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David Wright
Gleeson Developments Ltd
Rural Enterprise Centre
Redhills
Penrith
Cumbria
CA11 0DT

Date: 22 May 2019

Ref: C8095/7343/APC/APC

Dear David,

**Re: C8095 – Cleator Mills, Cleator Moor, Cumbria – Ground Gas Monitoring
Addendum Letter**

Further to our Geoenvironmental Appraisal Report for the above site (Sirius Report Ref. C8095, dated March 2019) the planned period of ground gas monitoring is now complete. This letter presents the results of that monitoring and an assessment of the risk posed by hazardous ground gases to the proposed development.

Whilst this letter discusses pertinent findings of the investigation, it must be read in conjunction with the aforementioned report, which presents in detail the site setting and the findings of previous phases of investigation.

Introduction

In undertaking this assessment, we have taken account of current best practice guidance in the assessment risk posed by hazardous permanent ground gases, including:

- BS8485:2015+A1:2019 “Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings”;
- BS8576:2013 “Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds (VOCs)”;
- CIRIA “Assessing Risks Posed by Hazardous Ground Gases to Buildings”, report C665, 2007;
- CIRIA “The VOCs Handbook. Investigating, Assessing and Managing Risks from Inhalation of VOCs at Land Affected by Contamination”, report C682, 2009;
- CL:AIRE “A Pragmatic Approach to Ground Gas Risk Assessment”, report ref. RB17, November 2012;
- NHBC “Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present”, report version 04, March 2007.

In addition, this risk assessment considers information presented in bespoke site specific British Geological Survey GeoReports, and associated best practice guidance detailed in Building Research Establishment report BR211:2015.

It is understood that the proposed development will comprise low rise residential properties. For the purposes of gas risk assessment, the proposed development is therefore considered to be characterised as comprising Type A buildings, as defined in Table 3 of BS 8485:2015.

Site Characterisation Relevant to Gas Risk Assessment

Site History

Historical OS maps show the site to have remained largely undeveloped, open farmland, with the exception of relatively recent installation of drainage infrastructure in the north of the site.

Surrounding land to the north, west and south-west has been gradually developed with residential properties. Land to the east and south has previously been occupied by textile and clothing mills, with a mill race adjacent to the eastern boundary of the site infilled between the 1960s and 1980s.

Summary of Relevant Site Investigation Works

The intrusive ground investigation included the excavation of 8 No. trial pits to a maximum depth of 3.1m, and the drilling of 38 No. window sample boreholes, at 20 No. locations across the site, to a maximum depth of 4.0m.

Geology

Site investigation evidence indicates the following geological sequence to underlay the site:

- Topsoil, ranging between 0.1m and 0.3m thick.
- Locally clayey, gravelly sand and sandy gravel with cobbles and boulders becoming more frequent with depth.
- Rockhead is recorded to comprise Skiddaw Group strata.

Hydrogeology

Superficial strata underlying the site are largely classified by the Environment Agency (EA) as a Secondary 'A' Aquifer.

The underlying Skiddaw Group bedrock is classified as a Secondary 'B' Aquifer.

No recorded groundwater abstractions have been identified within 1km of the site.

The majority of the site is recorded by the EA to be at significant risk of flooding from surface waters. The BGS records the site to have potential for groundwater flooding to occur at the surface.

Waste Disposal

There are no areas of recorded landfill within 250m of the site, although it is recognised that land to the east may include a backfilled mill race, infilled with unknown materials.

Chemical Contamination that could Influence Ground Gas Composition

No chemical contamination which could influence ground gas composition (e.g. hydrocarbon impacted soils) was identified during the ground investigation.

BGS GeoReport Radon Reports

Site specific Radon Georeports, obtained from the BGS, confirm that in the north-west of the site, there is a higher potential for radon to be present, and properties located within the north-western c. 15% of the site require full radon protective measures. Properties across the remaining c. 85% of the site do not require radon protective measures.

Plans within the Georeports, attached, show the exact extent of the area of the site requiring full protective measures.

Ground Gas Monitoring Data

Based upon a perceived very low source potential and high sensitivity end use, a ground gas monitoring programme comprising six visits over a period of three months was specified.

The wells selected for monitoring are described in detail in the above-referenced Geoenvironmental Appraisal Report and are shown on the Exploratory Hole Location Plan presented in Attachment A.

Ground gas and groundwater monitoring wells were installed into 6 No. boreholes, screened into the natural granular soils. Greater emphasis was placed on the east of the site, in closest proximity to the greatest perceived ground gas source comprising the infilled mill race.

Detailed records of the monitoring data obtained are presented in Attachment B.

The monitoring was carried out during the spring season, with monitoring events covering barometric pressure conditions ranging from 984 to 1030mbar. Two visits coincided with periods of barometric pressure at or below 1000mb.

Table 1 summarises the gas monitoring results obtained.

Table 1 - Summary of Ground Gas and Groundwater Monitoring Data

Well	Screened Response Zone	Concentration ranges (%v/v)			Concentration ranges (ppmv)		Flow (litres/hour)	
		Methane (Peak)	Carbon Dioxide (Steady)	Oxygen (Min.)	Hydrogen sulphide	Carbon monoxide	Peak	Steady
WS04	Superficial granular soils	ND	0.5 to 2.2	18.8 to 20.4	ND	ND	ND	ND
WS09	Superficial granular soils	ND	1.5 to 3.8	15.3 to 19.2	ND	ND	ND	ND
WS11	Superficial granular soils	ND	2.3 to 5.4	12.7 to 19.2	ND	ND	ND	ND
WS13	Superficial granular soils	ND	0.6 to 2.8	13.1 to 19.9	ND	ND	ND	ND
WS15	Superficial granular soils	ND	0.1 to 5.6	14.0 to 19.4	ND	ND	ND	ND
WS16	Superficial granular soils	ND	0.8 to 5.7	11.5 to 18.9	ND	ND	ND	ND

ND: None Detected – concentrations of gas or flows below equipment limit of detection

Revised Conceptual Site Model for Hazardous Ground Gases

Ground Gas Sources

The most significant potential sources of ground gases at this site, based on the conceptual site model as presented in the report of March 2019, are considered to be off-site made ground i.e. the adjacent backfilled mill race, and release of radon from underlying rock strata affecting the north-western corner of the site.

Transport Pathways

Perceived migratory pathways with respect to ground gases included vertical and lateral migration through the predominantly granular subsoil, which are likely to be substantially permeable and afford little, if any, restriction to ground gas migration.

Receptors

Proposed future buildings and their occupants, and possibly construction/ maintenance workers operating within enclosed spaces below ground level during the development phase, resulting from the presence of elevated concentrations of methane and/ or carbon dioxide, or depleted oxygen concentrations.

Ground Gas Risk Assessment

The risk assessment considers both the detected concentrations of ground gases and borehole flow rates, in accordance with BS8485:2015. Q_{hg} (Quantity of hazardous gas) values for methane and carbon dioxide have been calculated in accordance with BS8485:2015 on the basis of measured gas flows and concentrations or a limit of detection (LoD) of 0.1L/hr and 0.1% v/v, respectively, whichever is the higher (Attachment B).

A 'worst case check' Q_{hg} value has also been calculated for both carbon dioxide and methane.

No detectable peak or steady state borehole flow rates were recorded on any of the monitoring occasions.

A 'worst case check' Q_{hg} value for **methane**, based on the limits of detection of 0.1% v/v concentration and 0.1 l/hr flow, is **0.0001l/hr**.

A 'worst case check' for **carbon dioxide**, based on the highest detected steady state concentration of carbon dioxide in any well on any occasion (5.7% v/v) together with the steady state flow rate limit of detection of 0.1l/hr, is **0.0057l/hr**.

No detectable concentrations of hydrogen sulphide or carbon monoxide were identified and the potential risk from such gases is considered negligible.

On the basis of the worst case Qhg values, the site would currently be considered to fall within Characteristic Situation (CS) 1 as defined in BS8485:2015.

However, in addition to Qhg values, BS8485:2015 also requires that, for a site to be considered as CS1, then concentrations of methane and carbon dioxide should typically be <1% and <5% respectively.

This monitoring programme has persistently recorded concentrations of methane of <1% in all wells, concurring with a CS1 scenario. In four instances, concentrations of carbon dioxide have marginally exceeded 5%v/v, to a maximum of 5.7%v/v. Based on this data, it is reasonable to conclude that concentrations of carbon dioxide are not typically significantly in excess of 5%v/v, and the site may therefore be justifiably classed as **CS1**.

Radon Protective Measures Considerations

It has been identified that there is a higher potential for radon to be present beneath the north-west of the site, and full radon protective measures should be installed to properties within, or spanning that area, as a precautionary measure.

In respect of full radon protective measures, BRE211:2015 states “New buildings in areas of higher radon potential should incorporate full radon protection comprising a radon barrier across the footprint of the building supplemented by provision for subfloor depressurisation or ventilation (either a radon sump or ventilated subfloor void)”.

The radon barrier should extend fully across the footprint of the property, including any integral garages which occupied rooms above, or with direct access through a doorway from the garage to the house. This ensures protection to the rest of the dwelling and to the garage area should it be converted into an occupied space.

BRE211:2015 suggests that a 1200 gauge (200µm) thick polyethylene sheet manufactured from virgin polymer, may be sufficient to act as a radon barrier. However, it is also generally recognised that this type of membrane is unlikely to be sufficient to withstand the general rigours of a construction site, and in particular installation into plots, without incurring damage which would negate any benefit of the installation. Therefore BRE211:2015 also advises that, “where there is a risk of puncturing the membrane, stronger materials such as thicker or reinforced polyethylene sheet could be considered. The barrier can be constructed with other materials that match or better the airtightness and waterproofing properties offered by 200micometre polyethylene”.

In respect of requirements for a ventilated subfloor void, BR211 does not give indicative minimum requirements for void height or similar, although it is noted that “supplementary protection is also provided by locating underfloor vents on two or more sides of the underfloor space”. BRE does however provide further advice that, whilst there is no specific statutory requirement to inspect the radon barrier, it is strongly recommended that the barrier is visually inspected for completeness prior to it being covered by later construction.

It is also recommended that provision is made for the possible subsequent retrofitting of an electrically powered fan, to supplement radon dispersion from the subfloor void, if it is found, through testing after occupation, that the building still has an unacceptably high radon level, although the fan is not required to be installed during construction. It is noted in BRE211:2015, that ‘building regulations do not require a radon test for new dwellings built with radon protective measures’.

Conclusions and Recommendations

On the basis of the data obtained, and taking account the conceptual model for the site, it is recommended that the site is currently classified as falling within **Characteristic Situation (CS) 1** as defined in BS8485, for which no specific ground gas protective measures are required.

Radon protective measures should be incorporated into plots which fall within, or span, the area in the north-west of the site, as highlighted in the attached GeoReports. The extent of the affected area of site should be imposed on the proposed plot layout once finalised, to confirm exactly which plot numbers require such measures.

With consideration to Gleasons typical construction methods and practices, the most effective method of installing radon protective measures is considered to be the standard use of modular (‘block and beam’) suspended floor slabs, incorporating a gas tight membrane and the presence of a ventilated subfloor void, of at least 150mm clear height, connected to air bricks on external walls via periscopic vents positioned below the membrane to avoid unnecessary penetrations.

The membrane should be at least equivalent to a 1200 gauge/ 300 micrometer polyethylene membrane manufactured from virgin polymer, but which is also sufficiently robust to withstanding installation, follow-on construction and general site conditions. In this respect, it is recommended that as a minimum, a 2000 gauge membrane is incorporated into the floor slab. Further consideration should be given to the use of proprietary membranes which would also be compliant with BS8485, if a 2000 gauge membrane is considered unlikely to withstand construction practices.

The membrane should be appropriately lapped and sealed at joints and penetrations such as for services. The annulus between service ducts and services should also be appropriately sealed, for example using closed cell expanding foam on completion of installation.

Airbricks should be installed where possible on all sides of the buildings, and should be placed to give an actual opening of at least equivalent to 1500mm² for each metre run of wall on two opposite sides. Typically, this means vents should be positioned at 2m maximum centres along the external walls and not more than 450mm from corners.

Detailed construction drawings, confirming the presence of a subfloor void within the affected plots, the type of membrane to be used, the positioning of the membrane within the floor slab and particularly the relationship between the membrane, subfloor void, periscopic vents and air bricks on external walls should be prepared and submitted to regulators for approval. Such drawings should also confirm the methods of sealing joints and penetrations of the membrane.

It is recommended that independent validation of the installation of ground gas protective measures is carried out, in general accordance with guidance given in CIRIA Report C735, based on an 'intermediate risk' gas regime.

Following occupancy of the properties, further consideration could be given to subsequent radon testing within the property, although this is not a formal requirement. If such testing identifies unacceptably high radon levels, then there may be a requirement for the retrofitting of an electrical fan to supplement passive dispersion from the subfloor void.

Should the land use or proposed building type(s) change from those assumed in the preparation of this letter, then re-evaluation of the conclusions and recommendations will be required.

The conclusions and recommendations presented in this letter report are considered reasonable based on the findings of the work described. However, these cannot be guaranteed to gain regulatory or other approvals and, therefore, the report should be passed by the client to the appropriate regulatory authorities and/or other appropriate organisations for their comment and approval prior to undertaking any development works at the site.

Yours sincerely

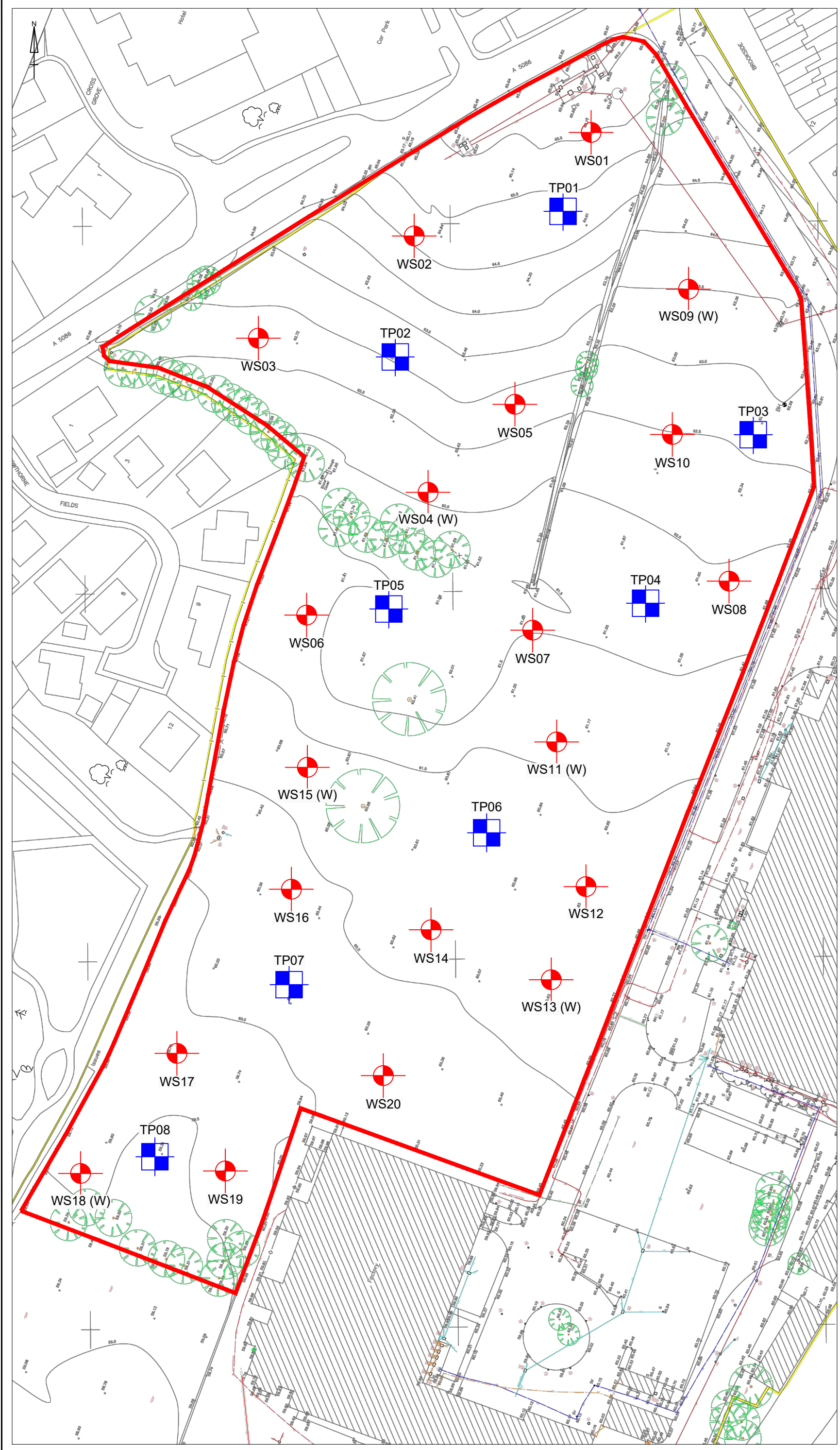
A black rectangular box redacting the signature of the Principal Engineer.




Principal Engineer

For and on behalf of Sirius Geotechnical Ltd

Enc.: Attachment A. Drawings.

Attachment B. Ground Gas Monitoring Results.



- NOTES**
-  Approximate Site Boundary
 -  Trial Pit Location
TP09
 -  Window Sample Location. 'W'
Denotes Monitoring Well.
WS18(W)

REVISION	BY	DATE
0	For Information	SM 21/03/19
A	>>	>>
B	>>	>>
C	>>	>>
D	>>	>>

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CLIENT

Gleeson Regeneration Ltd

SITE
**Cleator Mills,
Cleator,
Cumbria**

DRAWING TITLE
**Exploratory Hole
Location Plan**

DRAWING NO. CB095A/03	REVISION NO. 0
DRAWN BY DG/SM	APPROVED BY APC
DATE March 2019	SCALE 1:1000
	PAPER SIZE A3

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Gleeson Regeneration Ltd
Site: Cleator Mills, Cleator, Cumbria
Date: 13/03/2019

Job No: C8095
Visit No: 1 of 6
Operator: DB

Project Manager: APC

Monitoring Point	GAS CONCENTRATIONS												VOLATILES		FLOW DATA			Qhg per borehole		WELL AND WATER DATA					Comments	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Time for flow to equalise (secs)	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Top of BH (mAOD)	Water level (mAOD)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady										
WS 04	ND	ND	ND	ND	0.7	0.7	ND	ND	ND	ND	20.2	20.2	NR	NR	ND	ND			0.0001	0.0007	1.41	1.83	62.10	60.69	Granular soils	
WS 09	ND	ND	ND	ND	1.5	1.5	ND	ND	ND	ND	17.8	17.8	NR	NR	ND	ND			0.0001	0.0015	1.39	1.64	61.30	59.91	Granular soils	
WS 11	ND	ND	ND	ND	2.5	2.5	ND	ND	ND	ND	18.1	18.1	NR	NR	0.1	ND	0.0	10	0.0001	0.0025	1.00	1.51	61.10	60.10	Granular soils	
WS 13	ND	ND	ND	ND	0.6	0.6	ND	ND	ND	ND	19.9	19.9	NR	NR	ND	ND			0.0001	0.0006	1.07	1.09	60.70	59.63	Granular soils	
WS 15	ND	ND	ND	ND	0.1	0.1	ND	ND	ND	ND	20.3	20.3	NR	NR	ND	ND			0.0001	0.0001	0.47	1.70	60.80	60.33	Granular soils	Bailed to 1.33m bgl, 2.5l removed
WS 18	ND	ND	ND	ND	0.8	0.8	ND	ND	ND	ND	18.9	18.9	NR	NR	ND	ND			0.0001	0.0008	0.90	1.03	59.60	58.70	Granular soils	
Max	ND	ND	ND	ND	2.5	2.5	ND	ND	ND	ND	20.3	20.3	NR	NR	0.1	ND	0.0	10	0.0001	0.0025	1.41			60.69		
Min	ND	ND	ND	ND	0.1	0.1	ND	ND	ND	ND	17.8	17.8	NR	NR	0.1	ND	0.0	10	0.0001	0.0001	0.47			58.70		

ND - Not detected

NR - Not recorded

NB: Where no flow (ND) recorded, Qhg values are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of Qhg.

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground: Dry Moist Wet Snow Frozen
 Wind: Calm Light Moderate Strong
 Cloud cover: None Slight Cloudy Overcast
 Precipitation: None Slight Moderate Heavy
 Time monitoring performed: 13.35 Start 16.00 End
 Barometric pressure (mbar): 1034 Start 1007 End
 Pressure trend (Daily): Falling Steady Rising
 Source: weatheronline.co.uk
 Air Temperature (Deg. C): 10 Before 11 After

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM436-12746
Gas Range: CH₄ CO₂ O₂
Gas Flow range:
Date of last calibration: 04/03/2019
Date of next calibration: 17/04/2019

Ambient air check: CH₄ CO₂ O₂

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Gleeson Regeneration Ltd
Site: Cleator Mills, Cleator, Cumbria
Date: 26/03/2019

Job No: C8095
Visit No: 2 of 6
Operator: DB **Project Manager:** APC

Monitoring Point	GAS CONCENTRATIONS												VOLATILES		FLOW DATA			Qhg per borehole		WELL AND WATER DATA					Comments	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Time for flow to equalise (secs)	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Top of BH (mAOD)	Water level (mAOD)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady										
WS 04	ND	ND	ND	ND	1.3	1.3	ND	ND	ND	ND	19.6	19.6	NR	NR	ND	ND	0.0	0	0.0001	0.0013	DRY	1.62	62.10	DRY	Granular soils	
WS 09	ND	ND	ND	ND	3.6	3.6	ND	ND	ND	ND	16.2	16.2	NR	NR	ND	ND	0.0	0	0.0001	0.0036	1.62	1.65	61.30	59.68	Granular soils	
WS 11	ND	ND	ND	ND	5.3	5.3	ND	ND	ND	ND	13.5	13.5	NR	NR	ND	ND	0.0	0	0.0000	0.0053	1.45	1.51	61.10	59.65	Granular soils	
WS 13	ND	ND	ND	ND	1.3	1.3	ND	ND	ND	ND	17.1	17.1	NR	NR	ND	ND	0.0	0	0.0001	0.0013	1.07	1.09	60.70	59.63	Granular soils	
WS 15	ND	ND	ND	ND	2.1	2.1	ND	ND	ND	ND	19.4	19.4	NR	NR	ND	ND	1.0	30	0.0001	0.0021	1.08	2.00	60.80	59.72	Granular soils	
WS 18	ND	ND	ND	ND	4.6	4.6	ND	ND	ND	ND	12.8	12.8	NR	NR	ND	ND	0.0	0	0.0001	0.0046	1.01	1.03	59.60	58.59	Granular soils	
Max	ND	ND	ND	ND	5.3	5.3	ND	ND	ND	ND	19.6	19.6	NR	NR	ND	ND	1.0	30	0.0001	0.0053	1.62			59.72		
Min	ND	ND	ND	ND	1.3	1.3	ND	ND	ND	ND	12.8	12.8	NR	NR	ND	ND	0.0	0	0.0000	0.0013	DRY				DRY	

ND - Not detected
 NR - Not recorded

NB: Where no flow (ND) recorded, Qhg values are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of Qhg.

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground: Dry Moist Wet Snow Frozen

Wind: Calm Light Moderate Strong

Cloud cover: None Slight Cloudy Overcast

Precipitation: None Slight Moderate Heavy

Time monitoring performed: 10.00 Start 12.30 End

Barometric pressure (mbar): 1031 Start 1028 End

Pressure trend (Daily): Falling Steady Rising

Source:

Air Temperature (Deg. C): Before After

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM436-12746

Gas Range: CH₄ CO₂ O₂

Gas Flow range:

Date of last calibration: 04/03/2019

Date of next calibration: 17/04/2019

Ambient air check: CH₄ CO₂ O₂

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Gleeson Regeneration Ltd
Site: Cleator Mills, Cleator, Cumbria
Date: 09/04/2019

Job No: C8095
Visit No: 3 of 6
Operator: DB **Project Manager:** APC

Monitoring Point	GAS CONCENTRATIONS												VOLATILES		FLOW DATA			Qhg per borehole		WELL AND WATER DATA					Comments	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Time for flow to equalise (secs)	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Top of BH (mAOD)	Water level (mAOD)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady										
WS 04	ND	ND	ND	ND	0.5	0.5	ND	ND	ND	ND	19.7	19.7	NR	NR	ND	ND	0.0	0	0.0001	0.0005	DRY	1.82	62.10	DRY	Granular soils	
WS 09	ND	ND	ND	ND	3.8	3.8	ND	ND	ND	ND	15.3	5.3	NR	NR	ND	ND	0.0	0	0.0001	0.0038	1.62	1.64	61.30	59.68	Granular soils	
WS 11	ND	ND	ND	ND	5.4	5.4	ND	ND	ND	ND	12.7	12.7	NR	NR	ND	ND	0.0	0	0.0001	0.0054	1.50	1.52	61.10	59.60	Granular soils	
WS 13	ND	ND	ND	ND	2.4	2.4	ND	ND	ND	ND	13.1	13.1	NR	NR	ND	ND	0.0	0	0.0001	0.0024	1.08	1.10	60.70	59.62	Granular soils	
WS 15	ND	ND	ND	ND	1.9	1.9	ND	ND	ND	ND	18.9	18.9	NR	NR	ND	ND	0.0	30	0.0001	0.0019	0.96	1.96	60.80	59.84	Granular soils	
WS 18	ND	ND	ND	ND	4.8	4.8	ND	ND	ND	ND	11.5	11.5	NR	NR	ND	ND	0.0	0	0.0001	0.0048	1.03	1.05	59.60	58.57	Granular soils	
Max	ND	ND	ND	ND	5.4	5.4	ND	ND	ND	ND	19.7	19.7	NR	NR	ND	ND	0.0	30	0.0001	0.0054	1.62			59.84		
Min	ND	ND	ND	ND	0.5	0.5	ND	ND	ND	ND	11.5	5.3	NR	NR	ND	ND	0.0	0	0.0001	0.0005	DRY				DRY	

ND - Not detected
 NR - Not recorded

NB: Where no flow (ND) recorded, Qhg values are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of Qhg.

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground: Dry Moist Wet Snow Frozen

Wind: Calm Light Moderate Strong

Cloud cover: None Slight Cloudy Overcast

Precipitation: None Slight Moderate Heavy

Time monitoring performed: Start 11.30 End 13.30

Barometric pressure (mbar): Start 1010 End 1012

Pressure trend (Daily): Falling Steady Rising

Source:

Air Temperature (Deg. C): Before After

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM 436-12778

Gas Range: CH₄ CO₂ O₂

Gas Flow range:

Date of last calibration: 17/01/2019

Date of next calibration: 16/01/2020

Ambient air check: CH₄ CO₂ O₂

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Gleeson Regeneration Ltd
Site: Cleator Mills, Cleator, Cumbria
Date: 25/04/2019

Job No: C8095
Visit No: 4 of 6
Operator: DB **Project Manager:** APC

Monitoring Point	GAS CONCENTRATIONS												VOLATILES		FLOW DATA			Qhg per borehole		WELL AND WATER DATA					Comments	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Time for flow to equalise (secs)	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Top of BH (mAOD)	Water level (mAOD)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady										
WS 04	ND	ND	ND	ND	2.2	2.2	ND	ND	ND	ND	18.8	18.8	NR	NR	ND	ND	0.0	0	0.0001	0.0022	DRY	1.81	62.10	DRY	Granular soils	
WS 09	ND	ND	ND	ND	3.2	3.2	ND	ND	ND	ND	18.5	18.5	NR	NR	ND	ND	0.0	0	0.0001	0.0032	DRY	1.64	61.30	DRY	Granular soils	
WS 11	ND	ND	ND	ND	3.5	3.5	ND	ND	ND	ND	18.7	18.7	NR	NR	ND	ND	0.0	0	0.0001	0.0035	DRY	1.52	61.10	DRY	Granular soils	
WS 13	ND	ND	ND	ND	2.8	2.8	ND	ND	ND	ND	16.2	16.2	NR	NR	ND	ND	0.0	0	0.0001	0.0028	1.90	1.91	60.70	58.80	Granular soils	
WS 15	ND	ND	ND	ND	3.5	3.5	ND	ND	ND	ND	15.4	15.4	NR	NR	ND	ND	0.0	0	0.0001	0.0035	1.40	1.93	60.80	59.40	Granular soils	
WS 18	ND	ND	ND	ND	5.7	5.7	ND	ND	ND	ND	16.8	16.8	NR	NR	ND	ND	0.0	0	0.0001	0.0057	1.06	1.07	59.60	58.54	Granular soils	
Max	ND	ND	ND	ND	5.7	5.7	ND	ND	ND	ND	18.8	18.8	NR	NR	ND	ND	0.0	0	0.0001	0.0057	1.90			59.40		
Min	ND	ND	ND	ND	2.2	2.2	ND	ND	ND	ND	15.4	15.4	NR	NR	ND	ND	0.0	0	0.0001	0.0022	DRY				DRY	

ND - Not detected

NR - Not recorded

NB: Where no flow (ND) recorded, Qhg values are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of Qhg.

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground: Dry Moist Wet Snow Frozen

Wind: Calm Light Moderate Strong

Cloud cover: None Slight Cloudy Overcast

Precipitation: None Slight Moderate Heavy

Time monitoring performed: 11.00 Start 13.00 End

Barometric pressure (mbar): 987 Start 987 End

Pressure trend (Daily): Falling Steady Rising

Source: weatheronline.co.uk

Air Temperature (Deg. C): 14 Before 14 After

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM436-12778

Gas Range: CH₄ CO₂ O₂

Gas Flow range:

Date of last calibration: 05/04/2019

Date of next calibration: 06/05/2019

Ambient air check: CH₄ ND CO₂ ND O₂ 20.4

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Gleeson Regeneration Ltd
 Site: Cleator Mills, Cleator, Cumbria
 Date: 08/05/2019

Job No: C8095
 Visit No: 5 of 6
 Operator: DB Project Manager: APC

Monitoring Point	GAS CONCENTRATIONS												VOLATILES		FLOW DATA			Qhg per borehole		WELL AND WATER DATA					Comments	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Time for flow to equalise (secs)	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Top of BH (mAOD)	Water level (mAOD)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady										
WS 04	ND	ND	ND	ND	0.8	0.8	ND	ND	ND	ND	20.4	20.4	NR	NR	ND	ND	0.0	0	0.0001	0.0008	DRY	1.81	62.10	DRY	Granular soils	
WS 09	ND	ND	ND	ND	2.7	2.7	ND	ND	ND	ND	18.7	18.7	NR	NR	ND	ND	0.0	0	0.0001	0.0027	1.82	1.84	61.30	59.48	Granular soils	
WS 11	ND	ND	ND	ND	2.5	2.5	ND	ND	ND	ND	19.1	19.1	NR	NR	ND	ND	0.0	0	0.0001	0.0025	DRY	1.52	61.10	DRY	Granular soils	
WS 13	ND	ND	ND	ND	2.5	2.5	ND	ND	ND	ND	17.1	17.1	NR	NR	ND	ND	0.0	0	0.0001	0.0025	1.81	1.10	60.70	58.89	Granular soils	
WS 15	ND	ND	ND	ND	4.8	4.8	ND	ND	ND	ND	14.0	14.0	NR	NR	ND	ND	0.0	0	0.0001	0.0048	1.50	1.93	60.80	59.30	Granular soils	
WS 18	ND	ND	ND	ND	4.9	4.9	ND	ND	ND	ND	13.7	13.7	NR	NR	ND	ND	0.0	0	0.0001	0.0049	1.51	1.95	59.60	58.09	Granular soils	
Max	ND	ND	ND	ND	4.9	4.9	ND	ND	ND	ND	20.4	20.4	NR	NR	ND	ND	0.0	0	0.0001	0.0049	1.82			59.48		
Min	ND	ND	ND	ND	0.8	0.8	ND	ND	ND	ND	13.7	13.7	NR	NR	ND	ND	0.0	0	0.0001	0.0008	DRY				DRY	

ND - Not detected

NR - Not recorded

NB: Where no flow (ND) recorded, Qhg values are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of Qhg.

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground: Dry Moist Wet Snow Frozen

Wind: Calm Light Moderate Strong

Cloud cover: None Slight Cloudy Overcast

Precipitation: None Slight Moderate Heavy

Time monitoring performed: Start 11.30 End 13.35

Barometric pressure (mbar): Start 984 End 984

Pressure trend (Daily): Falling Steady Rising

Source:

Air Temperature (Deg. C): Before After

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM436-12778

Gas Range: CH₄ CO₂ O₂

Gas Flow range:

Date of last calibration: 07/05/2019

Date of next calibration: 03/06/2019

Ambient air check: CH₄ CO₂ O₂

Ground Gas and Groundwater Monitoring Record Sheet



JOB DETAILS:

Client: Gleeson Regeneration Ltd
Site: Cleator Mills, Cleator, Cumbria
Date: 20/05/2019

Job No: C8095
Visit No: 6 of 6
Operator: DB **Project Manager:** APC

Monitoring Point	GAS CONCENTRATIONS												VOLATILES		FLOW DATA			Qhg per borehole		WELL AND WATER DATA					Comments	
	Methane (%v/v)		%LEL		Carbon dioxide (%v/v)		Carbon monoxide (ppmv)		Hydrogen sulphide (ppmv)		Oxygen (%v/v)		PID Peak (ppm)	Product thickness (mm)	Flow rate (l/hr)		Differential borehole Pressure (Pa)	Time for flow to equalise (secs)	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Top of BH (mAOD)	Water level (mAOD)		Response Zone
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady										
WS 04	ND	ND	ND	ND	1.4	1.4	ND	ND	ND	ND	19.7	19.7	NR	NR	ND	ND	0.0	0	0.0001	0.0014	1.82	DRY	62.10	60.28	Granular soils	
WS 09	ND	ND	ND	ND	2.4	2.4	ND	ND	ND	ND	19.2	19.2	NR	NR	ND	ND	0.0	0	0.0001	0.0024	1.62	1.64	61.30	59.68	Granular soils	
WS 11	ND	ND	ND	ND	2.3	2.3	ND	ND	ND	ND	19.2	19.2	NR	NR	ND	ND	0.0	0	0.0001	0.0023	1.52	1.53	61.10	59.58	Granular soils	
WS 13	ND	ND	ND	ND	2.6	2.6	ND	ND	ND	ND	17.6	17.6	NR	NR	ND	ND	0.0	0	0.0001	0.0026	1.10	1.10	60.70	59.60	Granular soils	
WS 15	ND	ND	ND	ND	5.6	5.6	ND	ND	ND	ND	15.4	15.4	NR	NR	ND	ND	0.0	0	0.0001	0.0056	1.58	1.93	60.80	59.22	Granular soils	
WS 18	ND	ND	ND	ND	2.9	2.9	ND	ND	ND	ND	18.7	18.7	NR	NR	ND	ND	0.0	0	0.0001	0.0029	1.06	1.06	59.60	58.55	Granular soils	
Max	ND	ND	ND	ND	5.6	5.6	ND	ND	ND	ND	19.7	19.7	NR	NR	ND	ND	0.0	0	0.0001	0.0056	1.82			60.28		
Min	ND	ND	ND	ND	1.4	1.4	ND	ND	ND	ND	15.4	15.4	NR	NR	ND	ND	0.0	0	0.0001	0.0014	1.06			58.55		

ND - Not detected
 NR - Not recorded

NB: Where no flow (ND) recorded, Qhg values are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of Qhg.

METEOROLOGICAL AND SITE INFORMATION:

(Select correct box with X or enter data, as applicable)

State of ground: Dry Moist Wet Snow Frozen

Wind: Calm Light Moderate Strong

Cloud cover: None Slight Cloudy Overcast

Precipitation: None Moderate Heavy

Time monitoring performed: 12.00 Start 13.30 End

Barometric pressure (mbar): 1005 Start 1005 End

Pressure trend (Daily): Falling Steady Rising

Source: weatheronline.co.uk

Air Temperature (Deg. C): 19 Before 22 After

INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter: GFM436-12778

Gas Range: CH₄ CO₂ O₂

Gas Flow range:

Date of last calibration: 07/05/2019

Date of next calibration: 03/06/2019

Ambient air check: CH₄ ND CO₂ ND O₂ 20.9



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoReports

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Radon Report: England and Wales

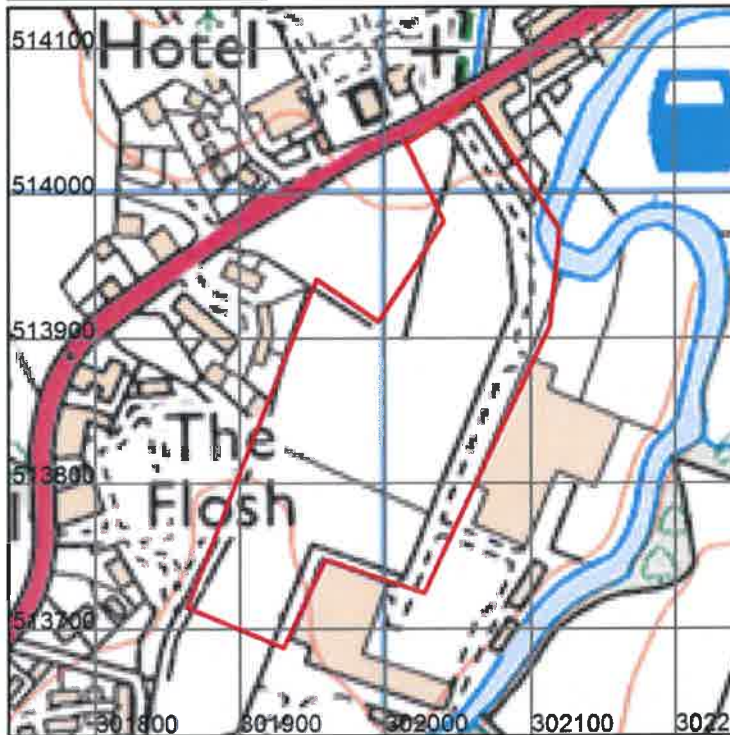
Advisory report on the requirement for radon protective measures in new buildings, conversions and extensions to existing buildings. The report also indicates whether a site is located within a radon Affected Area

Report Id: GR_220367/1

Client reference: C8095 - Cleator Mills



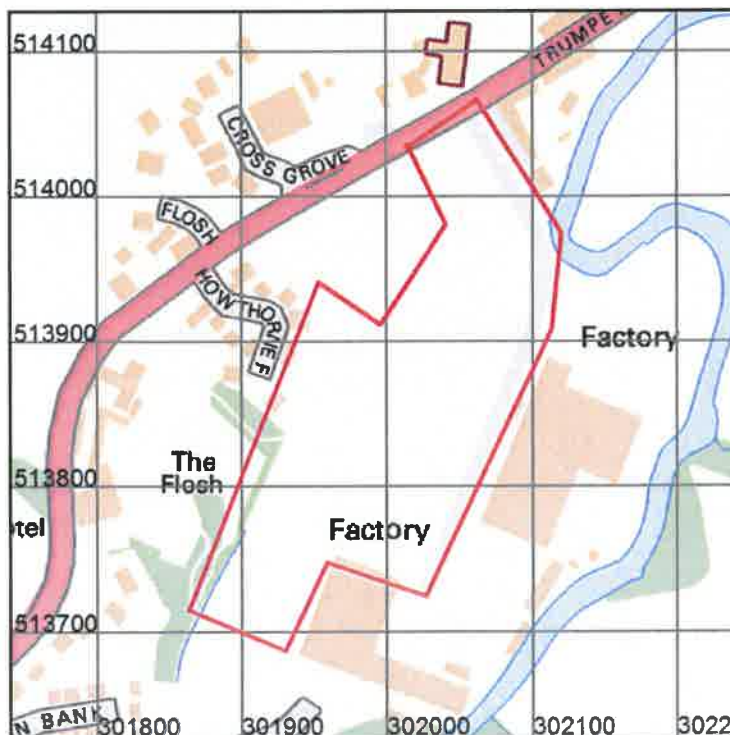
Search location



This report describes a site located at National Grid Reference 301992, 513877. Note that for sites of irregular shape, this point may lie outside the site boundary. Where the client has submitted a site plan the assessment will be based on the area given.

Search location indicated in red

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Radon Report: England and Wales

When extensions are made to existing buildings in high radon areas, or new buildings are constructed in these areas the Building Regulations for England, Wales and Scotland require that protective measures are taken against radon entering the building.

This report provides information on whether radon protective measures are required. Depending on the probability of buildings having high radon levels, the Regulations may require either:

1. No protective measures
2. Basic protective measures
3. Full protective measures

This is an advisory report on the requirement for radon protective measures in new buildings, conversions and extensions. The report also indicates whether a site is located within a radon Affected Area

Requirement for radon protective measures

The determination below follows advice in *BR211 Radon: Guidance on protective measures for new buildings (2015 edition)*, which also provides guidance on what to do if the result indicates that protective measures are required.

NO RADON PROTECTIVE MEASURES ARE REQUIRED FOR THE REPORT AREA.

More details of the protective measures required are available in *BR211 Radon: Guidance on protective measures for new buildings (2015 Edition)*. Additional information and guidance is available from the Building Research Establishment website (<http://www.bre.co.uk/radon/>).

If you require further information or guidance, you should contact your local authority building control officer or approved inspector.



Radon Affected Area

Is this property in a radon affected area – **YES**

The answer to the standard enquiry on house purchase known as **CON29 Standard Enquiry of Local Authority 3.13 Radon Gas: Location of the Property in a radon Affected Area** is **YES** this property is in a Radon Affected Area as defined by Public Health England (PHE).

The estimated probability of the property being above the Action Level for radon is: **1-3% (INTERMEDIATE PROBABILITY).**

Public Health England (PHE) recommends a radon 'Action Level' of 200 becquerels per cubic metre of air for the annual average of the radon gas concentration in a home. Where 1% or more of homes are estimated to exceed the Action Level (i.e. are in an Intermediate or Higher probability radon area) the area should be regarded as a radon Affected Area.

This report informs you whether the property is in a radon Affected Area as defined by PHE and the percentage of homes that are estimated to be at or above the radon Action Level. This does not necessarily mean there is a radon problem in the property; the only way to find out whether it is above or below the Action Level is to carry out a radon measurement in an existing property.

PHE advises that radon gas should be measured in all properties within radon Affected Areas and that homes with radon levels above the Action Level (200 Bq m⁻³) should be remediated, and where achievable to below the Target Level of 100 Bq m⁻³. Householders with levels between the Target Level and Action Level should seriously consider reducing their radon level, especially if they are at greater risk, such as if they are current or ex smokers. Whether or not a home is in fact above or below the Action Level or Target Level can only be established by having the building tested. PHE provides a radon testing service which can be accessed at www.ukradon.org.

The information in this report provides an answer to one of the standard legal enquiries on house purchase in England and Wales, known as Law Society CON29 Enquiries of the Local Authority (2016); 3.14 Radon Gas: Do records indicate that the property is in a "Radon Affected Area" as identified by Public Health England. The data can also be used to advise house buyers and sellers in Scotland.

If you are buying a new build property in a Radon Affected Area, you should ask the builder whether radon protective measures were incorporated in the construction of the property.



If you are buying a currently occupied property in a Radon Affected Area you should ask the present owner whether radon levels have been measured in the property. If they have, ask whether the results were above the Radon Action Level and if so whether remedial measures were installed, radon levels were retested, and the that the results of re-testing confirmed the effectiveness of the measures.

Further information on radon is available from PHE or www.ukradon.org.



What is radon?

Radon is a naturally occurring radioactive gas, which is produced by the radioactive decay of radium which, in turn, is derived from the radioactive decay of uranium. Uranium is found in small quantities in all soils and rocks, although the amount varies from place to place. Radon released from rocks and soils is quickly diluted in the atmosphere. Concentrations in the open air are normally very low and do not present a hazard. Radon that enters enclosed spaces such as some buildings (particularly basements), caves, mines, and tunnels may reach high concentrations in some circumstances. The construction method and degree of ventilation will influence radon levels in individual buildings. A person's exposure to radon will also vary according to how particular buildings and spaces are used.

Inhalation of the radioactive decay products of radon gas increases the chance of developing lung cancer. If individuals are exposed to high concentrations for significant periods of time, there may be cause for concern. In order to limit the risk to individuals, the Government has adopted an Action Level for radon in homes of 200 becquerels per cubic metre (Bq m^{-3}). The Government advises householders that, where the radon level exceeds the Action Level, measures should be taken to reduce the concentration.

Radon in workplaces

The Ionising Radiation Regulations, 1999, require employers to take action when radon is present above a defined level in the workplace. Advice may be obtained from your local Health and Safety Executive Area Office or the Environmental Health Department of your local authority. The BRE publishes a guide (BR293): **Radon in the workplace**. BRE publications may be obtained from the BRE Bookshop, Tel: 01923 664262, email: bookshop@bre.co.uk website: www.brebookshop.com



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**Report issued by
BGS Enquiry Service**



**British
Geological Survey**
NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoReports

**Alastair Cook
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Radon Report: England and Wales

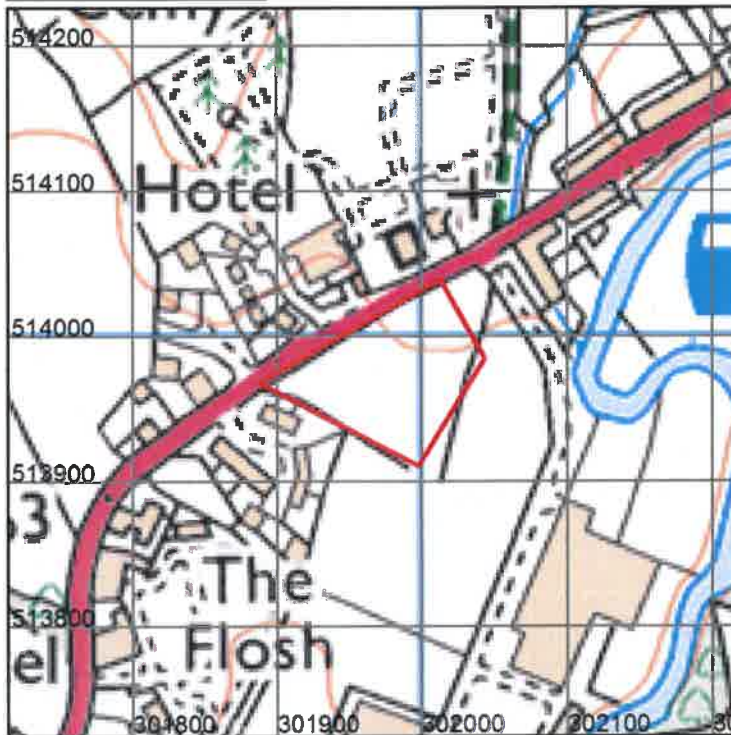
Advisory report on the requirement for radon protective measures in new buildings, conversions and extensions to existing buildings. The report also indicates whether a site is located within a radon Affected Area

Report Id: GR_220362/1

Client reference: C8095 - Cleator Mills



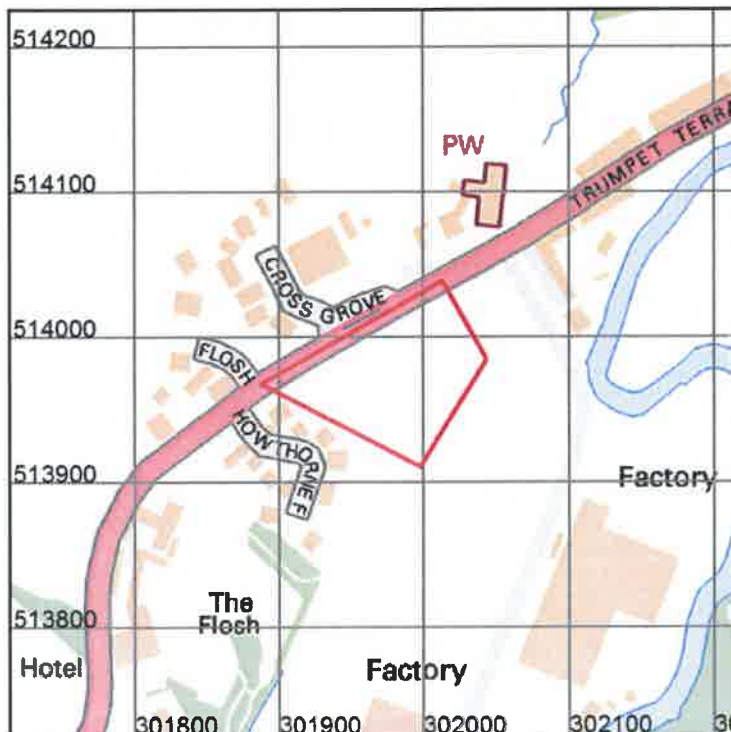
Search location



This report describes a site located at National Grid Reference 301966, 513975. Note that for sites of irregular shape, this point may lie outside the site boundary. Where the client has submitted a site plan the assessment will be based on the area given.

Search location indicated in red

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Radon Report: England and Wales

When extensions are made to existing buildings in high radon areas, or new buildings are constructed in these areas the Building Regulations for England, Wales and Scotland require that protective measures are taken against radon entering the building.

This report provides information on whether radon protective measures are required. Depending on the probability of buildings having high radon levels, the Regulations may require either:

1. No protective measures
2. Basic protective measures
3. Full protective measures

This is an advisory report on the requirement for radon protective measures in new buildings, conversions and extensions. The report also indicates whether a site is located within a radon Affected Area

Requirement for radon protective measures

The determination below follows advice in *BR211 Radon: Guidance on protective measures for new buildings (2015 edition)*, which also provides guidance on what to do if the result indicates that protective measures are required.

FULL RADON PROTECTIVE MEASURES ARE REQUIRED FOR THE REPORT AREA.

More details of the protective measures required are available in *BR211 Radon: Guidance on protective measures for new buildings (2015 Edition)*. Additional information and guidance is available from the Building Research Establishment website (<http://www.bre.co.uk/radon/>).

If you require further information or guidance, you should contact your local authority building control officer or approved inspector.



Radon Affected Area

Is this property in a radon affected area – **YES**

The answer to the standard enquiry on house purchase known as **CON29 Standard Enquiry of Local Authority 3.13 Radon Gas: Location of the Property in a radon Affected Area** is **YES** this property is in a Radon Affected Area as defined by Public Health England (PHE).

The estimated probability of the property being above the Action Level for radon is: **10-30% (HIGHER PROBABILITY)**.

Public Health England (PHE) recommends a radon 'Action Level' of 200 becquerels per cubic metre of air for the annual average of the radon gas concentration in a home. Where 1% or more of homes are estimated to exceed the Action Level (i.e. are in an Intermediate or Higher probability radon area) the area should be regarded as a radon Affected Area.

This report informs you whether the property is in a radon Affected Area as defined by PHE and the percentage of homes that are estimated to be at or above the radon Action Level. This does not necessarily mean there is a radon problem in the property; the only way to find out whether it is above or below the Action Level is to carry out a radon measurement in an existing property.

PHE advises that radon gas should be measured in all properties within radon Affected Areas and that homes with radon levels above the Action Level (200 Bq m⁻³) should be remediated, and where achievable to below the Target Level of 100 Bq m⁻³. Householders with levels between the Target Level and Action Level should seriously consider reducing their radon level, especially if they are at greater risk, such as if they are current or ex smokers. Whether or not a home is in fact above or below the Action Level or Target Level can only be established by having the building tested. PHE provides a radon testing service which can be accessed at www.ukradon.org.

The information in this report provides an answer to one of the standard legal enquiries on house purchase in England and Wales, known as Law Society CON29 Enquiries of the Local Authority (2016); 3.14 Radon Gas: Do records indicate that the property is in a "Radon Affected Area" as identified by Public Health England. The data can also be used to advise house buyers and sellers in Scotland.

If you are buying a new build property in a Radon Affected Area, you should ask the builder whether radon protective measures were incorporated in the construction of the property.



If you are buying a currently occupied property in a Radon Affected Area you should ask the present owner whether radon levels have been measured in the property. If they have, ask whether the results were above the Radon Action Level and if so whether remedial measures were installed, radon levels were retested, and the that the results of re-testing confirmed the effectiveness of the measures.

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What is radon?

Radon is a naturally occurring radioactive gas, which is produced by the radioactive decay of radium which, in turn, is derived from the radioactive decay of uranium. Uranium is found in small quantities in all soils and rocks, although the amount varies from place to place. Radon released from rocks and soils is quickly diluted in the atmosphere. Concentrations in the open air are normally very low and do not present a hazard. Radon that enters enclosed spaces such as some buildings (particularly basements), caves, mines, and tunnels may reach high concentrations in some circumstances. The construction method and degree of ventilation will influence radon levels in individual buildings. A person's exposure to radon will also vary according to how particular buildings and spaces are used.

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