GROUND GAS ASSESSMENT

Client	Bugler Developments Limited
Works	Installation of monitoring wells, ground gas testing and risk assessment.
Site	Land at Sullivan Crescent, Harefield, UB9 6NL

Project	Version	Date	Comments
23-248.04	2	22 November2024	Including third round of monitoring

1.0 INTRODUCTION

Aviron Associates Limited (Aviron) was instructed by Bugler Developments Limited [The Client] to attend site and re-install ground gas monitoring wells to enable the monitoring of ground gases, leading to completion of a risk assessment and recommendations in regard to ground gas protection.

This assessment has been prepared following the recommendation made within our Preliminary Risk Assessment and Site Investigation report, dated October 2023, and referenced 23-248.01.

Table 1 provides a brief summary of the site and the environment it sits within.

Table 1: The Site and Environs	
Current Site Arrangement	The site is currently under development into six new semi-detached homes with private gardens set around a new access road and a number of parking bays. Enclosed within **Appendix I** as **Figure 1** is a Site Plan
Previous Site Use	The site previously comprised a cleared parcel of land which was occupied by a series of lock-up garages.
Locality	The site is located on the edge of a rural area with homes of Ash Grove to the north and Sullivan Crescent to the west, and open agricultural fields to the east.
Geology	The British Geological Survey (BGS) indicates the is underlain by superficial geology of Gerrards Cross Gravel, in turn underlain by the London Clay Formation. The previous Aviron report of 2023 noted the following ground conditions: • Concrete hardstanding, to depths of up to 0.25m below ground level (bgl). • MADE GROUND noted routinely across the site to depths of between 0.4m and 0.9m bgl. • Overlying natural horizon of medium dense and dense becoming locally very dense slightly clayey becoming gravelly and very gravelly SAND (Gerrards Cross Gravel) to depths of between 1.9m and 2.5m bgl. • Firm and stiff, high strength, becoming very stiff, becoming fissured silty CLAY (London Clay Formation) to the termination depth of BH1 at 25.0m bgl. • Claystone was noted between 9.7m and 9.9m bgl. No groundwater noted during monitoring between 0.85m bgl and 1.34m bgl.

2.0 PRELIMINARY GROUND GAS RISK ASSESSMENT

The Preliminary Ground Gas Risk Assessment prepared within the aforementioned report is presented within Table 2.

Table 2: Preliminary Bio-Ground Gas Risk Assessment			
Potential Source	**Risk**	**Risk Rating**	**Rationale**
Made Ground (CO_2 + CH_4)	Human health Explosion	Very low	Nominal Made Ground is anticipated due to the development of the site as lock-up garages. However, it is not anticipated that sufficiently thick units of organic Made Ground exist and thus a very low risk of ground gas production is considered. The site is underlain by the superficial strata of the Gerrards Cross Gravel above the solid geological strata of the London Clay Formation.
Alluvial Strata (CO_2 + CH_4)	Human health Explosion	Negligible	No alluvium noted within 250m of the site.
Landfills (CO_2 + CH_4)	Human health Explosion	Negligible	No landfill sites noted within 500m of the site.
Infilled Ground + Burial Sites (CO_2 + CH_4)	Human health Explosion	Negligible	No infilled ground noted within 250m of the site.
Coal Mining (CO_2 + CH_4)	Human health Explosion	Negligible	Not located in a coal mining area.
Soil Vapours	Human health Explosion	Very Low	Soil vapour risks identified associated with potential for small-scale hydrocarbon storage and spillages, and maintenance of vehicles at the lock-up garages across the site, as well as the three chambered interceptor in the north-west of the site.
COMBINED RISK RATING = VERY LOW			

A VERY LOW combined risk is considered in relation to bio-ground gas ingress into the new homes, and bio-ground gas monitoring would be considered prudent.

3.0 PREVIOUS GROUND INVESTIGATION AND MONITORING COMPLETED - 2023

Pertinent to this assessment the 2020 investigation and interpretation is summarised as follows:

- Three monitoring wells (WS1, WS3 and WS5) were installed within window sample boreholes to depths of up to 2.5m bgl.
- **Figure 2**, which is enclosed within **Appendix I** is presented as a Monitoring Well Location Plan providing the location of wells installed in 2023 (and 2024).
- Three rounds of gas monitoring were completed on 3 October, 19 October and 19 October 2023 whereby elevated carbon dioxide (>5%), depleted oxygen (<16%) and no methane (0.0%/<0.1%) was recorded. No flow rate was recorded (0.0l/h/<0.1l/h). At the time of monitoring barometric pressure was 1012m, 1010mB and 978mB respectively.
- Based on the maximum concentrations and flows recorded, the **GSV** for **methane** was **0.0 L/hr** and the **GSV** for **carbon dioxide** was **0.0l/hr**.
- However, elevated carbon dioxide (>5%) and depleted oxygen (<16%) has been recorded. Whilst there is an absence of flow from the ground, suggestive that the poor gaseous ground gas conditions will not mobilise to the surface and into new homes, it is the advice of C665 that the characteristic situation is increased to CS2.

- In light of the technical requirements to prolong the gas risk assessment to gather additional data in the pursuit of reducing the situation to CS1, professional opinion suggests it more prudent to install gas protection to CS2 in accordance with BS8485.

Replacement monitoring wells shall be installed for completion of the assessment.

4.0 GROUND INVESTIGATION

4.1 Drilling of Boreholes and installation of Monitoring Wells

Window sample boreholes MW1, MW2 and MW3 were drilled using an Archway Dart drilling rig on 4 October 2024.

The locations of the 'MW' boreholes are illustrated in **Figure 2** which is included as **Appendix I.** Wells were positions where spatially available.

The action of window sampling enables the installation of monitoring wells to depths of up to 3m bgl and the construction of a suitable response zone for the monitoring of ground gases.

Ground conditions encountered within the window sample boreholes drilling were consistent with previously completed works. The **exploratory hole logs** are presented in **Appendix II** and generally ground conditions are summarised in table 3.

Table 3: Summary of Ground Conditions Encountered

Unit	Description	From (bgl)	To (bgl)
Made Ground	**MW1, MW2, MW3** Light brown sandy fine medium and coarse subangular to rounded gravel of flint. Reworked	GL	0.3m/ 0.5m
Gerrards Cross Gravel	**MW1, MW2, MW3** Orange brown slightly clayey gravelly coarse SAND. Gravel is fine to coarse sub-angular of flint.	0.3m/ 0.5m	>2.0m/ 2.5m
	MW1, MW2 Orange brown very gravelly coarse SAND. Gravel content increasing with depth fine to coarse sub-angular of flint.	>2.0m/ 2.5m	>3.0m
Groundwater	Groundwater was not encountered.		
Observations	No abnormal observations.		
GL = Ground Level			

4.2 Monitoring Well Installation

All three window sample boreholes were converted to monitoring wells to enable ground gas monitoring along with routine standing level groundwater monitoring. Wells were installed into 101mm diameter window sample boreholes using 63mm external diameter and 50mm internal diameter HDPE standpipe. Table 4 describes the construction of the wells.

Table 4: Monitoring Well Construction

Location	Depth of plain pipe and bentonite seal	Response zone; depths of slotted pipe with gravel screen	Notes
MW1	GL-1.0m	1.0m – 2.0m	All wells left proud (with plain pipe) to enable identification and signage to avoid damage.
MW2	GL-1.0m	1.0m – 3.0m	
MW3	GL-1.0m	1.0m – 2.0m	

5.0 GAS MONITORING

5.1 Monitoring Completed

The presence of soil vapours was determined prior to bulk ground gas monitoring using a MiniRAE Photon Ionisation Detector (PID) from RAEs Systems. The presence of hazardous bio-gases including methane (CH4), carbon dioxide (CO2) and oxygen (O2) was determined using a GFM Infra-Red Gas Analyser from Ribble Enviro Limited. The flow rate and atmospheric pressure, in millibars (mb), was also measured during the monitoring process. Depth to groundwater was measured using an electronic dip meter.

Monitoring work was completed on the dates specified within table 5 which also summarises weather conditions and atmosphere pressure. To determine rising or falling pressures local 'online' weather trends from the Met Office and/or the monitoring apparatus were consulted.

Table 5: Background Gas Monitoring Data				
Date	**Atmospheric Pressure**	**Rising/Falling Pressure?**	**Worst Case Conditions?**	**Groundwater above response zone?**
16 Oct 2024	999mB	Falling	Yes	No
30 Oct 2024	1029mB	Steady	No	No
21 Nov 2024	999mB	Falling	Yes	No

Note 2 of C665 indicates 'worst case' conditions occur during falling and sub-1000mB atmospheric pressures. Section 5.5.1 of C665 indicates 'worst case' conditions are likely to occur during weather conditions such as rainfall, frost or dry weather.

Table 7 summaries the results obtained from 2024 which are enclosed in **Appendix III**.

Table 7: Summary of Monitoring Results			
Gas	**Measured Conc. Range (% v/v)**		**Comments**
	Low	**High**	
CH_4	0.0 (<0.1)	0.0 (<0.1)	Methane was not detected (<0.1%) and thus is below the guidance value of 1% at which point the characteristic situation is advised to increase to CS2.
CO_2	0.0 (<0.1)	0.8	Carbon dioxide has been detected at concentrations below the guidance value of 5% at which point the characteristic situation is advised to increase to CS2.
O_2	19.1	20.2	Oxygen has been recorded at ambient concentrations, above 16% the point where it is considered there is potential for asphyxiation.
Vapour*	0.0 (<0.1)	1.3	Very low (PID) concentrations have been recorded. This concurs with the ground conditions and geochemical laboratory results suggesting the absence of soil vapour risk to new homes.

*vapour concentration in parts per million (ppm)

It is considered the integrity of the monitoring wells has not been compromised as there is no evidence of surface damage which may affect the underlying installations. There is a bentonite seal within the bored annulus preventing escape of ground gases and entry of atmospheric gases. The gas valve remained closed prior to all monitoring occasions so passive venting of ground gas is unlikely to have occurred as site visits were unannounced.

5.2 Interpretation of Data

Under normal use of the site (i.e. above ground), the risk presented by methane and carbon dioxide is dependent on both the concentrations and the rate of flow. In accordance with Wilson and Card methodology specified in the CIRIA C655 document, Gas Screening Values (GSV) were determined using the formula below.

GSV =	(Maximum steady concentration / 100) x Flow rate
GSV measured in litres per hour (l/hr)	Maximum steady concentration measured in percent (%) Flow rate measured in l/hr.

Based on the maximum concentrations and flows recorded, the **GSV** for **methane** was **0.0 L/hr** and the **GSV** for **carbon dioxide** was **0.0l/hr**.

Based on the GSV for carbon dioxide which is below 0.07l/h, along with the maximum recorded concentrations for carbon dioxide (<5%) and methane (<1%) the site is likely to to fall within Characteristic Situation 1 (CS1). It is likely following re-development ground conditions have been excavated and aerated thus removing aerobic conditions in the sub-soil.

Gas protection shall not required for the new homes based on:

- the limited potential source of risk;
- the acceptable 2024 results;
- the GSV for carbon dioxide and methane is between 0.07l/h and 0.7l/h;
- the maximum concentrations carbon dioxide and methane are below 5% and 1% respectively;
- no abnormal ground conditions were recorded during the investigation;

Bio-ground gas protection to new homes shall not be necessary.

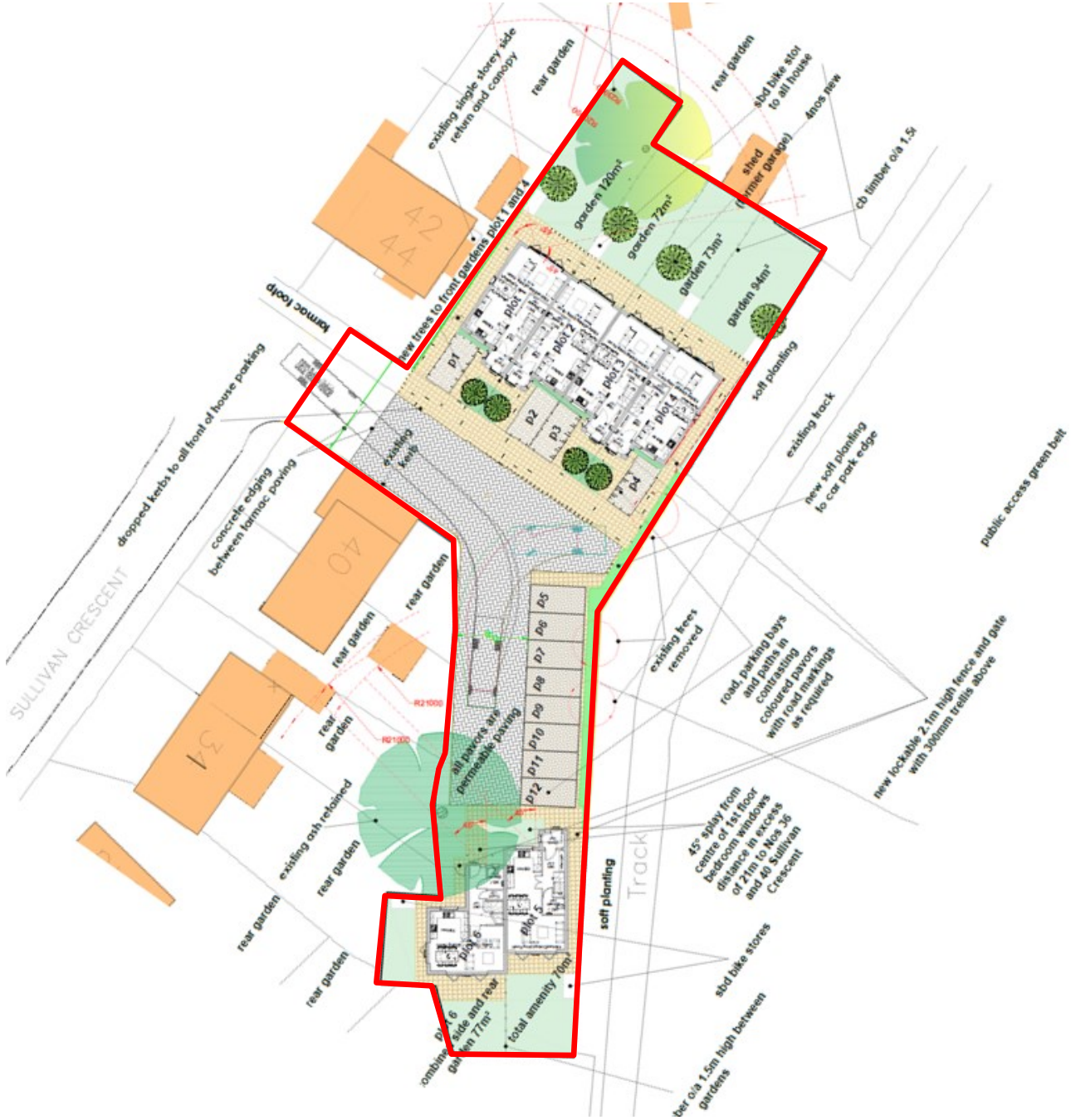
We trust that you find the above to be satisfactory, however should you require any further information please do not hesitate to contact the undersigned.

Prepared by
James Burkitt BEng (Hons) CEnv MRICS
Managing Director

Appendix I

Figure 1 – Site Plan

Figure 2 –Monitoring Well Location Plan



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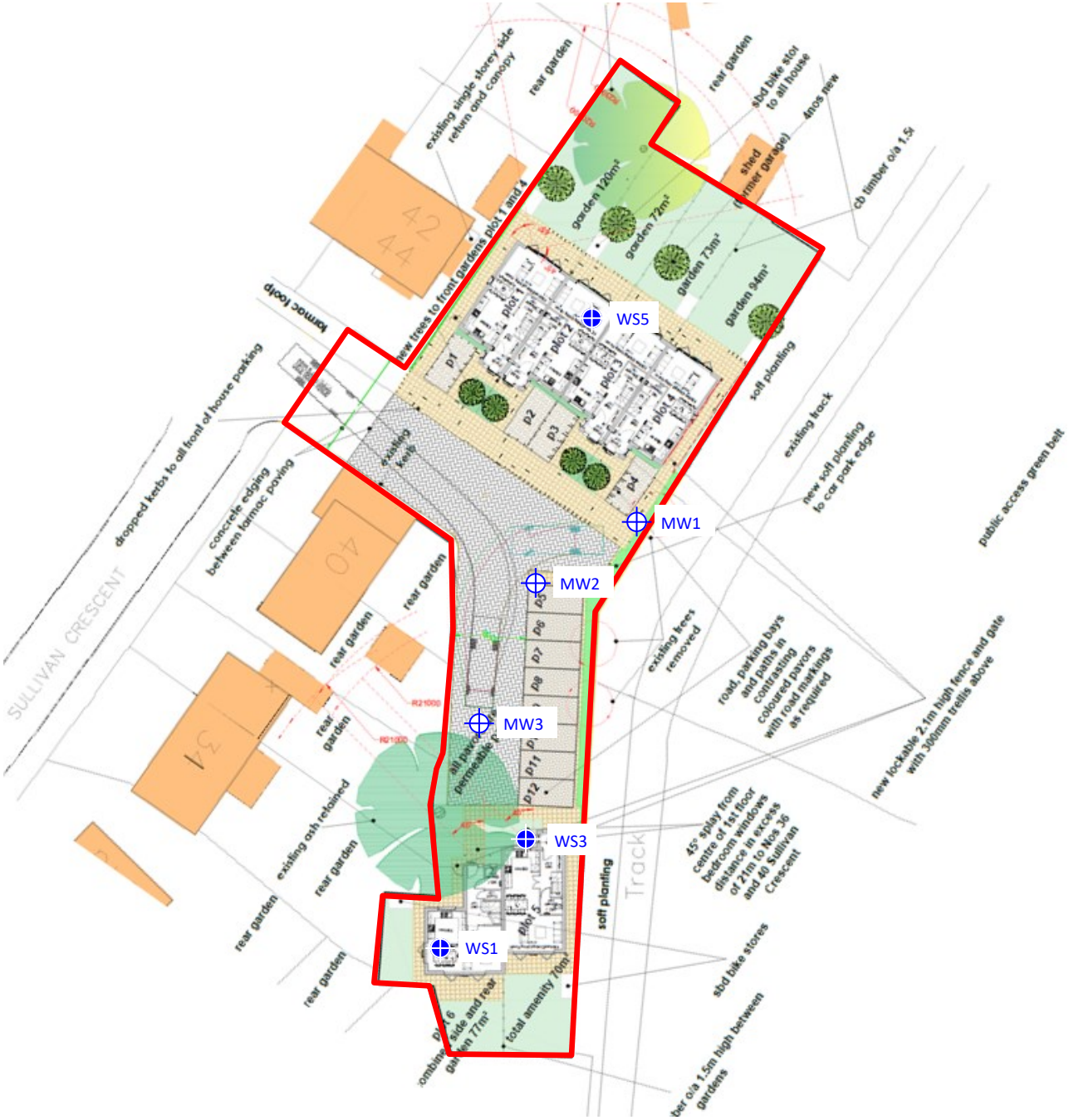
Legend

Notes

Figure 1

Drawing Title	Site Plan
Project Number	23-248.04
Project Title	Land at Sullivan Crescent, Harefield, UB9 6NL
Drawn by	DN
Checked by	JB
Scale	NTS



Legend

- 2023 Monitoring Well
- 2024 Monitoring Well

Notes

Figure 2

Drawing Title

Monitoring Well Location Plan

Project Number	23-248.04
Project Title	Land at Sullivan Crescent, Harefield, UB9 6NL
Drawn by	DN
Checked by	JB
Scale	NTS

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Appendix II
Window Sample Logs

Window Sampling Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 04/10/2024
Location: Harefield, UB9 6NL	Contractor: Geospec	
Project No. : 23-248.04	Crew Name: DO	Drilling Equipment: Archway Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
MW1	WS		dn	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown sandy fine medium and coarse subangular to rounded gravel of flint. Reworked.
					0.50			Orange brown slightly clayey gravelly coarse SAND. Gravel is fine to coarse sub-angular of flint.
					2.00			Orange brown very gravelly coarse SAND. Gravel content increasing with depth fine to coarse sub-angular of flint.
					3.00			End of Borehole at 3.00m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

50mm diameter standpipe installed to 3.0m

Window Sampling Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 04/10/2024
Location: Harefield, UB9 6NL	Contractor: Geospec	
Project No. : 23-248.04	Crew Name: DO	Drilling Equipment: Archway Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
MW2	WS		dn	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Light brown sandy fine medium and coarse subangular to rounded gravel of flint. Reworked.
								Orange brown slightly clayey gravelly coarse SAND. Gravel is fine to coarse sub-angular of flint.
					2.50			Orange brown very gravelly coarse SAND. Gravel content increasing with depth fine to coarse sub-angular of flint.
					4.00			End of Borehole at 4.00m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

50mm diameter standpipe installed to 4.0m

Window Sampling Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 04/10/2024
Location: Harefield, UB9 6NL	Contractor: Geospec	
Project No. : 23-248.04	Crew Name: DO	Drilling Equipment: Archway Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
MW3	WS		dn	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown sandy fine medium and coarse subangular to rounded gravel of flint. Reworked.
					0.40			Orange brown slightly clayey gravelly coarse SAND. Gravel is fine to coarse sub-angular of flint.
					2.00			End of Borehole at 2.00m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

50mm diameter standpipe installed to 2.0m

Appendix III
Ground Gas Monitoring Results

MONITORING DATA SHEET

SITE 23-248.04
PROJECT Land at Sullivan Crescent, Harefield, UB9 6NL

VISIT NUMBER 4
DATE 16/10/2024

EQUIPMENT GFM435 + MiniRAE
TAKEN BY AC

Record of Stable Concentrations										Interpretation		
Location	Time	Flow (l/h)	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Baro. Prs. (mB)	PID (ppm)	Water (m bgl)	Base Well (m bgl)	CH4 GSV (l/h)	CO2 GSV (l/h)	CS
Site	14:50	n/a	0.0	0.0	20.4	999	0.0	n/a	n/a	n/a	n/a	n/a
MW1	15:33	0.0	0.0	0.0	18.8	999	1.3	2.13	3.02	0	0	CS-1
MW2	15:19	0.0	0.0	0.8	18.8	999	0.0	1.84	2.99	0	0	CS-1
MW3	15:09	0.0	0.0	0.0	20.2	999	0.0	1.36	1.85	0	0	CS-1

Weather Observations					
State of Ground	Cloud Cover	Wind	Rain	Air Temperature °C	
Dry	Clear	Calm	None	Before	14
Moist	Sunny	Light	Slight		
Wet	Slight	Moderate	Moderate	After	14
Snow	Cloudy	Strong	Heavy		
Frozen	Overcast				
	Fog/Mist				

Pressure Observations			
Source	Pressure Records		Trend
Metoffice	Location	**Yeading**	Falling
GFM435	Time	**12:12**	Steady
	Pressure	**1000**	Rising

Notes	
Worst case conditions? (<1000mB and Falling)	Yes

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MONITORING DATA SHEET

SITE 23-248.04
PROJECT Land at Sullivan Crescent, Harefield, UB9 6NL

VISIT NUMBER 5
DATE 30/10/2024

EQUIPMENT GFM435 + MiniRAE
TAKEN BY AC

Record of Stable Concentrations										Interpretation		
Location	Time	Flow (l/h)	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Baro. Prs. (mB)	PID (ppm)	Water (m bgl)	Base Well (m bgl)	CH4 GSV (l/h)	CO2 GSV (l/h)	CS
Site	15:01	n/a	0.0	0.0	20.3	1029	0.0	n/a	n/a	n/a	n/a	n/a
MW1	15:36	0.0	0.0	0.1	19.1	1029	0.8	2.16	3.02	0	0	CS-1
MW2	15:22	0.0	0.0	0.7	18.9	1029	0.1	1.89	2.99	0	0	CS-1
MW3	15:13	0.0	0.0	0.2	19.9	1028	0.0	1.45	1.85	0	0	CS-1

Weather Observations					
State of Ground	Cloud Cover	Wind	Rain	Air Temperature °C	
Dry	Clear	Calm	None	Before	12
Moist	Sunny	Light	Slight		
Wet	Slight	Moderate	Moderate	After	12
Snow	Cloudy	Strong	Heavy		
Frozen	Overcast				
	Fog/Mist				

Pressure Observations			
Source	Pressure Records		Trend
Metoffice	Location	**Henley**	Falling
GFM435	Time	**14:01**	Steady
	Pressure	**1029**	Rising

Notes	
Worst case conditions? (<1000mB and Falling)	No

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MONITORING DATA SHEET

SITE 23-248.04

PROJECT Land at Sullivan Crescent, Harefield, UB9 6NL

VISIT NUMBER 6

DATE 21/11/2024

EQUIPMENT GFM435 + MiniRAE

TAKEN BY AC

Record of Stable Concentrations										Interpretation		
Location	Time	Flow (l/h)	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Baro. Prs. (mB)	PID (ppm)	Water (m bgl)	Base Well (m bgl)	CH4 GSV (l/h)	CO2 GSV (l/h)	CS
Site	11:01	n/a	0.0	0.0	20.3	999	0.0	n/a	n/a	n/a	n/a	n/a
MW1	11:17	0.0	0.0	0.4	18.9	999	0.2	2.14	3.02	0	0	CS-1
MW2	11:09	0.0	0.0	0.5	19.1	999	0.3	1.94	2.99	0	0	CS-1
MW3	11:03	0.0	0.0	0.3	19.8	999	0.1	1.56	1.85	0	0	CS-1

Weather Observations					
State of Ground	Cloud Cover	Wind	Rain	Air Temperature °C	
Dry	Clear	Calm	None	Before	1
Moist	Sunny	Light	Slight		
Wet	Slight	Moderate	Moderate	After	1
Snow	Cloudy	Strong	Heavy		
Frozen	Overcast				
	Fog/Mist				

Pressure Observations			
Source	Pressure Records		Trend
Metoffice	Location	**Henley**	Falling
GFM435	Time	**9:17am**	Steady
	Pressure	**1000mB**	Rising

Notes	
Worst case conditions? (<1000mB and Falling)	Yes

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