ROBERTS
ENVIRONMENTAL LTD

23 Grey Street
Newcastle upon Tyne
NE1 6EE

Our Ref: 161107.02
24 March 2017

Mr C Leach,
Gentoo Group limited,
Emperor House
2 Emperor Way
Doxford Park
Sunderland
SR3 3XR

Re: Hazardous Ground Gas Risk Assessment – Dunelm House, East Boldon.

Dear Mr C Leach,

This letter report is an addendum to the Roberts Environmental Ltd., Phase I & Phase II Geo-Environmental Site Investigation and Risk Assessment report (Ref: 161107.R.001, December 2016), undertaken for the proposed development of residential properties.

As part of the original Phase II ground investigation, a preliminary ground gas risk assessment was carried out, using one out of a scheduled six gas monitoring rounds which had been undertaken at the subject site. Following the production of the Phase II report, a further five gas monitoring rounds have been carried out. The results from all six ground gas monitoring rounds have been used to complete this addendum report.

All of the monitoring was undertaken using a Gas Data GFM 435 infra-red gas analyser with integral flow meter and electronic dipmeter. Gas monitoring was undertaken during periods of lower, high and falling pressure. A summary of the range of gas monitoring results recorded are shown in the table below, with a copy of the monitoring sheets enclosed with this letter report.

Gas monitoring results

The results of the six ground gas monitoring rounds undertaken at the site are summarised in the table below.

BH No.	Methane Range (% v/v)	Carbon Dioxide Range (% v/v)	Oxygen Range (% v/v)	Total Gas Emission Rate (l/hr)	Atmospheric Pressure Range (m bars)
WS1	0.0	0.0-3.5	5.6-20.0	0.4	975 – 1028
WS3	0.0	0.0-3.3	15.5-20.2	<0.1	975 – 1028
WS4	0.0	0.1-2.5	13.7-19.9	<0.1	975 – 1028

CEnv
Chartered Environmentalist

Roberts Environmental Limited registered in England and Wales number 07950036
Registered Office: 23 Grey Street, Newcastle upon Tyne, NE1 6EE

The ground gas monitoring results have identified no detectable concentrations of Methane ground gas being produced beneath the site or migrating onto the site. Carbon Dioxide (CO_2) has been recorded slightly above atmospheric levels, up to a maximum concentration of 3.5%v/v. In addition, no significant concentrations of Carbon Monoxide or Hydrogen Sulphide has been recorded.

Gas flow rates have been limited throughout the monitoring period, indicating negligible gas generation rates, even during periods of lower/falling pressure.

However, depleted Oxygen levels have been recorded, notably within WS1 where significantly depleted levels have been recorded on two occasions. Lowest oxygen levels were recorded at 5.6%. Given that Methane, Carbon Dioxide, Carbon Monoxide and Hydrogen Sulphide levels were not recorded in significantly elevated concentrations, it is considered likely that oxygen levels are being influenced by groundwater levels and the impermeable cohesive nature of the natural soils beneath the site. These conditions would likely result in a restricted exchange of gases between the sub-surface and the atmosphere.

Ground Gas Classification

To determine the Gas Screening Value (GSV) and subsequently the Characteristic Situation value (CS) for the site, the ground gas risk assessment has been undertaken with reference to the document CIRIA C665, Table 8.5, page 88. In accordance with CIRIA C665 the following equation is used: -

Gas Screening Value (l/hr) = maximum gas concentration (%) / 100 x measured borehole flow rate (l/hr).

Therefore, based on the gas monitoring data; the peak Carbon Dioxide concentration of 3.5% and worst case flow rate of 0.4l/hr have been adopted. As such, the calculation is as follows;

Carbon Dioxide
= (3.5 (% by vol) / 100) x 0.4 (l/hr)
The gas screening value (GSV) for Carbon Dioxide is calculated at 0.014 l/hr.

The GSV of 0.014 l/hr for Carbon Dioxide falls within a Characteristic Situation 1 (CS1) classification category as such, based upon the above, ground gas protection measures would not be required for this site. However, despite the lack of significant ground gas concentrations or flow rate, due to the depleted oxygen levels recorded, it would be prudent to adopt a conservative approach and as such REL consider an increase to Characteristic Situation 2 would be appropriate. As such, basic ground gas protection measures would be required.

It should be noted that within the REL Phase I & Phase II Geo-Environmental Site Investigation and Risk Assessment report (Ref: 161107.R.001, December 2016), Section 10, the additional works section indicates that vapour protection would likely be needed due to the elevated concentrations of volatile organic compounds identified within the soil samples.

Taking the above into account, any future gas protection measures adopted at the site should would need to provide a suitable level of protection against ground gas and those volatiles identified.

Following installation of gas protection measures, validation inspections would be required to confirm the measures adopted have been installed correctly. Further details are provided in **Enclosure 1**.

We trust the information we have provided to you is to your satisfaction. However, if you require any further information or clarification, please do not hesitate to contact us.

Yours sincerely,



Sam Turner BSc (Hons), FGS
Consultant
For and on behalf of Roberts Environmental Ltd
Tel: 0191 230 4521
Mobile: 0749 6794 242

Roberts Environmental Monitoring Form

Site: Dunelm House, East Boldon

Equipment: GFM435 Gas Analyser

Job No: 161107

Weather: Cool, fair, overcast

Date: 01-12-16

Temp: 5°C

Visit: 1 **of** 6

Borehole	Gas Flow (l/hr)	Borehole Pressure (pa)	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Atm Pressure	Other Gases (PPM)			Depth to Water m bgl (Base BH)
			Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	mb	PID	H_2S	CO	
WS1	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.6	19.1	17.7	1022.0	1.0	0.0	0.0	1.8 (4.8)
WS3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.5	18.5	20.0	1020.0	1.0	0.0	0.0	2.16 (4.8)
WS4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	19.5	18.9	1020.0	1.0	0.0	0.0	1.43 (4.8)

Notes:
Minimum monitoring period 3 minutes extended where elevated consentrations of gasses initially recorded.
* LEL = Lower Explosive Limit = 5 % v/v

Additional Notes:

Monitored by: SJT

Project lead SJT

Signed: S Turner

Signed: S Turner

Roberts Environmental Monitoring Form

Site: Dunelm House, East Boldon

Equipment: GFM435 Gas Analyser

Job No: 161107

Weather: Clear, cool, dry

Date: 21-12-16

Temp: 7°C

Visit: 2 **of** 6

Borehole	Gas Flow (l/hr)	Borehole Pressure (pa)	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Atm Pressure	Other Gases (PPM)			Depth to Water m bgl (Base BH)
			Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	mb	PID	H_2S	CO	
WS1	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.1	17.8	12.4	1004.0	1.0	0.0	0.0	1.84 (4.8)
WS3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.3	19.0	20.2	1005.0	1.0	0.0	0.0	2.11 (4.8)
WS4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.5	19.9	13.7	1005.0	1.0	0.0	0.0	1.31(4.8)

Notes:
Minimum monitoring period 3 minutes extended where elevated consentrations of gasses initially recorded.
* LEL = Lower Explosive Limit = 5 % v/v

Additional Notes:

Monitored by: SJT

Signed: S Turner

Project lead SJT

Signed: S Turner

Roberts Environmental Monitoring Form

Site: Dunelm House, East Boldon

Equipment: GFM435 Gas Analyser

Job No: 161107

Weather: Sunny, dry

Date: 05-01-17

Temp: 6°C

Visit: 3 **of** 6

Borehole	Gas Flow (l/hr)	Borehole Pressure (pa)	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Atm Pressure	Other Gases (PPM)			Depth to Water m bgl (Base BH)
			Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	mb	PID	H_2S	CO	
WS1	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.4	18.1	10.3	1028.0	1.0	0.0	0.0	1.81 (4.8)
WS3	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.5	15.8	19.7	1026.0	1.0	0.0	0.0	2.09 (4.8)
WS4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.2	18.4	15.5	1026.0	1.0	0.0	0.0	1.25 (4.8)

Notes:
Minimum monitoring period 3 minutes extended where elevated consentrations of gasses initially recorded.
* LEL = Lower Explosive Limit = 5 % v/v

Additional Notes:

Monitored by: SJT

Signed: S Turner

Project lead SJT

Signed: S Turner

Roberts Environmental Monitoring Form

Site: Dunelm House, East Boldon

Equipment: GFM435 Gas Analyser

Job No: 161107

Weather: Clear, sunny, dry

Date: 25-01-17

Temp: 5°C

Visit: 4 **of** 6

Borehole	Gas Flow (l/hr)	Borehole Pressure (pa)	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Atm Pressure	Other Gases (PPM)			Depth to Water m bgl (Base BH)
			Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	mb	PID	H_2S	CO	
WS1	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	18.4	20.0	1015.0	1.0	0.0	0.0	1.73 (4.8)
WS3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	18.9	20.2	1015.0	1.0	0.0	0.0	2.10 (4.8)
WS4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.6	19.7	17.6	1015.0	1.0	0.0	0.0	1.10 (4.8)

Notes:
Minimum monitoring period 3 minutes extended where elevated consentrations of gasses initially recorded.
* LEL = Lower Explosive Limit = 5 % v/v

Additional Notes:

Monitored by: SJT

Signed: S Turner

Project lead SJT

Signed: S Turner

Roberts Environmental Monitoring Form

Site: Dunelm House, East Boldon

Equipment: GFM435 Gas Analyser

Job No: 161107

Weather: Overcast, dry

Date: 09-02-17

Temp: 1°C

Visit: 5 **of** 6

Borehole	Gas Flow (l/hr)	Borehole Pressure (pa)	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Atm Pressure	Other Gases (PPM)			Depth to Water m bgl (Base BH)
			Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	mb	PID	H_2S	CO	
WS1	0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.3	18.5	6.4	1022.0	1.0	0.0	0.0	1.70 (4.8)
WS3	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.1	18.3	19.9	1023.0	1.0	0.0	0.0	1.95 (4.8)
WS4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.6	19.3	18.2	1023.0	1.0	0.0	0.0	1.09 (4.8)

Notes:
Minimum monitoring period 3 minutes extended where elevated consentrations of gasses initially recorded.
* LEL = Lower Explosive Limit = 5 % v/v

Additional Notes:

Monitored by: SJT

Signed: S Turner

Project lead SJT

Signed: S Turner

Roberts Environmental Monitoring Form

Site: Dunelm House, East Boldon

Equipment: GFM435 Gas Analyser

Job No: 161107

Weather: Overcast, dry

Date: 27-02-17

Temp: 6°C

Visit: 6 **of** 6

Borehole	Gas Flow (l/hr)	Borehole Pressure (pa)	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Atm Pressure	Other Gases (PPM)			Depth to Water m bgl (Base BH)
			Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	mb	PID	H_2S	CO	
WS1	0.4	0.0	0.0	0.0	0.0	0.0	2.2	3.5	10.3	5.6	975.0	1.0	0.0	0.0	1.72 (4.8)
WS3	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.0	15.5	17.1	975.0	1.0	0.0	0.0	1.1 (4.8)
WS4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	19.5	19.7	975.0	1.0	0.0	0.0	1.95 (4.8)

Notes:
Minimum monitoring period 3 minutes extended where elevated consentrations of gasses initially recorded.
* LEL = Lower Explosive Limit = 5 % v/v

Additional Notes:

Monitored by: SJT

Project lead SJT

Signed:

Signed: