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Mr S Cole Redrow Homes Limited Redrow House St David's Park Ewloe Flintshire CH5 3RX

18th April 2016

Our Ref: C6069A/GH/7125 RevA

Dear Steve

#### Re: Woolton Road, Allerton, Liverpool - Gas Assessment Letter Report

#### Introduction

Sirius Geotechnical and Environmental Ltd (Sirius) was commissioned by Redrow Homes Limited (Redrow) to undertake a ground gas risk assessment of land at Woolton Road, Liverpool. It is understood that Redrow is proposing to redevelop the site for a residential end use, comprising low rise houses with private gardens, associated areas of hardstanding, access roads and public open space (POS).

A Geoenvironmental Appraisal report (ref. C6069 RevB, dated April 2016) has been produced by Sirius for the site.

This letter report supplements the findings and recommendations incorporated within the report, with regards to the ground gas risk assessment, and intends to provide a desk-based, qualitative approach to ground gas risk at the site.

This approach is consistent with the risk-based strategy presented in based on principles described in BS8576:2013 ("Guidance on Investigations for Ground Gas - Permanent Gases and Volatile Organic Compounds") and BS8485:2015 ("Code of Practice for the Design of Protective Measures

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for Methane and Carbon Dioxide Ground Gases for New Buildings"). It also draws on the guidance presented in CL:AIRE Research Bulletin RB17 ("A Pragmatic Approach to Ground Gas Risk Assessment", dated November 2012), which facilitates integration of desk-based information, site-won data and the conceptual site model to evaluate the level of risk posed by likely gas generation at a site.

## Site Description and Environmental Setting

The site comprises undeveloped, partly wooded, disused former recreational land / playing fields. The site is roughly rectangular in shape, and gently rises in height (by approximately 5m - 9m) towards the east and south east.

Densely wooded / overgrown vegetated areas are located along the majority of the site perimeter, and within the eastern and central southern site areas.

## Geology

The site is recorded to be underlain by Triassic Chester Pebble Bed Formation (comprising sandstones).

Inspection of the historical OS maps and geological information has not revealed any evidence of quarrying/pits beneath, or in the vicinity of, the site. Based on published geological information and the Coal Authority gazetteer, it is concluded that there is a negligible risk of coal mining-derived gas affecting the site.

## Landfilling and Waste Management

Three local authority-recorded landfills are located within 1.5km of the site, the two closest records being located 846m to the northeast (referenced as Woolton Quarry, Liverpool, Merseyside Waste Disposal Authority). The third registered landfill is located 959m to the north east, also referenced to Woolton Quarry. The third registered landfill license is currently lapsed / cancelled, last dated September 1979. Recorded authorised wastes included construction industrial wastes, inert non-hazardous wastes and timber (timber less than 10% per load).

Information provided on the Environment Agency website indicates that one of the landfills associated with Woolton Quarry (named as Woolton Quarry North) was in operation between 1979 and 1983, and accepted inert wastes.

There is no evidence of landfilling or other infilled land on or within 250m of the site, with the exception of a small former pond located adjacent to the northeast of the site, which appears to have been infilled / vegetated over in the mid 1970's.



The distance of the landfills from the site and absence of viable lateral flow pathways indicates that these do not represent a potential risk to the site.

#### **Previous Fieldwork**

The intrusive investigation, which was supervised by a Sirius Geoenvironmental Engineer, took place between 13<sup>th</sup> and 15<sup>th</sup> August 2014 and comprised the excavation of 33 trial pits, and the drilling of 8 window sample boreholes. Permanent monitoring installations for gas and groundwater monitoring were installed in each window sample borehole (WS1 to WS8).

The exploratory hole locations were based on the findings of the preliminary conceptual site model, in order to target specific areas of interest and achieve a general site coverage. The intrusive ground investigation was scoped using guidance presented in BS 5930:1999+A2:2010, BS10175:2011+A1:2013 and BS EN 1997:2004 and 2007.

Exploratory hole locations are shown on the attached site features plan (Drawing No. C6069A/01).

## **Ground Conditions**

The investigation identified topsoil (partly reworked) across the site. Locally, within the northwest and central southern areas of the site, this was underlain by a variable thickness of made ground to a maximum depth of 1.65m bgl. Made ground soils were recorded to include reworked granular and cohesive natural soils with anthropogenic inclusions, including brick, sandstone, concrete and occasional glass, metal, wood and plastic.

The topsoil and / or made ground were found to be underlain by strata of the Chester Pebble Beds Formation, typically comprising an upper layer of residual sandstone over competent sandstone bedrock.

No evidence of significant volumes of potentially degradable anthropogenic and / or natural materials or soils were encountered during the site investigation works, including no olfactory or visual evidence of hydrocarbon or similar contamination. Based on a visual assessment of the reworked made ground soils, it is considered that they will pose a very low gas generation potential.

The natural soils are not considered to pose a significant source of ground gas, given the generally low organic content (<1%; Environment Agency, 2002) of the Triassic sandstones. In addition, given the typically high permeability of these, the risk of any ground gas present remaining within trapped gas pockets is low/negligible.



## Groundwater

No groundwater strikes / ingresses were recorded as part of the site investigation works. A subsequent monitoring visit recorded the remaining intact gas and groundwater monitoring wells to be dry. Groundwater level variation will therefore not influence the shallow ground gas regime.

# Chemical Laboratory Testing

Selected samples of the topsoil (both natural and reworked) and made ground were tested for a range of potential contaminants at a UKAS and MCERTS-accredited laboratory. The full set of chemical laboratory data is included within the Sirius Geoenvironmental Appraisal report (ref. C6069 RevB); however in summary, no determinands were recorded at concentrations above the relevant generic assessment criteria (GACs).

Total organic carbon (TOC) was analysed within a number of selected soil samples, with the results summarised below in Table 1.

Sample Ref.	Ground Type	Anthropogenic Material Content	TOC Result (%)
TP1 at 1.0m	Cohesive made ground (reworked natural strata)	Low content of brick cobbles and boulders with occasional wood fragments.	0.9
TP29 at 0.6m	Granular made ground (reworked natural strata)	Low to moderate content of brick and concrete gravel and cobbles.	2.1
TP2 at 0.2m	Reworked topsoil	Low to moderate content of brick, concrete, metal, wood and plastic gravel and cobbles.	2.9
TP32 at 0.3m		esive made ground orked natural strata)Low content of brick cobbles and boulders with occasional wood fragments.nular made ground orked natural strata)Low to moderate content of brick and concrete gravel and cobbles.Low to moderate content of brick, concrete, metal, wood and plastic gravel	1.0
TP10 at 0.2m			1.9
TP18 at 0.2m	Topsoil		2.1
TP24 at 0.2m			1.9

# Table 1Summary of TOC Results

Topsoil typically records slightly elevated TOC concentrations, as a result of its natural organic content (rootlets, humic materials, etc.). The concentrations of TOC within made ground soils is



attributable to localised poorly degradable or recalcitrant organic materials, including wood and plastic. The thinness of the strata, the TOC concentration, and the slow biodegradability of the organic matter present mean that neither soil type represents a significant source of biogenic hazardous ground gases.

#### **Ground Gas Monitoring**

Ground gas monitoring was carried out on one occasion, and the results are summarised in Table 2 below.

Only two of the eight boreholes were located on the first visit, as it became apparent that the majority of boreholes had been purposely buried / destroyed (and the associated marker stakes removed) by an unknown third party. The second monitoring visit found that the remaining two boreholes had also been buried / destroyed. The monitoring technician reported being watched / monitored on both visits by external parties.

Full details of ground gas monitoring results are attached to this letter report.

Well	Methane (range) %v/v	Carbon Dioxide (range) %v/v	Oxygen (range) %v/v	Flow (range) l/hr
WS4	0.1	0.9	20.0 - 20.1	ND - 0.1
WS7	0.1 - 0.2	0.6	19.7 - 20.1	ND

ND - Not Detected

The results of the ground gas visit (within two boreholes only) indicated very low concentrations of both methane and carbon dioxide, with oxygen recorded at approximately atmospheric concentrations. Flow rates were non-detectable to very low.

Gas screening values (GSVs) have been calculated for both monitoring locations for methane and carbon dioxide. Based on the limited dataset available, the 'worst case' GSV was 0.0009l/hr for carbon dioxide. This GSV is considered representative of Characteristic Situation 1 (CS1), in accordance with Table 2 of BS8485:2015. Assuming a private, 'Type A' building (i.e. a low rise residential property), a gas score of 0 is calculated, indicating that no ground gas protection measures would be required.

# **Ground Gas Conceptual Site Model**

The preliminary combined conceptual site model and conceptual exposure model, presented in Sirius Geoenvironmental Appraisal report (ref. C6069 RevB), has been revised in light of the ground gas assessment presented above.



The revised conceptual model has been developed for the proposed future land use (low rise residential). This summarises the understanding of potential ground gas sources, transport pathways and receptors.

The revised conceptual model is presented in schematic form in Drawing No. C6069A/02, attached to this letter report. In summary, the revised CSM has not identified any potential linkages associated with ground gas which could result in an unacceptable risk to the proposed end-use.

#### **Ground Gas Risk Assessment**

Current guidance, such as CIRIA C665, would indicate that six gas monitoring visits over a minimum three month period would generally be required for a low rise residential end use, assuming a very low ground gas risk. However, this and related guidance is not prescriptive and a risk-based approach is recommended by all current guidance.

Reviewing the Conceptual Site Model, it is evident that there are no significant potential sources of ground gas within 750m of the site, and the recorded ground conditions encountered in the intrusive site investigation indicate the presence of natural and reworked topsoil / made ground over sandstone bedrock. There are very limited amounts of potentially degradable components within the reworked topsoil and made ground, the recorded organic matter content is very low, and these strata are thin. Consequently, the potential for hazardous ground gas production from the soils is negligible to very low and no significant pressure-driven flow will be possible.

In addition to the above, good construction of new properties generally limit the potential for any ground gas ingress, by means of well-constructed floor slabs with good seals around service entries. Many new build properties therefore typically have an inherent level of gas protection provided in their construction, and this can be taken into account as part of the assessment of risk from hazardous ground gas.

As a consequence, the ground gas risk to the proposed development can be characterised as negligible to very low.

Given the above, and the practicalities of maintaining intact operable gas monitoring boreholes at the site, it is considered that reinstatement of boreholes will be futile, and that no further gas monitoring is viable or necessary.

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

The above conclusions are subject to approval by the relevant regulators and, if applicable, the NHBC.



We trust that the above and enclosed are satisfactory and self-explanatory, and that you will forward this letter to the appropriate regulators for their comment / approval.

Please do not hesitate to contact the undersigned for any further information.

Yours sincerely

G Haurday.

Gemma Halliday Principal Engineer For and on behalf of Sirius Geotechnical & Environmental Ltd

Enc. Gas and Groundwater Monitoring Data Drawing No. C6069A/01 Site Features and EHLP C6069A/02 Ground Gas Conceptual Site Model

#### Ground Gas and Groundwater Monitoring Record Sheet

JOB DETAILS:

NB:

Client:	Redrow Homes Ltd	Job No:	C6069				
Site:	Woolton Road, Liverpool	Visit No:	1	of	6		
Date:	22/08/2014	Operator:	JC			Project Manager:	GH

					GAS C	ONCE	NTRAT	IONS					VOLA	TILES			LOW DATA		Worst-cree	dible GSVs	WELL	AND W	ATER DATA	Comments
Monitoring Point	Methane	e (%v/v)	%L	.EL	Carbon (%	dioxide v/v)		rbon de (ppmv)	Hydro sulphide		Oxyge	n (%v/v)	PID Peak (ppm)	Product thickness (mm)	Flow ra	ite (l/hr)	Differential borehole	Time for flow to equalise	Methane (l/hr)	CO2 (l/hr)	Water level (mbgl)	Depth of well (m)	Response Zone	
	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady			Peak	Steady	Pressure (Pa)	(secs)			(111591)	()		
WS1	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.50	0.50 - 2.50	Unable to locate as boreholes appear to be buried
WS2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.00	1.00 - 2.00	Unable to locate as boreholes appear to be buried
WS3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.70	0.10 - 0.70	Unable to locate as boreholes appear to be buried
WS4	0.1	0.1	2	2	0.9	0.9	ND	ND	ND	ND	20.0	20.1	NR	NR	0.1	ND	0.80	5	0.0001	0.0009	DRY	0.80	0.10 - 0.80	Borehole buried but located
WS5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1.00	0.10 - 1.00	Unable to locate as boreholes appear to be buried
WS6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1.00	0.10 - 1.00	Unable to locate as boreholes appear to be buried
WS7	0.2	0.1	2	2	0.6	0.6	ND	ND	ND	ND	19.7	20.1	NR	NR	ND	ND	0.01	5	0.0002	0.0006	DRY	1.00	0.10 - 1.00	
WS8	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.50	0.50 - 1.00	Unable to locate as boreholes appear to be buried
Мах	0.2	0.1	2.0	2.0	0.9	0.9	ND	ND	ND	ND	20.0	20.1	NR	NR	0.1	ND	0.8	5	0.0002	0.0009	DRY	2.50		
Min	0.1	0.1	2.0	2.0	0.6	0.6	ND	ND	ND	ND	19.7	20.1	NR	NR	ND	ND	0.01	5	0.0001	0.0006	DRY	0.50		
	ND -	Not detec	ted									-			-				Worst-pos	sible GSVs			MG - Made ground	- 1

Frozen

- ND Not detected
- NR Not recorded
- NA Non applicable

Where no flow (ND) recorded, GSVs are calculated using equiment limit of detection (0.11/hr). Where negative flows recorded, these are converted to positive values for calculation of GSVs.

METEOROLOGICAL AND SITE INFORM	IATION:		(Select correct bo	x with X o	or enter data, as a	applicable)	_	_
State of ground:	Dry	Х	Moist		Wet		Snow	
Wind:	Calm		Light	Х	Moderate		Strong	
Cloud cover:	None		Slight	Х	Cloudy		Overcast	
Precipitation:	None	Х	Slight		Moderate		Heavy	
Time monitoring performed:			Start				End	
Barometric pressure (mbar):		1005	Start			1006	End	
Pressure trend (Daily):			Falling	Х	Steady		Rising	
Source:	wunderground.co.uk		_				_	
Air Temperature (Deg. C):		13	Before			16	After	

#### INSTRUMENTATION TECHNICAL SPECIFICATIONS:

Ground gas meter:	G5006	72				
Gas Range:	CH₄	0-100%	CO2	0-100%	<b>O</b> <sub>2</sub>	0-25%
Gas Flow range:	+100/-	50 1/hour				
Differential Pressure:						
Date of last calibration:		03/06/2014				
Date of next calibration:		03/12/2014				
			_			
Ambient air check:	CH <sub>4</sub>	ND	$CO_2$	ND	<b>O</b> <sub>2</sub>	20.8

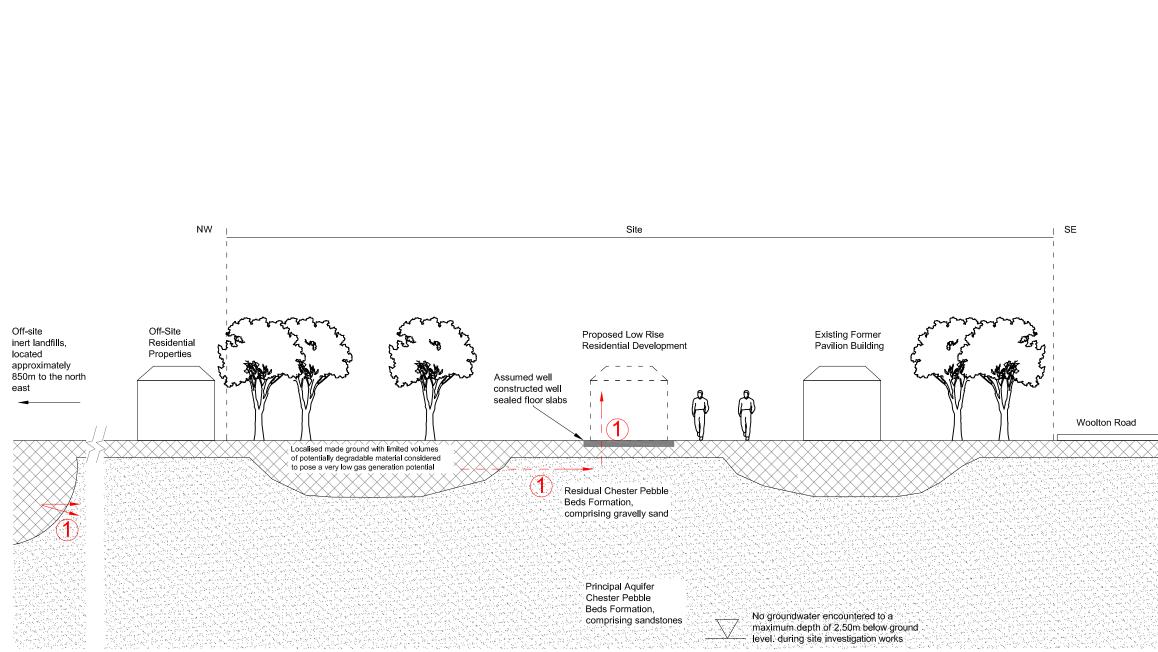
NAT - Natural C - Cohesive G - Granular

0.0009

0.0002



		NOTES
	+	Window Sample Borehole Location Trial Pit Location
	+	
)	+	
- <b>A</b> *	+	
<b>.</b>	+	
	+	REVISION           0         >>           A         >>           B         >>           C         >>
		D >> SIRIUS GEOTECHNICAL & ENVIRONMENTAL 4245 Park Approach, Thorpe Park, Leeds LS15 6CB www.thes/rlusgroup.com TEL: 0113 264 9960 FAX: 0113 264 9962
	+	CLIENT Redrow Homes Limited
	+	SITE Woolton Road Liverpool
	+	DRAWING TITLE Site Features Plan showing Exploratory Hole Locations
-	+	DRAWING NO.     REVISION NO.       C6069A RevA     0       DRAWN BY     APPROVED BY       DT     GH       DATE     SCALE       April 2016     1:2000



Contamination Sources	Contamination Pathways	Potential Receptors	Risk of Significant Contaminant Linkage
Shallow localised made ground on and off-site, with limited volumes of potentially degradable material.	1 Migration of ground gas in granular strata	Future site users, adjacent site users and construction workers	Negligible / Very Low, given generally inert nature of made ground and off-site landfills.

	NOTES					
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Off-Site Residential Properties						
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