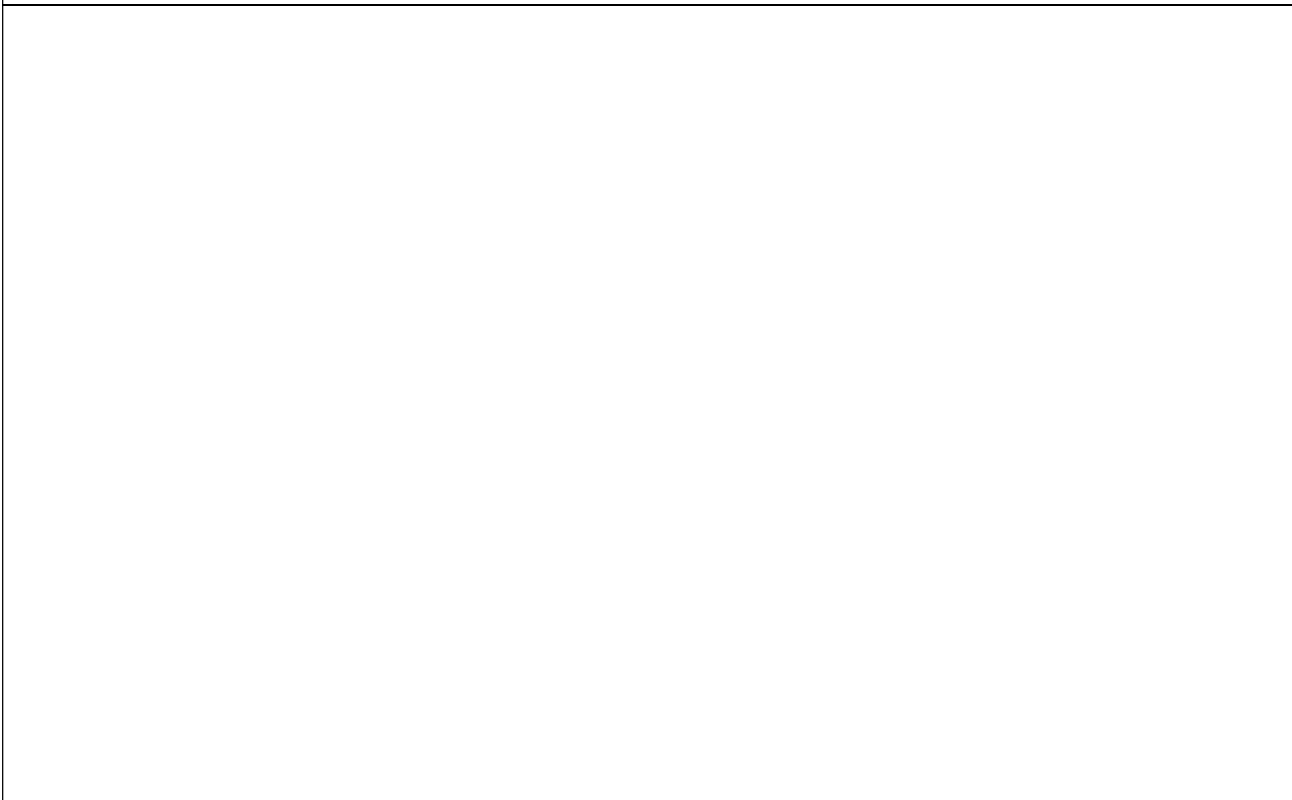


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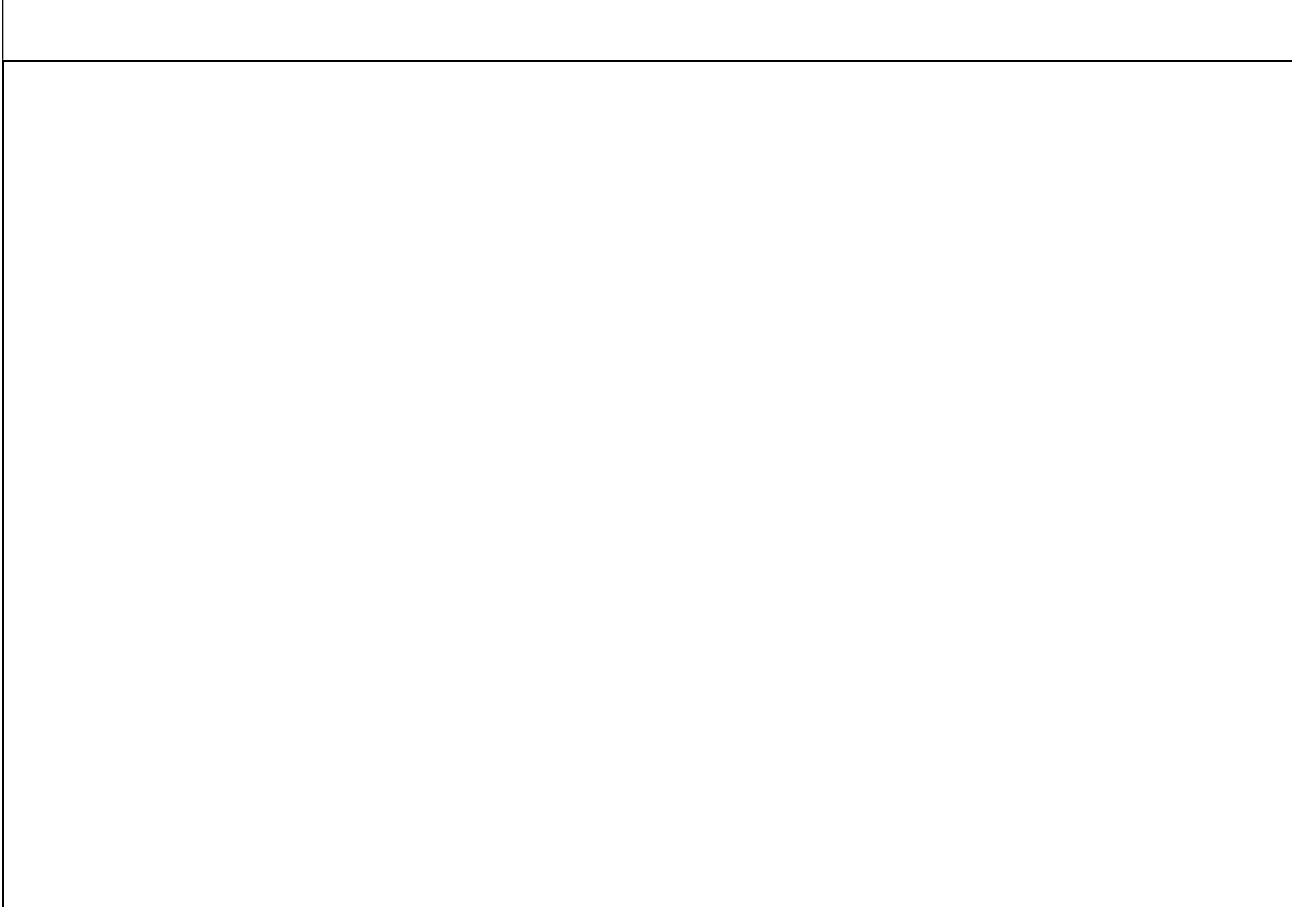


Photo 3



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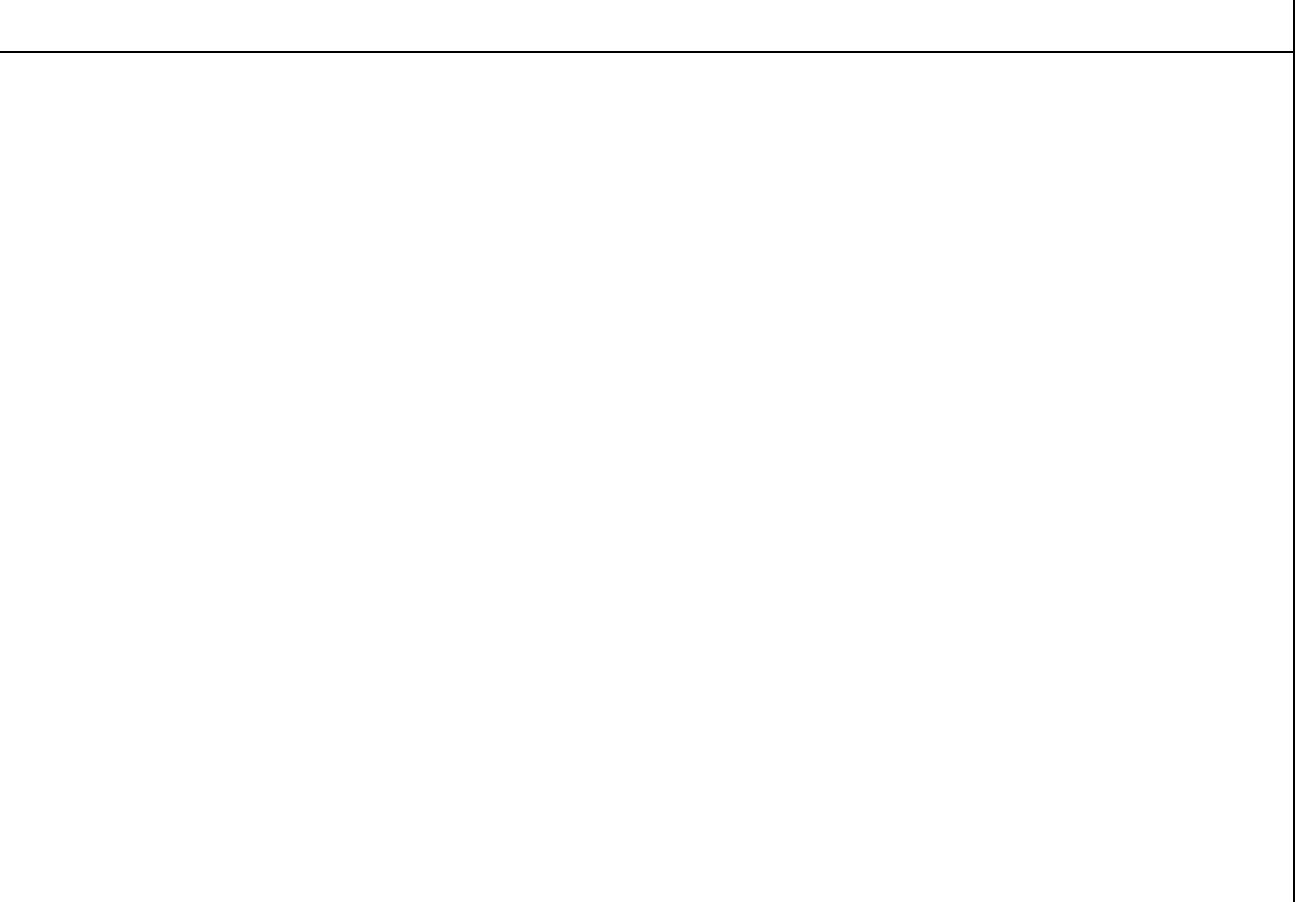


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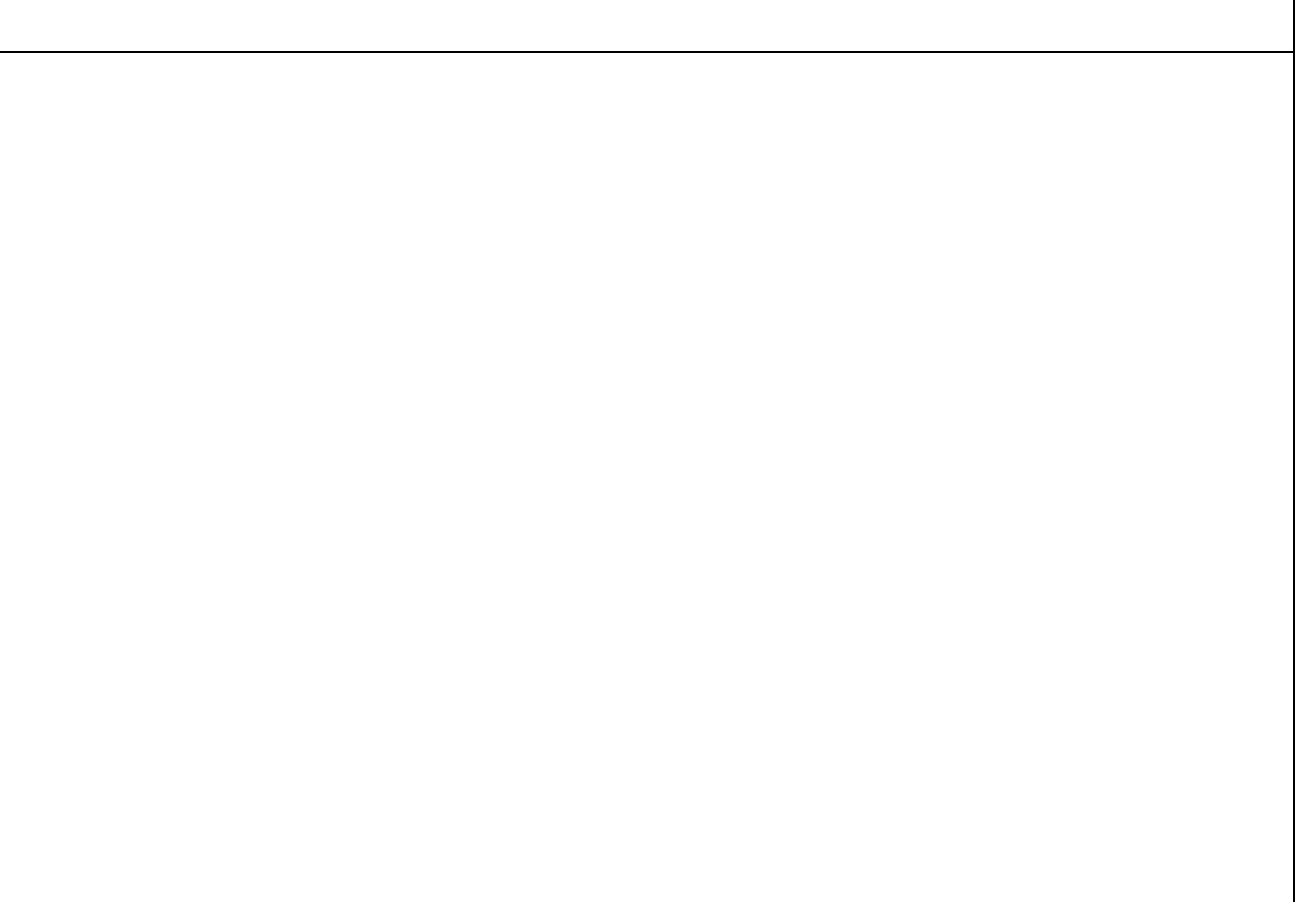


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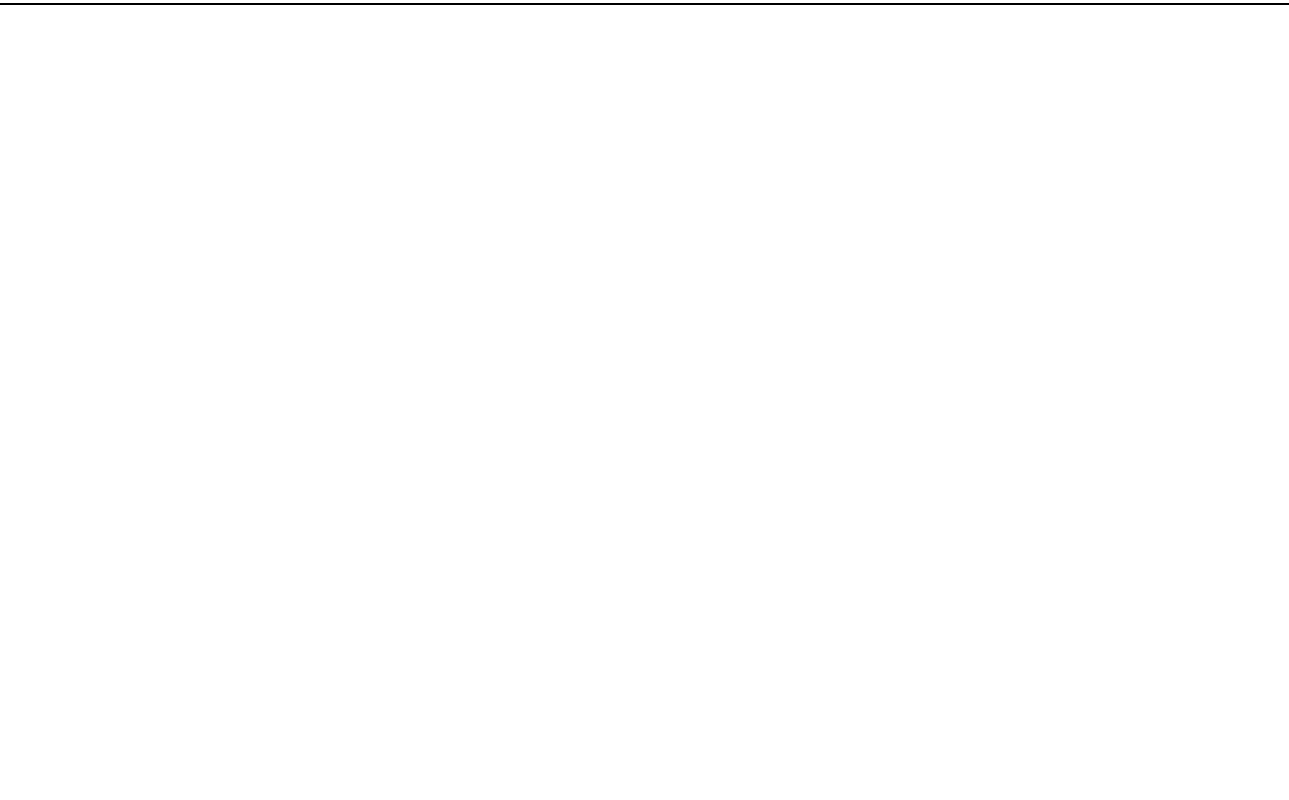


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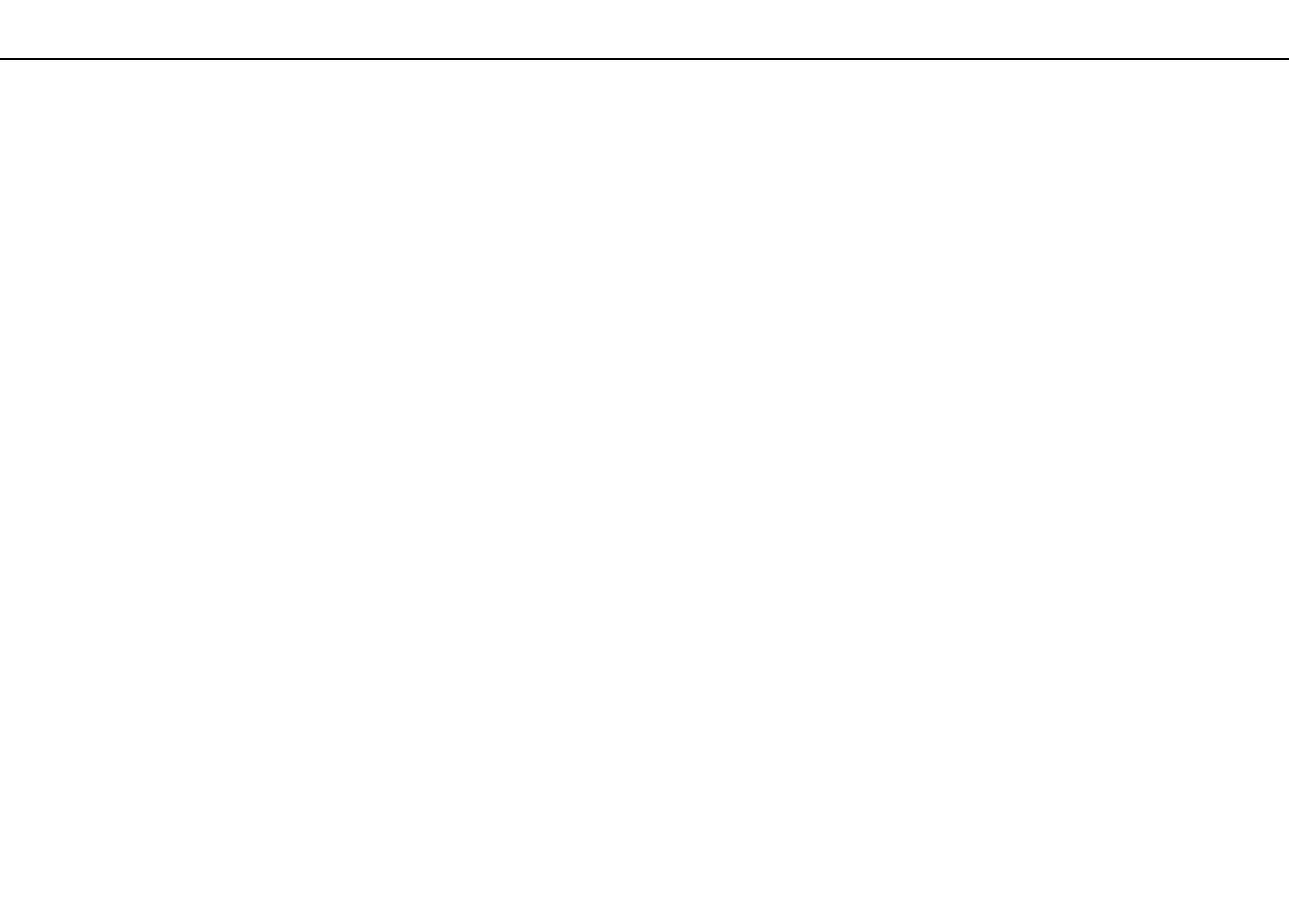
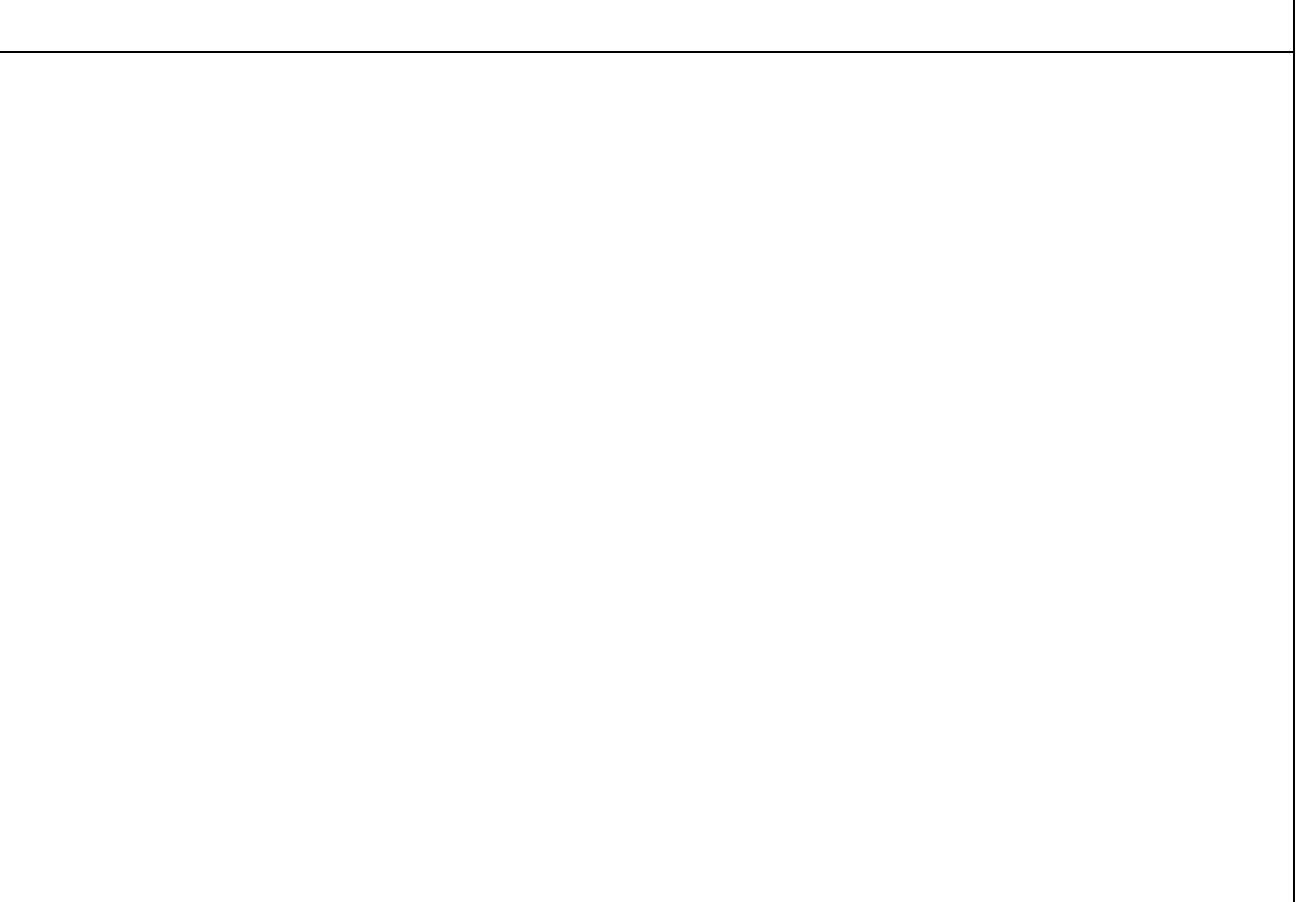


Photo 9



Photo 10



The gas protection measures inspected are:	
--	--

Name:

Signature:

Position:

Date: