# PHASE II GROUND INVESTIGATION REPORT



HAWTHORNE FARM, HAWTHORNE PLACE CLITHEROE, LANCASHIRE, BB7 2HU PERSIMMON HOMES (LANCASHIRE) LIMITED



### **QUALITY CONTROL**

Project No.	GEOL19-9988 Client Persimmon Homes (Lancashire) Limited										
Report Type	Phase II Ground In	Phase II Ground Investigation Report									
Project Type	Proposed Residential Development										
Site Address	Hawthorne Farm, Hawthorne Place, Clitheroe, Lancashire, BB7 2HU										
NGR	374380, 442540										
Date	07/10/2019										
Prepared by	Richard Stripp										
Qualifications	BSc (Hons) MSc FGS MII	EnvSc									
Position	Director			and the second s							
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Qualifications	BSc (Hons) CSci CEnv FG	iS MIEnvSc	FCMI MIoD	MCMUL							
Position	Director										

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REPORT REVISION HISTORY									
lssue	Description	Date	Author	Approval					
1	Final Issue	07/10/2019	RS TMc						



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### INTRODUCTION

Geol Consultants Limited (GEOL) were instructed by Persimmon Homes (Lancashire) Limited to undertake a Phase II Ground Investigation over a parcel of undeveloped land located off Hawthorne Place, in the Lancashire town of Clitheroe. It is proposed to develop the site, which is currently used as agricultural grazing land, for the construction of 53 no. residential properties with private gardens, along with road infrastructure and areas of public open space.

The purpose of this report is to provide information relating to the following;

- Identify the ground conditions and assess the geotechnical properties of the underlying deposits
- $oldsymbol{
  abla}$  Assess the potential contamination issues associated with the recorded site history and to assess the impacts from those contaminants towards the future site end-users (Human Health) and nearby sensitive receptors (Controlled Waters)
- Assess the risks associated with potential sources of hazardous ground gas generation
- 🔻 Confirm the Conceptual Site Model (CSM) developed from the results of the Phase I Preliminary Contamination Risk Assessment completed for the site (reference; GEOL19-9988, August 2019) for all potential source, pathway and receptor linkages
- igsim Determine the scope of any further investigation works or remediation works required for the site prior to commencing with any future development works

The information contained in this ground investigation report is limited to the area of the site as shown on the existing and proposed development plans contained in Appendix I, and to those areas accessible at the time of the ground investigation works being undertaken. When considering the scope of works completed for this site / development, any features or issues not specifically mentioned can not be assumed to have been covered.





All relevant details and descriptions relating to the site have been summarised in the Table below.

Detail	Description
Site address and access	Hawthorne Farm, Hawthorne Place, Clitheroe, Lancashire, BB7 2HU. Access to the site can be gained via an existing gate (field gate), positioned adjacent to no. 44 Hawthorne Place.
NGR	374380, 442540
Approximate size	1.64 Ha
Current site use	Agricultural grazing land.
Proposed site use	Residential housing with private gardens, road infrastructure and areas of public open space.
Surrounding land uses	Agricultural land to the north and north-east, and residential housing to the south-east, south-west and west.
Site topography	The site is generally level in nature, with site levels between c.79m and c.82m AOD.
Site observations	The site surfacing comprises mainly grass. A copse of trees is present in the central-eastern portion of the site. A row of additional trees, trending towards the north-eastern corner of the site are also present. There are no above ground structures present on site, except for an animal pen adjacent to the entrance of the site. A narrow covered / culverted watercourse is present along the north-eastern and south-eastern site boundaries, and a manhole cover was noted on the eastern corner of the site. An additional manhole was also noted in the central portion of the site in an area of overgrown nettles and trees. A proposed development layout plan provided by the client indicates the presence of a gas main crossing the site from the northern boundary trending towards Hawthorne Place to the south.
Investigation Works	<ul> <li>An intrusive ground investigation has been completed by GEOL comprising the completion of 15 no. windowless sampling boreholes (labelled BH01 to BH15), including the installation of 3 no. ground gas &amp; groundwater monitoring wells (BH02, BH06 &amp; BH15) and the completion of 3 no. variable head (falling) permeability tests, to inform foundation design, drainage and contamination status of existing soils. Representative samples have been recovered to allow for geotechnical and chemical (ground contamination) laboratory testing.</li> <li>For this site a Human Health Generic Quantitative Risk Assessment (GQRA) and Hazardous Ground Gas Risk Assessment has been completed.</li> </ul>





## **GROUND CONDITONS**

Detailed descriptions of the strata and groundwater observations made during the investigation works, together with samples recovered and the results of all in situ field testing, are presented on the borehole record sheets and the variable head (falling) permeability test sheets contained in Appendix II. The depths of strata on the borehole record sheets are recorded from current ground levels at each location, unless indicated otherwise. The boreholes have been accurately surveyed on site and the co-ordinates relating to their position, as well as the accompanying ground levels can be seen on each borehole record sheet. The borehole positions can also be seen on the Borehole Location Plans contained in Appendix II. A summary of the ground conditions encountered and water observations below the site can be seen in the Table below.

Strata	Depths Recorded	Water Depths	Description & Comments
TOPSOIL / SUBSOIL	From 0.00m to c.0.30m to c.0.85m	~	Below the initial grass surfacing natural topsoil was recorded across the whole of the site comprising dark brown sandy clayey soil. Below the topsoil layer, subsoil comprising medium brown, light brown and light orange brown sandy CLAY was recorded.
MADE GROUND	From 0.00m to at least c.1.10m	c.1.10m	Grass and topsoil overlying soft sandy gravelly clay with limestone cobbles (BH10 only).
DRIFT GEOLOGY: Glacial Till Deposits	From c.0.30m to c.0.85m to at least c.4.00m	Between c.1.20m and c.3.00m	The Glacial Till Deposits generally comprise of sandy gravelly CLAY. The deposits are typically firm and stiff in nature although occasional soft bands were noted, along with occasional sand & silty sandy clay layers.
SOLID GEOLOGY: Clitheroe Limestone Formation & Hodder Mudstone Formation	~	~	The solid geology was not encountered during these investigation works.

These investigation works have generally proven that made ground deposits are not pervasive across the site area, and corroborates with the Preliminary Conceptual Site Model developed for this site and proposed development contained within the Phase I Preliminary Contamination Risk Assessment. However, a localised area of disturbed deposits was encountered at the location of BH10 only, which is felt to be attributable to a manhole / inspection chamber in the vicinity of the copse of trees in the central portion of the site.

There was no visual or olfactory evidence of any unforeseen fuel or oil contamination, ashy deposits or potential asbestos containing materials (ACM's – cement sheeting, tiles, and the like) or bundles of fibres encountered within any of the exploratory positions put down.



# LABORATORY TESTING

#### **Determination of Particle Size Distribution**

A single representative sample of the natural sand layer encountered in BH09 has been tested to determine the particle size distribution (PSD). The results of the test are contained in the Ian Farmer Associates Test Report (reference; 80305/1), a copy of which can be found in Appendix III.

The results indicate that the natural sand deposit is generally poorly graded comprising clayey / silty slightly gravelly fine to medium grained sand.

### **Determination of Liquid & Plastic Limits**

Representative samples of the natural clay deposits (12 no.) have been tested to determine their moisture content and liquid & plastic limits, to ascertain their volume change potential (i.e. shrinkage or swelling) to help assist with future foundation design. The results of the tests are contained in the Ian Farmer Associates Test Report (reference; 80305/1), a copy of which can be found in Appendix III.

From these results the clays tested fall within the low and high plasticity range, and when taking into account the 425um passing (modified plasticity index) these clays display a negligible, low and moderate volume change (shrinkage or swelling) potential. As such some of the clay deposits tested may undergo significant changes in volume and therefore if new foundations were to be based within these clays they would need to be maintained at a minimum depth of 0.90m below finished ground levels.

Consideration will need to be given to the presence of existing, proposed or recently removed vegetation to avoid the effects of future shrinkage and swelling of the natural clay deposits, and as such minimum foundation depths may need to be increased to take this into account. Reference should be made to the NHBC Technical Standards guidance, Part 4.2 Building Near Trees, and BS5837:2012 – Trees in relation to design, demolition and construction – Recommendations.

### Determination of Chemical Attack on Buried Concrete

Representative samples of the topsoil and disturbed strata (11 no.) and natural deposits (4 no.) recovered from the site have been tested to determine their pH value and soluble sulphate (SO<sub>4</sub>) levels, so that these materials can be classified in accordance with the guidance BRE Special Digest 1:2005, Concrete in Aggressive Ground. The results of the tests are contained in the DETS Certificate of Analysis (reference; 19-16700), a copy of which can be found in Appendix III.





# LABORATORY TESTING (CONT'D)

### Determination of Chemical Attack on Buried Concrete (Cont'd)

The laboratory test results indicate soluble sulphate concentrations ranging between <10mg/l up to 81mg/l, with pH values ranging between 5.5 and 8.3. Therefore, based on these results and where future foundations and buried concrete are to be constructed, the deposits should be classified as Design Sulphate Class of DS-1. The Aggressive Chemical Environment for Concrete (ACEC) class for the deposits present has been assessed as AC-1.

### Contamination Screening / Screening Strategy

Ground contamination laboratory testing was completed by DETS of Consett, Co. Durham (UKAS & MCERTS accredited). When considering the findings of these investigation works, representative samples of the natural topsoil encountered across the site and disturbed strata have been screened for a range of chemical analytes to determine potential sources of contamination, albeit low risk for this site, and also for suitability of reuse either onsite or exported to another site.

During the investigation works, and as anticipated from the Preliminary Conceptual Site Model (CSM), there was no visual or olfactory evidence of hydrocarbon impacted soils (fuel, oil or solvents), deposits of ashy materials or potential asbestos materials / fibres, nonetheless screening for Polycyclic Aromatic Hydrocarbons (PAH's) and Asbestos is required for soils originating from a 'Greenfield Site' in accordance with the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG) published guidance.

The suite of chemical analysis carried out is summarised below, and the laboratory results are contained within the DETS Certificate of Analysis Test Report (reference; 19-16700);

- 11 no. Generic Soil Suites comprising metals, semi-metals & inorganics Arsenic, Cadmium, Chromium (III & VI), Copper, Lead, Mercury, Nickel, Selenium, Zinc, Cyanide (free) and Total Organic Carbon (TOC) / Soil Organic Matter (SOM)
- 11 no. Speciated Polycyclic Aromatic Hydrocarbons (PAH's) based on the current USEPA 16 PAH's
- 11 no. Asbestos Screens (presence)

A detailed ground contamination risk assessment has been undertaken for this development site, which can be seen attached in Appendix IV, and the findings are summarised on page 10 in the Ground Contamination Risk Assessment section of this report.



# GEOTECHNICAL RECOMMENDATIONS

It is understood that the proposed development of this site will comprise the construction of 53 no. 2 storey residential properties with areas of private gardens, car parking and road infrastructure.

Therefore, when considering site observations and the information gained from these intrusive investigation works completed, it is felt that conventional shallow strip footings can be adopted for the proposed development, placed within the underlying firm and stiff natural clay deposits, noted at depths of 0.44m and 1.25m, and maintained at a minimum depth of 0.90m below finished levels when taking into account the shrinkage and swelling potential of the natural clays. Such foundations should be designed to an allowable bearing pressure of 80kN/m<sup>2</sup>. Consideration will need to be given to the presence of existing, proposed or recently removed vegetation to avoid the effects of future shrinkage and swelling of the natural clay deposits, and as such minimum foundation depths may need to be increased to take this into account. Reference should be made to the NHBC Technical Standards guidance, Part 4.2 Building Near Trees, and BS5837:2012 – Trees in relation to design, demolition and construction – Recommendations.

As some variations in the shallow ground conditions have been identified below the site area within the boreholes, it is recommended that all foundation excavations are inspected by a suitably qualified Engineer to confirm the correct founding strata has been reached prior to pouring the concrete, in particular paying attention to the areas around the location of BH10 where disturbed strata has been recorded.

When considering the design of roads, pavements, areas of hardstanding and ground bearing floor slabs, and based on site observations, it is felt that an estimated design CBR value of 2% should be adopted for design purposes where the natural clay deposits are used as an undistubred sub-grade. It is recommended that the exposed formation level is proof rolled to identify any potential 'soft spots' and these can be taken care of with the introduction of additional sub-base or the use of geo-grid.

Variable head (falling) permeability tests were undertaken within BH02, BH06 and BH15, in general accordance with BS EN ISO 22282-2:2012 using the Hvorslev Method, to determine the coefficient of permeability (k) for the underlying natural deposits, in order to assess their suitability for the use of soakaways / SuDS. The results have identified very low permeability classifications, with poor & practically impervious drainage characteristics, and as such the ground conditions are considered unsuitable for the use of traditional soakaways.

During the investigation works, the band of natural sand encountered within BH09 was noted to have a standing water level at 1.20m below ground level, whilst minor seepages were noted within BH01 and BH05 at depths of 2.00m and 3.00m. On the first monitoring visit, the monitoring wells were noted to be dry, however by the second visit, water levels were recorded at 0.28m and 1.17m below ground level.



# GEOTECHNICAL RECOMMENDATIONS (CONT'D)

The high water levels have coincided with periods of heavy rainfall. All the boreholes were purged of the standing water so that the response zones were no longer flooded. The increase in water levels is felt to be attributable to the ingress of surface water infiltration rather than representing a continuous groundwater surface, particularly when considering the nature of the drift deposits. As such, some shallow groundwater ingresses should be anticipated for this proposed development when considering the construction of foundation and service excavations, particularly where these extend down to and beyond depths where water ingresses and standing water levels have been recorded. Therefore, it would be considered prudent for the developer / groundworks contractor to allow for the introduction of appropriate and temporary groundwater control measures, as well as suitable excavation support when considering the coarse nature of the soils encountered, to manage future water ingresses within the natural strata, and also particularly where excavations will remain open to the natural elements and during wetter periods of the year.

During the creation of deep excavations, potential instability issues may be encountered where excavations are left open for a long period of time. As such, temporary lateral trench support will be required for all excavations to prevent trench wall collapse and over-excavation, as well as providing a safe working environment for any operatives who may require access to deep excavations, those in excess of 1.20m deep. Reference should be made to CIRIA Report R97: Trenching Practice (2<sup>nd</sup> Edition, 2001 Revision) and HSE guidance HSG150: Health & Safety in Construction (3<sup>rd</sup> Edition, 2006).

The site has been classified in accordance with the guidance BRE Special Digest 1:2005, Concrete in Aggressive Ground, and where future foundations and buried concrete are to be constructed, the deposits present should be classified as Design Sulphate Class of DS-1. The Aggressive Chemical Environment for Concrete (ACEC) class for the deposits present has been assessed as AC-1.

Care should be taken during the creation of deep excavations, installation of drainage or services which may pass close to newly created foundations, so as not to allow any loose or coarse soils to move or 'flow', which could lead to settlement occurring below new foundations.

During the ground preparation works and the development of the site, where the ground conditions appear to differ from those already identified as part of these investigation works, then advice should be sought from a suitably qualified engineer to determine if a re-assessment of the ground conditions and recommendations is required before the development progresses further.



# GROUND **CONTAMINATION RISK** ASSESSMENT

Human Health Risk Assessment – Soils

The proposed development comprises the construction of residential properties with private garden areas, and the generic quantitative risk assessment (GQRA) has therefore been based on a CLEA end use classification of Residential with homegrown produce.

The detailed ground contamination risk assessment completed for this development site can be seen attached in Appendix IV, and based on the results of the contamination screening and risk assessment completed, the following has been identified;

igsim igsim The results have identified that the topsoil deposits present can be reused on this site as part of the proposed residential development without representing a risk towards the future end-users and as such there is no requirement for remediation.

However, if during the construction phase of works any visual and / or olfactory evidence of grossly contaminated materials are identified in the ground then this will need to be dealt with and a reassessment of this ground contamination risk assessment will need to be made.

#### Hazardous Ground Gas Risk Assessment

At this stage, 2 no. visit gas monitoring visits have been completed to date, and a copy of the monitoring results are contained in Appendix V, along with the detailed hazardous ground gas risk assessment completed for this site. The conclusions of this risk assessment should be treated as preliminary only until all the monitoring visits have been completed, at which point a final risk assessment will be undertaken and the results issued as an addendum report.

The GSV calculated indicates that the presence of hazardous ground gases does not exceed the GSV assessment value of 0.07 l/hr (Characteristic Situation 1) or 0.16 l/hr. for Methane and 0.78l/hr. for Carbon Dioxide (Green Classification for Situation B – Low rise housing with a ventilated underfloor void, NHBC Traffic Light System). Furthermore, neither the maximum concentration for Methane or Carbon Dioxide exceeds the action trigger level of 1% v/v or 5% v/v respectively, indicating that gas protection measures would not be required for the proposed residential development. In addition, from the results of the Phase I Preliminary Contamination Risk Assessment completed for this site, no protection measures are required with respect to Radon for this proposed development.

However, as there are 4 no. outstanding monitoring visits to be completed, this risk assessment and characterisation will need to be reassessed with the results issued as an addendum report.





# GROUND **CONTAMINATION RISK** ASSESSMENT (CONT'D)

#### Waste

An assessment of any excavated materials which are generated from the creation of foundations, services, and the like, which cannot be accommodated on site and are required to be discarded and removed from site as a waste should be classified in accordance with the Environment Agency's Technical Guidance WM3: Waste Classification - Guidance on the classification and assessment of waste (1<sup>st</sup> Edition v1.1, June 2018). It should be noted that excavated materials should be segregated into different waste streams (i.e. topsoil, made ground (where present) and natural strata) so that the materials can be appropriately assessed, classified and sent to the correct waste facility.

Where any materials are being removed from site they should be disposed of at a suitably licensed and appropriate landfill based on their classification, with a duty of care system in place and maintained throughout the disposal operation. It should be noted that prior to offsite disposal of any soils from this site, that additional sampling, analysis and screening may be required once the waste stream has been identified and volumes of material requiring disposal have been determined.

Excavated materials (i.e. natural strata) can be reused on this site as a general fill providing this material meets any geotechnical requirements for its intended end-use, however, these materials should be inspected to determine if any unforeseen potential contamination not previously identified requires an assessment. It may be necessary for confirmatory contamination screening to be carried out to confirm the suitability of these materials.

### **Construction Workforce**

During the groundworks and future development of this site, whilst the site generally represents a low risk when considering ground contamination issues, where appropriate the provision of suitable PPE should be adopted, along with toolbox talks informing site workers of the risks and potential health effects from exposure, if deemed necessary. The findings of this report should be used by the principal contractor responsible for compiling the site health and safety plan, in accordance with current CDM Regulations.

### **End of Report**





# **APPENDIX I**

SITE LOCATION PLAN EXISTING SITE LAYOUT (TOPOGRAPHIC SURVEY) & PROPOSED DEVELOPMENT LAYOUT PLANS







3 Gladstone Terrace Gateshead Tyne & Wear NE8 4DY Tel: 0191 477 2020 Email: enquiries@geolconsultants.co.uk







# **APPENDIX II**

# BOREHOLE LOCATION PLANS BOREHOLE RECORD SHEETS AND VARIABLE HEAD (FALLING) PERMEABILITY TEST SHEETS









GEOL-CONSULTANTS LTD BOREHOLE LOCATION PLAN FOR HAWTHORNE FARM, HAWTHORNE PLACE, CLITHEROE

DATE: - 7.10.2019 REF: - GEOL19-9988 SCALE: -1:1000

GEOL CONSULTANTS LTD	

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GEOL CONSULTANTS LTD	

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Hole Diameter Depth Base Diameter 3.00 110 Remarks	Casing Depth Base 1.00	g Diameter g Diameter 115	Depth Top Depth B	Chiselling ase Dura	ation	Tool	Inclination a Depth Top Depth Base	nd Orientation Orien	itation		

	GEO	LTD				F	Per	rCL	JSS	ion		Drill	ing l	Log	J			
Projec	t Name:	Hawtho	rne Fa	arm, H	lawthorne	Client	t: Persi	mmon	Homes	(Lanca	ashir	re)	Date: 14/0	08/2019				
Locat	ion: Clith	eroe, BB	57 2HI	J		Contr	actor: (	Geol C	Consulta	nts Lim	ited		Co-ords: I	E374360	0.04 N4	42587.8	88	
Projec	ct No. : G	GEOL19-9	9988			Crew	Name:	TMc					Drilling Ec	quipmen	t: Wind	owless	Samplir	ng
Bor	ehole N BH05	umber		Hole F	е Туре ЗН		Lev 81.15m	el AoD		Log	ged FMc	Ву	S	cale 1:20		Page She	e Numb et 1 of	er 1
Well	Water	Sar	mple	and li	n Situ Testir	ng	De	epth	Level	Leae	end		Strat	tum Des	cription	<u>ווו</u>		
	Strikes	Depth (	(m)	Туре	Resul	ts	()	m)	(m)	ماند مان	a sila	Grass o	verlving dar	k brown s	sandv cl	lavev soi	1	
		0.10 - 0 0.50 - 1 1.00 1.50 - 2 2.00	.00	B	HVP=6	50	0.	.10	80.85 80.05 78.15			Grass o (TOPSC) Firm to s sandy g Stiff (hig sandy g cobbles	verlying dar DIL). stiff (mediun ravelly CLA (GLACIAL '	k brown s n strengtt Y (GLACI Y (GLACI Y with oc TILL).	sandy cl h) mediu IAL TILL wn and c casiona	ayey soi um brown _). dark grey I limestoi	n ne	
																		4 —
Depth	Hole Diame Base D	eter Diameter	Depth	Casing Base	Diameter Diameter	Depth	n Top 🛛 🖸	Depth Ba	Chiselling ase Dui	ation		Tool	Depth Top	Inclina Depth B	ation and ( ase Inc	Orientation clination	Orient	tation
3.0	0	110									_							
Rema	arks																AGS	5



					•							
Projeo Place	ct Name:	Hawthorr	ne Farm, F	lawthorne	Client: Limited	Persimmon 1	Homes	(Lancashir	e)	Date: 15/08/2019		
Locati	ion: Clith	eroe, BB7	2HU		Contra	ctor: Geol C	onsultan	ts Limited		Co-ords: E374345.22	2 N442507.1	4
Projec	ct No. : C	EOL19-9	988		Crew N	lame: RS				Drilling Equipment: V	Vindowless S	Sampling
Bor	ehole N	umber	Hole	туре				Logged	Ву	Scale	Page	Number
	BHUb	Sam	t ble and lu	3H a Situ Testir		Donth		RS		1:20	Snee	
Well	Strikes	Depth (r	n) Type	Resul	ts	(m)	(m)	Legend		Stratum Descri	otion	
		0.00 - 0.1	6 ES					alia alia alia ia alia alia a	Grass o	overlying dark brown san	dy clayey soil	
						0.16	80.56	salta salta salta	Medium	n brown sandy CLAY with	n occasional c	oal
									fragme	nts (SUBSOIL).		
		0.40	В			0.35	80.37		Firm (m	nedium strength) medium	brown slightly	у _
		0.55			-0				sandy (	JLAY (GLACIAL TILL).		-
		0.55		HVP=	00							
		0.80		HVP=6	50							
		1.00	В			0.90	79.82		Firm da	rk brown and grey sand GLACIAL TILL).	/ slightly grave	elly
E		1.00				1.05	79.67	 	Soft da	rk brown and black silty s	andy CLAY	/ _
H								××	(GLACI	AL TILL).		
H						1.30	79.42		Stiff da	rk brown sandy very grav	elly CLAY wit	h –
Η		1.40	В						band of	f sand (GLACIAL TILL).	,	
H												
H												
						2.00	78.72			End of Borehole at 2	2.000m	2
												-
												3 —
												4 —
	Hole Diame	ter	Casing	Diameter			Chiselling			Inclination	and Orientation	
Depth 2.0	Base D	0iameter 110	Depth Base 2.00	Diameter 115	Depth 1	Top Depth Ba	se Dura	ation	Tool	Depth Top Depth Base	Inclination	Orientation
Rem	arks											
												AGS

GEOL CONSULTANTS LTD	

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Project Nai Place	ne: Hawtho	rne ⊢arm,	Hawthorne	Limited	ersimmon i	Homes	(Lancasi	nire)	Date: 14/0	8/2019			
Location: C	litheroe, BE	87 2HU		Contracto	or: Geol Co	onsultan	its Limite	d	Co-ords: E	374372.65	N442556.2	22	
Project No.	: GEOL19-	9988		Crew Nar	me: TMc				Drilling Eq	uipment: W	/indowless	Samplin	g
Borehole	e Number 107	Но	e Type BH	81.1	₋evel 5m AoD		Logge TN	d By Ic	1	cale :20	Page She	e Numbe et 1 of 1	er I
Woll Wat	er Sa	mple and	In Situ Testi	ng	Depth	Level	Logon	4	Strat		tion		
Strik	es Depth	(m) Type	Resu	lts	(m)	(m)	Legen	<b>'</b>	Ouau				
	0.10 - 0 0.50 - 1 0.50 1.00 - 1 2.00 - 2	.30 ES .00 B .50 B	HVP=	50	0.40	80.75 79.95 79.15	Mile Mile and A an	للالا TOF للالا للالا HI Firm Sant Firm Firm Sant Firm Sant Firm Sant Firm Sant Firm Sant Firm Sant Firm Sant Firm Sant Firm Firm Sant Firm Sant Firm Sant Firm Sant Firm Firm Sant Firm	ss overlying darf SOIL.	k brown sand gth) medium Y (GLACIAL <sup>-</sup> (GLACIAL <sup>-</sup> (GLACIAL TI (GLACIAL TI (GLACIAL TI	y clayey brown and g TILL). gravelly CLA <sup>1</sup> LL).	grey Y with	1
	2.50		HVP=.	40				2.9.2.9.2.9.2.9.2.9.2.9.2.9					
	3.00     HVP=60       3.50     HVP=60       3.50     HVP=60         3.50     HVP=60         3.50     HVP=60         3.50     HVP=60         3.50     HVP=60         3.50     HVP=60						th) medium I bccasional cc	brown silty s obbles (GLA	andy CIAL	3			
Hole D	iameter	Casin	g Diameter		4.00	77.15 Chiselling		9 K 9 K 9 K	End of I	Borehole at 4	.000m and Orientation		- - - 4 —
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Bas	se Dura	ation	Tool	Depth Top	Depth Base	Inclination	Orienta	ation
Remarks												AGS	

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						I	CICU	331		21 m	ing i	_0g			
Projec <u>Place</u>	t Name	: Hawtho	rne Fa	arm, H	lawthorne	Client: Limited	Persimmon 1	Homes (	(Lancashii	re)	Date: 15/0	8/2019			
Locati	on: Clith	neroe, BE	37 2HL	J		Contra	ctor: Geol Co	onsultan	ts Limited		Co-ords: I	374393.5	9 N442595	5.40	
Projec	t No. : 0	GEOL19-	9988			Crew N	lame: RS				Drilling Ec	uipment: \	Vindowles	s Samplin	g
Bor	ehole N BH08	umber }		Hole E	Туре 3Н	8	Level 0.58m AoD		Logged RS	Ву	S	cale I:20	Pag Sł	ge Numbe neet 1 of 1	er 1
Well	Water Strikes	Sa	mple a	and Ir	n Situ Testir	ng	Depth (m)	Level (m)	Legend		Strat	um Descri	ption		
		Depth 0.00 - 0	(m) .25	Type ES	Resul	ts	(,	()	ماند ماند ماند بریاد ماند م	Grass	overlying dar	k brown sar	idy clayey s	oil	
									site site site site site site	(10PS	OIL).				-
							0.25	80.33		Firm (n	nedium stren	gth) mediun	n brown san	dy	-
											000 0012).				-
		0.55			HVP=	50									-
		0.75		в											-
		0.75					0.85	79.73		Initially	soft (low stre	enath) beco	ming stiff da	rk	-
		0.90			HVP=3	30				brown	and dark gre	y sandy gra TILL).	velly CLAY v	with	- - 1
										Noted	to become ve	ery gravelly	from c.1.00r	n bgl.	
		1.25		в											-
															-
															-
															-
															-
															-
2////							2.00	78.58		•	End of	Borehole at	2.000m		2 —
															-
															-
															-
															-
															-
															-
															3 —
															-
															-
															-
															-
															-
															-
	Hole Diam	eter		Casing I	Diameter			Chiselling	<u> </u>			Inclinatio	n and Orientation	on	4 -
Depth E	Base [	Diameter 110	Depth 2.0	Base 00	Diameter 115	Depth	Top Depth Bas	se Dura	ition	Tool	Depth Top	Depth Base	e Inclination	Orienta	ation
Rema	irks		I								1				
														AGS	
															-

GEOL CONSULTANTS LTD	

								551		21 m	ing i	_0g			
Projec Place	t Name	: Hawthor	rne Fari	m, H	lawthorne	Clier Limit	nt: Persimmon ted	Homes	(Lancashir	re)	Date: 15/0	8/2019			
Locati	on: Clith	neroe, BB	7 2HU			Cont	tractor: Geol C	onsultar	nts Limited		Co-ords: E	374385.88	3 N442481	.79	
Projec	:t No. : (	GEOL19-9	9988			Crev	v Name: RS				Drilling Eq	uipment: V	Vindowless	s Samplir	ng
Bor	ehole N BH09	umber )	ŀ	Hole E	Туре 3Н		Level 79.56m AoD		Logged RS	Ву	S 1	cale :20	Pag Sh	ge Numb	er 1
Well	Water	Sar	mple ar	nd Ir	n Situ Testi	ng	Depth	Level	Legend		Strat	um Descrii	ntion		
	Strikes	Depth (	(m) Ty	ype	Resu	lts	(m)	(m)		Cross				ail	
		0.00 - 0	.20 6	_0					ی ماند ماند م ماند ماند م	(TOPS	OIL).	C DIOWIT San	uy clayey so	JII	
							0.20	79.36	k she she s	Mediun	n brown sand	y CLAY (SL	JB-SOIL).		
		0.65			HVP=	50	0.55	79.01		Firm (m slightly	nedium streno gravelly CLA	gth) medium Y (GLACIAI	h brown san _ TILL).	dy	
		0.00								0,		,	,		
							0.90	78 66							
				_			0.00			Stiff da CLAY (	rk brown and GLACIAL TIL	dark grey s L).	andy gravel	lly	1 -
	1.05 - 1.70 Б						1.05	78.51	× × × ×	Mediun (GLAC	n brown silty IAL TILL).	slightly grav	elly SAND		
									$\times \times \times \times \times \times$						-
									× × × × ×						
									× × × ×						
									$\mathbf{x} \mathbf{x} \mathbf{x}$						
							1.70	77.86		Initially gravelly	soft becomin y CLAY (GLA	g firm slight CIAL TILL).	ly silty sand	У	
															-
		2.00		в	HVP=	40									2 —
		2.00													
							2.70	76.86			End of	Davahala at (	700		
											End of	Dorenole at 2	2.70011		
															-
															3 —
															-
															-
	Hole Diam	eter	Ci	asing [	Diameter			Chiselling			_	Inclination	and Orientatio	on	
Depth 2.7	Base [	Diameter 110	Depth B 2.70	lase	Diameter 115	Dep	th Top Depth Ba	se Dura	ation	Tool	Depth Top	Depth Base	Inclination	Orient	ation
Remarks							I		1	1					
														AUD	2

CONSULTANTS LTD			Percu	issi	on E	Drilling Lo	рс		
Project Name: Hawtho	rne Farm, Hawth	orne Cli	ient: Persimmon	Homes	(Lancashir	e) Date: 15/08/2	2019		
Location: Clitheroe, BE	37 2HU	Co	ontractor: Geol C	onsultar	its Limited	Co-ords: E37	4407.54 N442	2522.17	
Project No. : GEOL19-	9988	Cro	ew Name: RS			Drilling Equip	ment: Window	wless Sampling	
Borehole Number	Hole Type				Logged	By Scal	e	Page Number	
BH10 Water Sa	mple and In Situ	Testina	79.00111 AOD	l evel	RS	1:20	)	Sheet 1 of 1	
Well Strikes Depth	(m) Type	Results	(m)	(m)	Legend	Stratum	Description		
Strikes Depth 0.00 - 0 0.20 - 1	(m) Type 20 ES .10 ES	Results	(m) 0.20 1.10	(m) 79.60 78.70		Grass overlying dark br (MADE GROUND). Disturbed medium brow large limestone cobbles End of Bor	ehole at 1.100m	rey soil ly clay with ND). 1 - 2 - 3 -	
Hole Diameter Depth Base Diameter Remarks	Casing Diamete Depth Base Diar	r Deter De	epth Top Depth Ba	Chiselling se Dura	ation	Tool Depth Top Depth Top	Inclination and Ori apth Base Inclin	entation nation Orientation	

G						Ρ	ercı	JSS	ior	n [	Drill	ing l	_og			
Project N	ame:	Hawthor	ne Fa	arm, F	lawthorne	Client: P	ersimmor	n Home	s (Lano	cashir	re)	Date: 15/0	8/2019			
Place Location:	Clithe	eroe, BB	7 2HI	U		Limited Contract	tor: Geol (	Consult	ants Lii	mited		Co-ords: E	374426.39	N442562.	62	
Project N	o. : G	EOL19-9	9988			Crew Na	ame: RS					Drilling Eq	uipment: W	/indowless	Samplir	ng
Boreho	ble Nu	ımber		Hole	туре	70			Lo	gged	Ву	S	cale	Pag	e Numb	er
E We	3H11 ater	Sar	nple	and lu	3H n Situ Testir	19. 10	Denth		1	RS		1	:20	She	eet 1 of	1
Well Str	ikes	Depth (	m)	Туре	Resul	ts	(m)	(m)	Leg	gend		Strat	um Descrip	tion		
		0.90 1.00 1.00 - 2. 2.00 2.20	00	B B B	HVP=7	10	0.30 0.60 1.00 3.00	79.34 79.04 78.64 76.64			Grass o (TOPSC) Firm me CLAY (S Firm (m gravelly sandsto	edium brown SUBSOIL). edium stren, r CLAY with one cobbles of dium brown he cobbles (find the cobbles of the co	and orange gth) medium occasional lir (GLACIAL TI sandy grave GLACIAL TIL Borehole at 3	iy clayey so sandy grave brown sand nestone and LL). Ily CLAY wit L).	il illy y h	
Hole	e Diame	ter	_	Casing	Diameter	_		Chisellin	ıg			_	Inclination	and Orientatio	n	<u> </u>
Depth Base	B B B	iameter	Depth	Base	Diameter	Depth To	p Depth B	ase D	uration		Tool	Depth Top	Depth Base	Inclination	Orient	tation

		LTD			F	Percu	ISS	ion [	Drilling Log	g		
Projec	ct Name:	Hawthorn	e Farm, F	lawthorne	Client:	Persimmon	Homes	(Lancashir	re) Date: 15/08/201	9		
Locati	ion: Clith	eroe, BB7	2HU		Contra	ctor: Geol C	Consulta	nts Limited	Co-ords: E37442	26.74 N4442	488.59	
Projec	ct No. : G	GEOL19-99	988		Crew N	lame: RS			Drilling Equipme	nt: Windowle	ess Samplii	ng
Bor	rehole N BH12	umber	Hole	е Туре вн	79	Level 9.29m AoD		Logged RS	By Scale	F	Page Numb Sheet 1 of	er 1
Well	Water	Sam	ple and l	n Situ Testi	ng	Depth	Level	Legend	Stratum De	escription		
	Strikes	Depth (m	n) Type	Resu	lts	(m)	(m)		Grass overlying dark brown		u soil	
		0.00 - 0.2						ક હોઠ હોઠ હોઠ હોઠ હોઠ હોઠ	(TOPSOIL).	i sandy claye	y 501	-
						0.20	79.09		Medium brown sandy CLA	Y (SUBSOIL).		-
						0.40	78.89					
									slightly gravelly CLAY with	nt orange slig occasional sa	intly sandy indstone	-
									CODDIES (GLACIAL TILL).			-
												-
												-
		1.00	в			1.00	78.29		Stiff dark brown and dark g	rey sandy gra	velly	1 -
									CLAY with occasional large TILL).	rootlets (GLA	ACIÁL	-
												-
												-
												-
						1.65	77.64		Soft (low strength) dark gre	ow strength) dark grey and medium brown		
		1.80	в						slightly silty very sandy ČL (GLACIAL TILL).	AY with bands	of sand	
		1.80		HVP=	40							
		2.00	SPT	N=7 (1,1/2	,1,2,2)							2 -
												-
		0.05				2.30	76.99		Soft (low strength) brown s	lightly silty sa	ndv CLAY	
		2.35	В	HVP=	40			$\times \times \times \times$	(GLACIAL TILL).			-
						2.60	76 60					-
						2.00	70.09		Stiff dark brown slightly sar limestone cobbles (GLACI	ndy gravelly C AL TILL).	LAY with	
												-
						2.90	76.39		End of Boreho	e at 2.900m		
												3 -
												-
												-
												-
												-
												-
												-
												4 -
Darth	Hole Diame	eter	Casing	Diameter	Dor# 7		Chiselling		Incl	nation and Orien	tation	tation
2.9	oase L	110	2.90	115	Deptn			auon		Dase inclinat	uon Orien	เสมอท
Remarks												
											AGS	S
												-

				Pe	ercu	JSS	ior	ר E	Drill	ing l	_og			
Project Name	: Hawthorne	Farm, F	lawthorne	Client: Pe	ersimmon	Home	s (Land	cashir	e)	Date: 15/0	)8/2019			
Location: Clit	neroe, BB7 2	2HU		Contracto	or: Geol C	Consulta	ants Lir	nited		Co-ords: I	E374424.32	N442531.	92	
Project No. :	GEOL19-998	38		Crew Na	me: RS					Drilling Ec	uipment: W	/indowless	Samplir	ng
Borehole N	lumber	Hole	е Туре	ا 79 6			Lo	gged	Ву	S	cale	Pag	e Numb	er 1
Water	Samp	le and li	n Situ Testir	ng l	Depth	Leve	Ι.							
VVell Strikes	Depth (m)	Туре	Resul	ts	(m)	(m)	Leg	jend		Strat	tum Descrip	tion		
Strikes	Depth (m) 0.00 - 0.20 0.45 0.80 2.00	Type ES B	Resul	40 40	(m) 0.20 0.80 2.00 3.00	(m) 79.44 78.84 77.64			Grass o (TOPSC Firm (m orange s Firm me with occ TILL).	edium stren sandy grave	k brown sand gth) medium illy CLAY (GL a and grey sa estone cobble sandy grave e cobbles (G Borehole at 3	ly clayey so brown and I ACIAL TILL ndy gravelly is (GLACIAL IV CALY with LACIAL TILL	il ight ). CLAY -	
Hole Diam Depth Base	leter Diameter De	Casing epth Base	Diameter Diameter	Depth Top	Depth Ba	Chisellir ase Di	ng uration		Tool	Depth Top	Inclination Depth Base	and Orientation	n Orient	4 –
Remarks											AGS			

GEOL CONSULTANTS LTD	

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Projec Place	t Name:	Hawthorr	ne Farm, F	lawthorne	Client: I Limited	Persimmon	Homes	(Lancashir	e)	Date: 15/08/207	19			
Locati	on: Clith	ieroe, BB7	7 2HU		Contrac	tor: Geol C	onsultar	nts Limited		Co-ords: E3744	126.94 N	442503.	13	
Projec	:t No. : 0	GEOL19-9	988		Crew Name: RS					Drilling Equipment: Windowless Sampling				ıg
Bor	ehole N BH14	umber	Hole E	е Туре ВН	79	Level .13m AoD		Logged RS	Ву	Scale 1:20	Scale Page Number 1:20 Sheet 1 of 1			er 1
Well	Water Strikes	Sam	nple and li	n Situ Testii	ng te	Depth (m)	Level (m)	Legend		Stratum Description				
		0.00 - 0.2	20 ES	Resul	13			ાં સાંધ સાંધ આ સાંધ સાંધ સાંધ સાંધ સાંધ	Grass of (TOPS)	overlying dark brow DIL).	vn sandy	clayey soi		
						0.20	78.93		Medium	h brown sandy graי	velly CLA	Y (SUBSC	DIL).	
						0.40	78.73		Firm (m brown s	(medium strength) dark grey and medium า sandy gravelly CLAY (GLACIAL TILL).				
		0.90 1.00	в	HVP=	70									
						1.15	77.98		Firm (m brown s	edium strength) o andy gravelly CLA	ccasional Y (GLAC	ly soft me IAL TILL).	dium	· -
		1.35	В											
		1.70		HVP=	70	1.80	77.33		Stiff /bi/	ab atronath) acces	ionally fire	n modium		-
		1.90 1.90	В	HVP=	90				brown s limestor	an strength) occas sandy gravelly CLA ne cobbles (GLAC	IONAIIY IIIT YY with oc IAL TILL)	n medum casional		2
		2.50	В											
						2.80	76.33			End of Boreh	ole at 2.80	00m		-
														3   
														4 —
Depth 2.8	Hole Diame Base []	eter Diameter 110	Casing Depth Base 2.80	Diameter Diameter 115	Depth To	op Depth Ba	Chiselling se Dura	ation	Tool	Depth Top Dept	clination and h Base I	d Orientation nclination	Orient	ation
Rema	arks												AGS	

<b>GEOL</b>	

						•	0100			21 m		-9			
P P	rojeo ace	t Name:	Hawthorne	Farm, F	lawthorne	Limited Date: 15/08/2019									
Lo	ocati	on: Clith	eroe, BB7 2l	HU		Contrac	tor: Geol C	onsultan	ts Limited		Co-ords: E374444.82 N442535.64				
Ρ	rojeo	xt No. : G	GEOL19-998	8		Crew Name: RS					Drilling Equipment: Windowless Sampling Rig				g Rig
	Bor	ehole N	umber	Hole	Туре	70	Level Logged By S			Sc	ale	Page	Numbe	ər	
		BH15	Sampl	t and lu	3H 2 Situ Tostir	79	.29m AOD		RS		1:	20	Shee	et 1 of 7	
۷	Vell	Strikes	Depth (m)	Type	Resul	ts	(m)	(m)	Legend		Stratu	tion			
			0.00 - 0.20	ES					یاد ماد ماد د ماد ماد	Grass o	overlying dark				
							0.20	70 00	sslia sslia sslia ta sslia sslia s	(10-30	JIL).				
							0.20	19.09		Stiff (me sandy s	edium strengt lightly gravell	h) medium b y CLAY (GL/	rown and ora ACIAL TILL).	ange	_
			0.40		HVP=4	46									-
							0.50	78.79		Stiff (hic	nh strenath) m	edium brow	n slightly sar	ndv	_
										gravelly		ccasional lim	estone cobb	les	
										(02/10/	, <u>, , , , , , , , , , , , , , , , , , </u>				-
			0.80		HVP=1	10									_
			1.00												_
	H		1.00												-
															-
			1.25		HVP=1	00									-
															_
															_
															_
							1.72	77.57		Soft (lov	w strength) be	ecoming firm	(low / mediu	ım	
			1.85		HVP=4	40				gravelly	CLAY (GLAC	CIAL TILL).	Sity Salidy		-
			2.00	в											2 —
															-
			2.30		HVP=4	40									-
			2 50	В											
	$\square$		2.00												-
							2.72	76.57	· · · · · · · · · · · · · · · · · · ·		End of D	archele at 0	720		-
												orenole at 2.	72011		-
															-
															3 —
															-
															-
															-
															-
															4 —
~		Hole Diame	eter	Casing	Diameter			Chiselling		L		Inclination	and Orientation		
D	epth 2.7	Base D	Diameter Dep 110	oth Base 2.72	Diameter 115	Depth To	p Depth Ba	se Dura	ition	Tool	Depth Top	Depth Base	Inclination	Orienta	ation
R	ema	arks													
														AGS	



### **Geol Consultants Limited**

VARIABLE HEAD (FALLING) PERMEABILITY TEST



	SITE DETAILS	Land at H	Hawthorne Fai	m, Hawthor	ne Place, C	litheroe	BOREHOL	E: BH02 at 3	3.00mBGL	
	Bottom of Boret	nole	3.00	mBGI		Operator		RS		
	Base of casing		1.00	mBGL		Date		30/08/2019		
	Diameter of cas	ing	50.00	mm	_	Time		11.00		
	Height of casing	)	0.00	mAGL		Weather		Dry		
	Elevation of Bor	ehole		mAOD	_	Input volun	ne of water	c.8	litres	
	Groundwater Le	evel	3.00	mBGL		Test Zone		2.00	m	
		TEST CA	LCULATION		Elapsed (minutes)	Elapsed (seconds)	Total seconds	Water Depth (m)	Head (metres)	H/Ho
	Intake Eactor (F	.)			0	0	0 60	0.500	2.500 2.480	1.000
		1			2	0	120	0.520	2.480	0.992
F=	2 πL		_	(i)	3	0	180	0.520	2.480	0.992
	$Log_e$ [(L/D)+ $\sqrt{\langle}$	1+(L/D) <sup>2</sup> }]			4	0	240	0.530	2.470	0.988
		00455			5	0	300	0.530	2.470	0.988
	(From BS 5930)	2015 for st	andpipes)		10	0	600 1200	0.530	2.470	0.988
	L=lenath of test	zone			30	0	1200	0.540	2.460	0.984
	D=diameter of s	standpipe			40	0	2400	0.550	2.450	0.980
					50	0	3000	0.550	2.450	0.980
	Permeability (k)				60	0	3600	0.550	2.450	0.980
	<u>· · · · · · · · · · · · · · · · · · · </u>									
k=	$\frac{A}{F(t_2 - t_1)}$	x Log <sub>e</sub> (H	<sub>1</sub> /H <sub>2</sub> )	(ii)						
	or									
k=	A FT			(iii)						
	Where T is the l corresponding t	Basic Time o an H/Ho	Lag Factor value of 0.37							
1 -	2.00	m								
D=	0.050	m								
L/D=	40.00									
t <sub>1</sub> =	0	S								
t <sub>2</sub> =	3600	S								
H <sub>1</sub> =	2.50	m								
H <sub>2</sub> =	2.45	m								
Δ-	0 00106	m <sup>2</sup>								
F=	2.8676		From (i)							
T=		S								
k=	3.84253E-09	ms⁻¹	From (ii)							
Rem	arks				1					
Draina Perme	ge Characteristics: ability Classificatio	POOR / PRA n: VERY LO	ACTICALLY IMPE W	ERVIOUS	]					

Variable Head (Falling) Permeability Test at BH02





### **Geol Consultants Limited**

VARIABLE HEAD (FALLING) PERMEABILITY TEST



	SITE DETAILS	: Land at ⊦	lawthorne Fai	m, Hawthor	ne Place, C	litheroe	BOREHOL	E: BH06 at 3	3.00mBGL	
	Bottom of Borel	nole	2.00	mBGL		Operator		RS		
	Base of casing		1.00	mBGL		Date		30/08/2019		
	Diameter of cas	ing	50.00	mm	_	Time		11.10		
	Height of casing	<b>)</b>	0.00	mAGL	-	Weather		Dry	1.4	
	Elevation of Boi	rehole	2.00	mAOD	-	Input volun	ne of water	C.5	litres	
	Groundwater Le	evei	2.00	MBGL		Test Zone		1.00	m	ſ
		TEST CA	LCULATION		Elapsed (minutes)	Elapsed (seconds)	Total seconds	Water Depth (m)	Head (metres)	H/Ho
	Intake Factor (F	-)			0	0 0	0 60	0.400 0.440	1.600 1.560	1.000 0.975
		-			2	0	120	0.450	1.550	0.969
F=	2 πL		_	(i)	3	0	180	0.460	1.540	0.963
	$Log_e$ [(L/D)+ $$ {	1+(L/D) <sup>2</sup> }]			4	0	240	0.460	1.540	0.963
		0045 for at			5	0	300	0.470	1.530	0.956
	(FIOII) BS 5930	.∠015 10r St	anupipes)		20	0	1200	0.480	1.520	0.950
	L=length of test	zone			30	0	1800	0.500	1.500	0.938
	D=diameter of s	standpipe			40	0	2400	0.530	1.470	0.919
					50	0	3000	0.550	1.450	0.906
	Permeability (k)	1			60	0	3600	0.550	1.450	0.906
				<i></i>						
K=	$\frac{A}{F(t_2 - t_1)}$	x Log <sub>e</sub> (H <sub>1</sub>	<sub>1</sub> /H <sub>2</sub> )	(11)						
	or									
k=	A FT			(iii)						
	Where T is the corresponding t	Basic Time o an H/Ho v	Lag Factor value of 0.37							
	1 00	m								
D=	0.050	m								
L/D=	20.00									
	0									
t <sub>1</sub> =	0	S								
$t_2 =$	3600	S								
$H_1 =$	1.60	m								
H <sub>2</sub> =	1.45	m								
Δ-	0 00106	m <sup>2</sup>								
F=	1.7030		From (i)							
T=		S								
k=	3.15273E-08	ms⁻¹	From (ii)							
Rem	arks				1					
Draina Perme	ge Characteristics ability Classificatic	: POOR on: VERY LOV	v							

Variable Head (Falling) Permeability Test at BH06





### **Geol Consultants Limited**

VARIABLE HEAD (FALLING) PERMEABILITY TEST



	SITE DETAILS	: Land at H	lawthorne Fa	rm, Hawthor	ne Place, C	litheroe	BOREHOL	.E: BH15 at 2	2.72mBGL	
	Bottom of Borel Base of casing Diameter of cas Height of casing Elevation of Bor Groundwater Le	nole ing J rehole evel	2.72 0.72 50.00 0.00 2.72	mBGL mBGL mm mAGL mAOD mBGL		Operator Date Time Weather Input volun Test Zone	ne of water	RS 30/08/2019 11.20 Dry c.8 2.00	litres m	
		TEST CA	LCULATION		Elapsed (minutes)	Elapsed (seconds)	Total seconds	Water Depth (m)	Head (metres)	H/Ho
F=	<u>Intake Factor (F</u> 2 πL Log <sub>e</sub> [(L/D)+ √ { (From BS 5930: L=length of test D=diameter of s	:) 1+(L/D) <sup>2</sup> }] :2015 for st zone standpipe	andpipes)	(i)	0 1 2 3 4 5 10 20 30 40 50	0 0 0 0 0 0 0 0 0 0 0 0 0	0 60 120 180 240 300 600 1200 1800 2400 3000	0.300 0.320 0.320 0.320 0.320 0.320 0.330 0.330 0.330 0.340 0.340 0.350	2.420 2.400 2.400 2.400 2.400 2.390 2.390 2.390 2.380 2.380 2.380 2.370	1.000 0.992 0.992 0.992 0.992 0.992 0.988 0.988 0.988 0.983 0.983 0.979
k=	$\frac{Permeability (k)}{A}$ $\frac{A}{F(t_2 - t_1)}$ or	x Log <sub>e</sub> (H	<sub>1</sub> /H <sub>2</sub> )	(ii) (iii)	60	0	3600	0.350	2.370	0.979
κ-	FT Where T is the I corresponding t	Basic Time o an H/Ho	Lag Factor value of 0.37	(111)						
L= D= L/D=	2.00 0.050 40.00	m m								
t <sub>1</sub> = t <sub>2</sub> = H <sub>1</sub> = H <sub>2</sub> =	0 3600 2.42 2.37	s s m m								
A= F= T= k=	0.00196 2.8676 3.97089E-09	m² s ms <sup>-1</sup>	From (i) From (ii)							
Rem Draina Perme	arks ge Characteristics: ability Classificatio	: POOR / PRA on: VERY LO	ACTICALLY IMPE W	ERVIOUS						

### Variable Head (Falling) Permeability Test at BH15





## LABORATORY TESTING





Unit 4, Faraday Close, Pattinson North Industrial Estate, Washington, NE38 8QJ. Tel: 0191 482 8500 Fax: 0191 482 8520 washington@ianfarmer.co.uk www.ianfarmer.co.uk

3 Gladstone Terrace Gateshead Tyne & Wear NE8 4DY

F.A.O.

<b>Final Test Report</b>	- 80305	/ 1
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Job Number: 80305

Originating Client: GEOL Consultants Ltd

Originating Reference: GEOL19-9988

Date Sampled: 16/08/2019

Date Scheduled: 22/08/2019

Date Testing Started: 02/09/2019

Date Testing Finished: 05/09/2019

Previ	ious Reports	Amendments	Date Issued

Amendments:

Authorised By:

Tim May

Tim Robinson Quality Technician

Report Issue Date: 05/09/2019



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Page. 1





Client:

Laboratory Test Report

80305

2

Job Number:

Page:

Site: Clitheroe

GEOL Consultants Ltd

Determination of Water Content, Liquid Limit and Plastic Limit and Derivation of Plasticity and Liquidity Index

	-				-		-		-			
Borehole / Trial	Depth (m)	Sample	Natural /	Natural Water	Sample 425 µr	Passing n Sieve	Liquid Limit	Plastic Limit	Plasticity	Liquidity	Class	Description / Remarks
Pit	Dopur (iii)	Campie	Sieved	Content %	Percentage %	Water Content %	%	%	Index %	Index	01000	Doonplon / romand
BH01	0.50	В	Natural	31.5	98	32.0	65	31	34	0.03	СН	Brown slightly silty CLAY
BH01	3.00	В	Natural	8.8	89	9.3	25	12	13	-0.21	CL	Brown gravelly, silty CLAY
BH03	1.00	В	Natural	26	100	26.0	58	29	29	-0.10	СН	Brown slightly gravelly, silty CLAY
BH04	1.00	В	Natural	17.8	100	18.0	32	19	13	-0.09	CL	Brown slightly gravelly, silty CLAY
BH05	0.50	В	Natural	11.7	30	28.0	26	14	12	1.13	CL	Brown gravelly, silty CLAY
BH05	1.50	В	Natural	18.2	100	18.0	24	14	10	0.42	CL	Brown slightly gravelly, silty CLAY
BH07	0.50	В	Natural	13.5	95	14.0	28	16	12	-0.17	CL	Brown slightly gravelly, silty CLAY
BH07	2.00	В	Natural	18.2	97	19.0	27	17	10	0.16	CL	Brown slightly gravelly, silty CLAY
BH09	1.05	В		19.6								Brown slightly gravelly, silty SAND
BH11	1.00	В	Natural	10.6	88	11.0	22	12	10	-0.06	CL	Brown gravelly, silty CLAY
BH12	1.80	В	Natural	18	98	18.0	27	18	9	0.04	CL	Brown silty CLAY
BH14	1.00	В	Natural	10	100	10.0	33	20	13	-0.77	CL	Brown slightly gravelly, silty CLAY
BH15	2.00	В	Natural	19	100	19.0	30	21	9	-0.22	CL	Brown slightly gravelly, silty CLAY
			ĺ									
			ĺ									
			ĺ									
			ĺ									
			Í									
Meth	od of Prep	aration:	BS EN IS BS 1377	SO 17892 : ' : Part 1 : 2	Part 1 : 20 2016 : Claus	14 : Clause se 8.4.3 Pre	e 5.1 Water eparation of	content test   samples for	preparation plasticity te	sts		CL2



Method of Test: BS EN ISO 17892 : Part 1 : 2010 : Clause 4.2 Preparation of samples for plastic limit tests Method of Test: BS EN ISO 17892 : Part 1 : 2014 : Clause 5.2 Water content test execution BS 1377 : Part 2 : 1990 : Clause 4.3 or 4.4 Determination of the liquid limit BS 1377 : Part 2 : 1990 : Clause 5.3 Determination of the plastic limit and plasticity index



Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method





### Final Test Report - 80305 / 1

Site: Clitheroe

Job Number: 80305

Originating Client: GEOL Consultants Ltd

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

This test report shall not be reproduced, except in full and only with the written permission of Ian Farmer Associates Ltd.

Samples will be retained for 28 days from date of issue of the final test report before being disposed of, unless we receive written instruction to the contrary.

Report Issue Date: 05/09/2019



### **GROUND CONTAMINATION RISK ASSESSMENT**

Phase II Ground Investigation Report Hawthorne Farm, Hawthorne Place, Clitheroe, Lancashire, BB7 2HU Project No.: GEOL19-9988

3 Gladstone Terrace, **GEOL** Gateshead, NE8 4DY Tel. 0191 477 2020 Email: enquiries@geolconsultants.co.uk



## GROUND CONTAMINATION RISK ASSESSMENT

A GQRA is carried out by comparing measured concentrations in soil with generic screening values appropriate for the conceptual model and pollutant linkage(s) being assessed. In simple terms, provided the measured concentrations are below appropriate generic screening criteria, the risk from the pollutant linkages(s) being assessed are unlikely to be significant. The generic screening values referred to above usually take the form of risk-based Generic Assessment Criteria (GAC) values, that are most typically derived using the Environment Agency's Contaminated Land Exposure Assessment (CLEA) model. For the purposes of this contamination risk assessment, and when considering the nature and sensitivity of the proposed development, the results have been compared against currently available assessment values published by LQM / CIEH (Suitable 4 Use Levels – S4UL's), CL:AIRE Category 4 Screening Levels (C4SL's) and Atkins ATRISKsoil Soil Screening Values (SSVs) for Cyanide only.

To allow an assessment of the level of risk to be made, the topsoil present on this site has been assessed as a single averaging area, and as such the results have been subjected to statistical analysis utilising the contaminated land statistical analysis sheets developed by ESI in accordance with CIEH / CL:AIRE guidance. A copy of the calculation sheet can be seen within this appendix.

<u>Analyte</u>	<u>Critical</u> <u>concentration</u> <u>(mg/kg)</u>	<u>No. of samples</u> <u>screened</u>	<u>Max.</u> concentration recorded (mg/kg)	<u>Statistical Upper</u> <u>Confidence Limit</u> <u>(UCL<sub>0.95</sub>)</u>	<u>Is max.</u> concentration a statistical outlier?
Arsenic	37(1)	11	36	25.55	Yes
Cadmium	11(1)	11	1.6	1.37	No
Chromium III	910 <sup>(1)</sup>	11	33	28.45	No
Chromium VI	6(1)	11	<1.0	0.50	No
Copper	2400 <sup>(1)</sup>	11	56	39.28	No
Lead	200 <sup>(3)</sup>	11	120	87.51	No
Mercury	40 <sup>(1)</sup>	11	0.14	0.10	No
Nickel	130(1)	11	50	39.08	No
Selenium	250 <sup>(1)</sup>	11	1.5	1.11	No
Zinc	3700 <sup>(1)</sup>	11	240	190.30	No
Cyanide	34 <sup>(2)</sup>	11	0.5	0.36	No
Asbestos	Presence	11	None present	~	~
Speciated PAH's					
Acenaphthene	510 <sup>(1)</sup>	11		0.12	Yes
Acenaphthylene	420 <sup>(1)</sup>	11		0.05	No

A summary of the results based on the soil concentrations recorded can be seen in the Table below and on the following page.

(1) = The LQM/CIEH Suitable 4 Use Levels (Residential with homegrown produce – for organic contaminants 2.5% SOM has been adopted based on site specific ave. value), (2) = ATRISK<sup>SOIL</sup> SSV (2015), (3) = CL:AIRE C4SLs (Residential with homegrown produce)



<u>Analyte</u>	<u>Critical</u> <u>concentration</u> <u>(mg/kg)</u>	<u>No. of samples</u> <u>screened</u>	<u>Max.</u> concentration recorded (mg/kg)	<u>Statistical Upper</u> <u>Confidence Limit</u> <u>(UCL<sub>0.95</sub>)</u>	<u>Is max.</u> concentration a statistical outlier?
Speciated PAH's					
Anthracene	5,400 <sup>(1)</sup>	11	0.2	0.27	Yes
Benzo(a)anthracene	11 <sup>(1)</sup>	8	<0.1	0.71	No
Benzo(a)pyrene	2.7(1)	11	0.5	0.73	No
Benzo(b)fluoranthene	3.3(1)	11	1.3	0.53	No
Benzo(ghi)perylene	340 <sup>(1)</sup>	11	1.3	0.53	No
Benzo(k)fluoranthene	93 <sup>(1)</sup>	11	0.9	0.30	No
Chrysene	22 <sup>(1)</sup>	11	0.8	0.72	No
Dibenz(ah)anthracene	0.28(1)	11	0.5	0.16	No
Fluoranthene	560 <sup>(1)</sup>	11	1.3	1.46	Yes
Fluorene	400 <sup>(1)</sup>	11	0.2	0.14	Yes
Indeno(123cd)pyrene	36 <sup>(1)</sup>	11	2.8	0.49	No
Naphthalene	5.6 <sup>(1)</sup>	11	0.2	0.05	No
Phenanthrene	220 <sup>(1)</sup>	11	0.8	0.53	Yes
Pyrene	1,200(1)	11	<0.1	1.37	No

(1) = The LQM/CIEH Suitable 4 Use Levels (Residential with homegrown produce – for organic contaminants 2.5% SOM has been adopted based on site specific ave. value), (2) = ATRISK<sup>SOIL</sup> SSV (2015), (3) = CL:AIRE C4SLs (Residential with homegrown produce)

The results have identified the following;

- The maximum concentration and upper confidence limit (UCL<sub>0.95</sub>) values for all of the contaminants screened for (metals, semi-metals and speciated PAH's) within the topsoil and disturbed soils do not exceed the critical concentrations adopted for this site.
- The results of the asbestos screening has not identified the presence of any ACM's or loose fibres.
- Therefore, based on these results, it is felt that the topsoil deposits encountered can remain on site without representing a significant risk towards the future end-users, and as such no remedial measures are required for this proposed development.





**DETS Certificate of Analysis** 







#### Certificate Number 19-16700

04-Sep-19

Client Geol-Consultants Ltd. 3, Gladstone Terrace Gateshead Tyne & Wear NE8 4DY

- *Our Reference* 19-16700
- Client Reference GEOL19-9988
  - Order No (not supplied)
  - Contract Title Clitheroe
  - Description 15 Soil samples.
  - Date Received 29-Aug-19
  - Date Started 29-Aug-19
- Date Completed 04-Sep-19
- Test Procedures Identified by prefix DETSn (details on request).
  - *Notes* Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick Contracts Manager





# Summary of Chemical Analysis Soil Samples

*Our Ref* 19-16700 *Client Ref* GEOL19-9988 *Contract Title* Clitheroe

			Lab No	1554137	1554138	1554139	1554140	1554141	1554142
		Sa	ample ID	BH1	BH1	BH3	BH3	BH4	BH4
			Depth	0.10-0.40	1.50-2.00	0.10-0.30	0.50-1.00	0.10-0.30	1.50-2.00
			Other ID						
		Sam	ple Type	BJ	В	BJ	В	BJ	В
		Sampl	ing Date	14/08/19	14/08/19	14/08/19	14/08/19	14/08/19	14/08/19
		Sampl	ing Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	Method	LOD	Units						
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	17		18		16	
Cadmium	DETSC 2301#	0.1	mg/kg	0.7		1.0		1.2	
Chromium	DETSC 2301#	0.15	mg/kg	26		29		28	
Chromium III	DETSC 2301*	0.15	mg/kg	26		29		28	
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0		< 1.0		< 1.0	
Copper	DETSC 2301#	0.2	mg/kg	37		56		36	
Lead	DETSC 2301#	0.3	mg/kg	82		120		84	
Mercury	DETSC 2325#	0.05	mg/kg	0.14		0.14		0.09	
Nickel	DETSC 2301#	1	mg/kg	27		33		31	
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5		< 0.5		0.8	
Zinc	DETSC 2301#	1	mg/kg	150		200		180	
Inorganics									
рН	DETSC 2008#		pН	5.5	8.2	6.4	8.0	6.0	8.2
Cyanide, Free	DETSC 2130#	0.1	mg/kg	0.5		0.4		0.4	
Total Organic Carbon	DETSC 2002	0.1	%	3.5		3.4		3.0	
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	14	81	17	15	20	54
PAHs				-					
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1		< 0.1	
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1		< 0.1	
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1		0.2		< 0.1	
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1		0.2		< 0.1	
Phenanthrene	DETSC 3301	0.1	mg/kg	< 0.1		1.0		< 0.1	
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1		0.5		< 0.1	
Fluoranthene	DETSC 3301	0.1	mg/kg	0.1		2.8		< 0.1	
Pyrene	DETSC 3301	0.1	mg/kg	0.1		2.6		< 0.1	
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1		1.3		< 0.1	
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1		1.3		< 0.1	
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1		0.9		< 0.1	
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1		0.5		< 0.1	
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1		1.3		< 0.1	
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1		0.8		< 0.1	
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1		0.2		< 0.1	
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1		0.8		< 0.1	
PAH Total	DETSC 3301	1.6	mg/kg	< 1.6		15		< 1.6	



# Summary of Chemical Analysis Soil Samples

*Our Ref* 19-16700 *Client Ref* GEOL19-9988 *Contract Title* Clitheroe

		Lab No	1554143	1554144	1554145	1554146	1554147	1554148	
		Sa	ample ID	BH5	BH7	BH7	BH9	BH10	BH10
			Depth	0.10-0.30	0.10-0.30	1.00-1.50	0.00-0.20	0.00-0.20	0.20-1.10
			Other ID						
		Sam	ple Type	BJ	BJ	В	BJ	BJ	BJ
		Sampl	ing Date	14/08/19	14/08/19	14/08/19	14/08/19	14/08/19	14/08/19
		Sampl	ing Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	Method	LOD	Units						
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	12	12		36	15	15
Cadmium	DETSC 2301#	0.1	mg/kg	1.0	0.5		1.6	1.6	1.5
Chromium	DETSC 2301#	0.15	mg/kg	26	33		27	24	23
Chromium III	DETSC 2301*	0.15	mg/kg	26	33		27	24	23
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	24	28		43	34	28
Lead	DETSC 2301#	0.3	mg/kg	54	31		84	50	43
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05	< 0.05		0.09	< 0.05	< 0.05
Nickel	DETSC 2301#	1	mg/kg	26	40		37	50	44
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	1.3		1.1	0.5	0.7
Zinc	DETSC 2301#	1	mg/kg	130	89		170	240	210
Inorganics									
рН	DETSC 2008#		рН	6.5	7.3	8.3	6.8	7.6	8.1
Cyanide, Free	DETSC 2130#	0.1	mg/kg	0.2	< 0.1		0.3	0.2	< 0.1
Total Organic Carbon	DETSC 2002	0.1	%	1.9	1.4		3.5	1.7	1.1
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	13	31	11	16	11	< 10
PAHs									
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		< 0.1	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		< 0.1	< 0.1	< 0.1
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		< 0.1	< 0.1	< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		< 0.1	< 0.1	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.2	< 0.1	< 0.1
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.1	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.5	< 0.1	< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.5	< 0.1	< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.3	< 0.1	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.3	< 0.1	< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.3	< 0.1	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.2	< 0.1	< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.4	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.3	< 0.1	< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.2	< 0.1	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1		0.4	< 0.1	< 0.1
PAH Total	DETSC 3301	1.6	mg/kg	< 1.6	< 1.6		3.8	< 1.6	< 1.6



# Summary of Chemical Analysis Soil Samples

*Our Ref* 19-16700 *Client Ref* GEOL19-9988 *Contract Title* Clitheroe

			Lab No	1554149	1554150	1554151
		Sa	ample ID	BH12	BH14	BH15
			Depth	0.00-0.20	0.00-0.20	0.00-0.20
			Other ID			
		Sam	ple Type	BJ	BJ	BJ
		Sampl	ing Date	14/08/19	14/08/19	14/08/19
		Sampl	ing Time	n/s	n/s	n/s
Test	Method	LOD	Units			
Metals						
Arsenic	DETSC 2301#	0.2	mg/kg	16	15	12
Cadmium	DETSC 2301#	0.1	mg/kg	1.0	1.6	1.1
Chromium	DETSC 2301#	0.15	mg/kg	26	27	28
Chromium III	DETSC 2301*	0.15	mg/kg	26	27	28
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	30	36	24
Lead	DETSC 2301#	0.3	mg/kg	63	120	54
Mercury	DETSC 2325#	0.05	mg/kg	0.06	0.07	0.12
Nickel	DETSC 2301#	1	mg/kg	33	37	25
Selenium	DETSC 2301#	0.5	mg/kg	1.5	1.4	1.2
Zinc	DETSC 2301#	1	mg/kg	120	200	130
Inorganics						
рН	DETSC 2008#		рН	6.5	6.6	6.4
Cyanide, Free	DETSC 2130#	0.1	mg/kg	0.3	0.3	0.4
Total Organic Carbon	DETSC 2002	0.1	%	2.5	2.7	2.5
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	12	13	12
PAHs						
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	0.1	0.1	0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	0.1	< 0.1	0.1
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	0.1	0.2	0.4
Pyrene	DETSC 3301	0.1	mg/kg	0.2	0.2	0.4
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	0.2	0.3
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1	0.4	0.2
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	0.2	0.3
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	0.1	0.2
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	0.3	0.3
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	0.4
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	0.5
PAH Total	DETSC 3301	1.6	mg/kg	< 1.6	2.0	3.5



# Summary of Asbestos Analysis Soil Samples

*Our Ref* 19-16700 *Client Ref* GEOL19-9988 *Contract Title* Clitheroe

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1554137	BH1 0.10-0.40	SOIL	NAD	none	Luke Donaghy
1554139	BH3 0.10-0.30	SOIL	NAD	none	Luke Donaghy
1554141	BH4 0.10-0.30	SOIL	NAD	none	Luke Donaghy
1554143	BH5 0.10-0.30	SOIL	NAD	none	Luke Donaghy
1554144	BH7 0.10-0.30	SOIL	NAD	none	Luke Donaghy
1554146	BH9 0.00-0.20	SOIL	NAD	none	Luke Donaghy
1554147	BH10 0.00-0.20	SOIL	NAD	none	Luke Donaghy
1554148	BH10 0.20-1.10	SOIL	NAD	none	Luke Donaghy
1554149	BH12 0.00-0.20	SOIL	NAD	none	Luke Donaghy
1554150	BH14 0.00-0.20	SOIL	NAD	none	Luke Donaghy
1554151	BH15 0.00-0.20	SOIL	NAD	none	Luke Donaghy

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: \* not included in laboratory scope of accreditation.



### Information in Support of the Analytical Results

*Our Ref* 19-16700 *Client Ref* GEOL19-9988 *Contract* Clitheroe

#### **Containers Received & Deviating Samples**

		Date			Inappropriate container for
Lab No	Sample ID	Sampled	<b>Containers Received</b>	Holding time exceeded for tests	tests
1554137	BH1 0.10-0.40 SOIL	14/08/19	GJ 250ml, PG		
1554138	BH1 1.50-2.00 SOIL	14/08/19	PG		
1554139	BH3 0.10-0.30 SOIL	14/08/19	GJ 250ml, PG		
1554140	BH3 0.50-1.00 SOIL	14/08/19	PG		
1554141	BH4 0.10-0.30 SOIL	14/08/19	GJ 250ml, PG		
1554142	BH4 1.50-2.00 SOIL	14/08/19	PG		
1554143	BH5 0.10-0.30 SOIL	14/08/19	GJ 250ml, PG		
1554144	BH7 0.10-0.30 SOIL	14/08/19	GJ 250ml, PG		
1554145	BH7 1.00-1.50 SOIL	14/08/19	PG		
1554146	BH9 0.00-0.20 SOIL	14/08/19	GJ 250ml, PG		
1554147	BH10 0.00-0.20 SOIL	14/08/19	GJ 250ml, PG		
1554148	BH10 0.20-1.10 SOIL	14/08/19	GJ 250ml, PG		
1554149	BH12 0.00-0.20 SOIL	14/08/19	GJ 250ml, PG		
1554150	BH14 0.00-0.20 SOIL	14/08/19	GJ 250ml, PG		
1554151	BH15 0.00-0.20 SOIL	14/08/19	GJ 250ml, PG		
Key: G-Glass	P-Plastic J-Jar G-Bag				

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.



### Information in Support of the Analytical Results

*Our Ref* 19-16700 *Client Ref* GEOL19-9988 *Contract* Clitheroe

#### **Soil Analysis Notes**

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425μm sieve, in accordance with BS1377. Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis. The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

#### Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months



### **CL:AIRE Statistical Analysis Calculation Sheets**





Client/client ref: Persimmon Homes Project ref: GEOL19-9988 Site ref: Clitheroe Data description: Level 1 GQRA Contaminant(s): Generic Test scenario: Planning Date: 25 September 2019 Hore detail: PS	Arsenic (total) (mg/kg)	Cadmium (total) (mg/kg)	Chromium (III) (mg/kg)	Chromium (VI) (mg/kg)	Copper (total) (mg/kg)	Lead (total) (mg/kg)	Mercury (total) (mg/kg)	Nickel (total) (mg/kg)	Selenium (total) (mg/kg)	Zinc (total) (mg/kg)	Cyanide (free) (mg/kg)
Critical concentration, C <sub>c</sub>	37	11	910	6	2400	200	40	130	250	3700	34
Notes	S4UL - Residential With Home-Grown Produce - LQM 2015	C4SL - Residential With Home-Grown Produce - CL:AIRE 2014	S4UL - Residential With Home-Grown Produce - LQM 2015	ATRISK(SOIL) SSV's - 2015 - Residential With Homegrown Produce -							
Sample size, n	11	11	11	11	11	11	11	11	11	11	11
Sample mean, $\overline{x}$	16.7272727	1.16363636	27	0.5	34.1818182	71.3636364	0.07363636	34.8181818	0.84090909	165.363636	0.28181818
Standard deviation, s	6.70955899	0.37755192	2.64575131	0	9.32542955	29.5407269	0.04599407	7.79510336	0.48364149	45.6339188	0.14538351
Number of non-detects	0 0		0	11	0	0	4	0	3	0	2
Set non-detect values to:	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit					
Outliers?	Yes	No	No	No	No	No	No	No	No	No	No
Distribution	Non-normal	Normal	Normal	Single value	Normal	Normal	Normal Normal		Normal	Normal	Normal
Statistical approach	Auto: Chebychev	Auto: One-sample t-test	Auto: One-sample t-test	Auto: Chebychev	Auto: One-sample t-test	Auto: One-sample t-test	Auto: One-sample t-test	Auto: One-sample t-test	Auto: One-sample t-test	Auto: One-sample t-test	Auto: One-sample t-test
Test scenario:	Planning: is true mean lower	than critical concentration (µ ·	< Cc)?	•	Evidence	level required:	95%	Use Log-Normal distribution	to test for outliers	•	
t statistic, $t_0$ (or $k_0$ )	-10.02108037	-86.40805542	-1106.899079	N/A	-841.4123109	-14.44238505	-2879.083439	-40.49752303	-1708.63591	-256.8936198	-769.2107672
Upper confidence limit (on true mean concentration, μ)	25.5453608	1.36996003	28.4458438	0.5	39.2779565	87.5069816	0.09877109	39.0780311	1.10520833	190.30155	0.36126701
Evidence level	lence level 99% 100% 100% 100%		100%	100%	100%	100%	100%	100%	100%	100%	
Base decision on:	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level					
Result	μ < Cc	μ < <b>C</b> c	μ < <b>C</b> c	μ < Cc	μ < <b>C</b> c	μ < <b>C</b> c	μ < Cc				
Select dataset	•γ ογ ογ ογ		ΟY	ΟY	ΟY	ΟY	ΟΥ	ΟΥ	ΟΥ		



Project ref: GEOLI9-9988 Site ref: Clitheroe Data description: Contamination Results Contaminant(s): Speciated PAH (USEPA 16) Test scenario: Planning Debut 37 Contember 3000	Acenaphthen e (mg/kg)	Acenaphthyle ne (mg/kg)	Anthracene (mg/kg)	Benzo(a)anth racene (mg/kg)	Benzo(a)pyre ne (mg/kg)	Benzo(b)fluo ranthene (mg/kg)	Benzo(ghi)pe rylene (mg/kg)	Benzo(k)fluor anthene (mg/kg)	Chrysene (mg/kg)	Dibenz(ah)an thracene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Indeno(123c d)pyrene (mg/kg)	Naphthalene (mg/kg)	Phenanthren e (mg/kg)	Pyrene (mg/kg)
Critical concentration, C <sub>c</sub>	510	420	5400	11	2.7	3.3	340	93	22	0.28	560	400	36	5.6	220	1200
Notes	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015	S4UL - Residential With Home-grown Produce, 2.5% SOM - LQM, 2015
Sample size, n	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Sample mean, $\overline{x}$	0.06363636	0.05	0.09545455	0.22272727	0.24090909	0.18636364	0.19090909	0.12272727	0.23181818	0.07727273	0.39545455	0.07727273	0.17272727	0.05	0.15909091	0.38636364
Standard deviation, s	0.0452267	7.2776E-18	0.13500842	0.37172815	0.3753786	0.25796406	0.25866792	0.13849844	0.37501515	0.06067799	0.81254371	0.04670994	0.24120908	7.2776E-18	0.28268196	0.75036355
Number of non-detects	10	11	9	7	7	7	8	7	7	9	5	7	8	11	7	5
Set non-detect values to:	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection land	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	fail detection limit
Outliers?	Vaa	#DTI//01	Voc	No	No	No	No	No	No	No	Yes	Vec	No	#DTV//01	Yes	No
outlierst	res	#DIV/0!	les	NO	NO	NO	NO	INU	INU	110		163	INU	#DIV/0:		110
Distribution	Non-normal	*DIV/0! Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal
Distribution Statistical approach	Non-normal Ada: Debyder	#DIV/0! Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal Adda: Debyshev	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Mon-normal	Non-normal	Non-normal
Distribution Statistical approach Test scenario:	Non-normal Ade: Chelgebry Planning: is true mean lower than official of	#DIV/0! Non-normal Auto: Chebyshev oncentration (p. < Co?	Non-normal Adde: Chebysher	Non-normal Add: Orebydev	Non-normal Adde: Diebydev Evidence	Non-normal	Non-normal Add: Onlyster 95%	NOn-normal Ade: Chetychev Use Lag Mormal desribution to test for cel	Non-normal Ada: Orbystev	Non-normal Add: Orbyshev	Non-normal Adda: Chebychev	Non-normal Ade: Orbysher	Non-normal Adda Orldyshev	Non-normal	Non-normal Adit: Cheltychev	Non-normal Mats Ordystev
Distribution       Statistical approach       Test scenario:       t statistic, t <sub>0</sub> (or k <sub>0</sub> )	Non-normal Add: Debydev Plening is too reset lower than cristed to -37395.33333	#DIV/0! Non-normal Ads: Debyder orcestration (u = CO? -1.91385E+20	Non-normal Ada: Oxiyydar -132654.3755	Non-normal Add: Oxthydev -96.15674738	Non-normal Adds Onlyder Evidence -21.72708285	Non-normal Add Onlyder level required: -40.03179235	Non-normal Add: Debyder 95% -4357.012153	Non-normal Adds: Ordeychev Use Log-Morreal distribution 10 text for cell -2224.133808	Non-normal Kets Orbystev -192.5172656	Non-normal Ada: Odiystev -11.08095909	Non-normal Atta: Orbystev -2284.182742	Non-normal Ada: Delyster -28396.39115	Non-normal Ada: Oxforder -492.625	*DIV/0: Non-normal Ads: Odgyber -2.52931E+18	Non-normal Auto Ordyster -2579.329106	Non-normal kee: Oheyshev -5302.320901
Test scenario:           t statistical approach           Test scenario:           t statistic, t <sub>0</sub> (or k <sub>0</sub> )           Upper confidence limit (on true mean concentration, µ)	Tes           Non-normal           Adm: Only/or           Merring: In four rear lower than celled 4           -37395.333333           0.12307589	#DIV/0! Non-normal Atto Devider reartifien y - 62 -1.91385E+20 0.05	-132654.3755 0.27289037	Non-normal Ate: 04tyder -96.15674738 0.71127378	Non-normal           Evidence           -21.72708285           0.73425322	Non-normal Ate Oxyder Ievel required: -40.03179235 0.52539483	Non-normal Atte Detyster -4357.012153 0.53086534	Non-normal           Ass: Delaysher           Del Lag Normal delayblecter to the for eet           -2224.133808           0.30474989	Non-normal Ads Debyter -192.5172656 0.72468465	Non-normal Ads Odgober -11.08095909 0.15701923	Non-normal Ada: Debyder -2284.182742 1.46334619	-28396.39115 0.13866161	Non-normal Ads Ordyster -492.625 0.4897381	+ DLV(0: Non-normal Add Detyder -2.52931E+18 0.05	Non-normal Att Objector -2579.329106 0.53060779	-5302.320901 1.37253454
Distribution Statistical approach Test scenario: t statistic, t <sub>0</sub> (or k <sub>0</sub> ) Upper confidence limit (on true mean concentration, µ) Evidence level	Tes           Non-normal           Astr Outplew           Perrig Is faceness here than clefal d           -37395.333333           0.12307589           100%	#DIV/0! Non-normal Ass Dehyler -1.91385E+20 0.05 <b>100%</b>	-132654.3755 0.27289037 100%	Non-normal Atto Orbitor -96.15674738 0.71127378 100%	Non-normal           Evidence           -21.72708285           0.73425322           100%	Non-normal Atte Oetydee evel required: -40.03179235 0.52539483 100%	Non-normal           95%           -4357.012153           0.53086534           100%	NO Non-normal Add Debyter De Leg Hornel debitister to tes for ea -2224.133808 0.30474989 100%	Non-normal Atta Datyster -192.5172656 0.72468465 100%	Non-normal Att: 049,590 -11.08095909 0.15701923 <b>99%</b>	Non-normal Acto Detryster -2284.182742 1.46334619 <b>100%</b>	-28396.39115 0.13866161 100%	-492.625 0.4897381	-2.52931E+18 0.05 100%	Non-normal Add: Chefyshe -2579.329106 0.53060779 100%	-5302.320901 1.37253454 100%
Distribution Statistical approach Test scenario: t statistic, t <sub>0</sub> (or k <sub>0</sub> ) Upper confidence limit (on true mean concentration, µ) Evidence level Base decision on:	Tes           Non-normal           Add Ontylev           Persig is four reas have the celled of -37395.333333           0.12307589           100%           referes test	+ DIV/0:     Non-normal     Acc Orbohor     -1.91385E+20     0.05     100%     vrbitas lant	-132654.3755 0.27289037 100%	Non-normal Acc Cetyder -96.15674738 0.71127378 100% videas ber	Evidence           -21.72708285         0.73425322           100%         vites keit	Ito           Non-normal           Arc Device           evel required:           -40.03179235           0.52539483           100%           voltas ket	Non-normal           Asc Crégoler           95%           -4357.012153           0.53086534           100%           videos bolt	Non-normal Acto Debyohr -2224.133808 0.30474989 100%	Non-normal Add: Debyster ter -192.5172656 0.72468465 100% withink key	Non-normal           Ate: Defpate           -11.08095909           0.15701923           99%           videas bot	Non-normal Ats Debute -2284.182742 1.46334619 100% vtbiss ket	-28396.39115 0.13866161 100%	-492.625 0.4897381 100%	+ D1 V/01     Non-normal     Ass: Cleipube     -2.52931E+18     0.05     100%     videas buil	Non-normal Alto Debyte -2579.329106 0.53060779 100% vrdeas ket	-5302.320901 1.37253454 100%
Distribution Statistical approach Test scenario: t statistic, t <sub>0</sub> (or k <sub>0</sub> ) Upper confidence limit (on true mean concentration, µ) Evidence level Base decision on: Result	Tess           Non-normal           Astronomia           -37395.33333           0.12307589           100%           extension           extension	#DIV/0!           Non-normal           Ann Order/or           -1.91385E+20           0.05           100%           Antex bett           # < Cc	-132654.3755 0.27289037 100% xxxxx bal	Non-normal Att Debylw -96.15674738 0.71127378 100% xteres bel µ < Cc	Non-normal           Evidence           -21.72708285           0.73425322           100%           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Non-normal           Ano-normal           Ano-obsphere           evel required:           -40.03179235           0.52539483           100%           Anothere           µ< Cc	Non-normal Att Deptw 95% -4357.012153 0.53086534 100% xtees tet µ < Cc	No           Non-normal           Anto Ordeyter           -2224.133808           0.30474989           100%           NO           NO           No	Non-normal Non-normal MAR 0 depter Inter 192.5172656 0.72468465 100% Norest	Non-normal Att Deptre -11.08095909 0.15701923 99% xees tet µ < Cc	Non-normal Att Despty -2284.182742 1.46334619 100% KKNKK KK F L C C	-28396.39115 0.13866161 100% xxxxx xx µ < Cc	но Non-normal Att Depter -492.625 0.4897381 100% извез ви µ < Сс	#DIV/0: Non-normal Act: Obytw -2.52931E+18 0.05 <b>100%</b> хамае вы	Non-normal           Are Orbitals           -2579.329106           0.53060779           100%           robust lost           μ < Cc	-5302.320901 1.37253454 100%



# **APPENDIX V**

# HAZARDOUS GROUND GAS RISK ASSESSMENT

Phase II Ground Investigation Report Hawthorne Farm, Hawthorne Place, Clitheroe, Lancashire, BB7 2HU Project No.: GEOL19-9988





### HAZARDOUS GROUND GAS RISK ASSESSMENT

Following the results of the Phase I Preliminary Contamination Risk Assessment, produced for the site by GEOL and the findings of the Phase II Investigation works, combined ground gas & water monitoring standpipes have been installed within three boreholes (BH02, BH06 & BH15), to confirm the ground gas regime below the site, as well as to monitor groundwater levels within the underlying deposits.

The monitoring installations have been constructed using 50mm diameter HDPE standpipe, comprising 1m of solid pipe within a bentonite seal and a response zone using slotted pipe up to depths of up to c.3m below existing site levels, and the ground gas and water levels were allowed to reach equilibrium, prior to the first monitoring visit. The design of the ground gas risk assessment for this site has been undertaken in general accordance with the CIRIA Report C665 (November 2007), BS 8576:2013 – Guidance on investigations for ground gas and BS8485:2015 + A1:2019 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, and is based on the following criteria;

- The proposed residential development has been classified as high sensitivity.
- The risk associated with the generation potential of a source has been assessed as very low.
- ▼ Therefore, in accordance with Tables 5.5a and 5.5b in CIRIA C665, the typical / idealised period of monitoring for this site has been determined as 6 no. recorded readings undertaken over a minimum period of 3 months.
- Monitoring visits are undertaken to target and correlate with the worst-case conditions for ground gas emissions to occur, comprising falling atmospheric pressure trends and low atmospheric pressures. Monitoring of the weather conditions and predicted atmospheric pressures were carried out up to 72 hours in advance of the monitoring visits, in order that a reasonable period of data is obtained to determine atmospheric trends, and to target the worst-case scenario.

A copy of the ground gas monitoring certificate can be seen attached, and monitoring was undertaken using a Gas Data GFM436 soil gas analyser with integral flow meter, and a Geotechnical Instruments electronic dip-meter. A summary of the gas monitoring results can be found in the Table below.

Position	Date	Atmospheric Pressure (mbar)	Water level (m bgl)	Max CH₄ (%v/v)	Max CO₂ (%v/v)	Min O₂ (%v/v)	Flow Rate (l/hr)
BH02		1011	Dry	0.0	0.6	20.4	<0.1
BH06	30/08/2019	(Falling – 1021-	Dry	0.0	1.4	19.7	<0.1
BH15		1015)	Dry	0.0	1.6	19.5	<0.1

Atmospheric pressure trend shown in brackets taken from www.weatheronline.co.uk for Bingley



Position	Date	Atmospheric Pressure (mbar)	Water level (m bgl)	Max CH₄ (%v/v)	Max CO₂ (%v/v)	Min O₂ (%v/v)	Flow Rate (I/hr)
BH02		1004-1006	0.30	~	~	~	~
BH06	02/10/2019	(Rising 996-	1.17	0.0	4.3	15.6	<0.1
BH15		1018)	0.28	0.0	1.9	18.7	<0.1

Atmospheric pressure trend shown in brackets taken from www.weatheronline.co.uk for Bingley

To date, no detectable concentrations of methane have been recorded (<0.1%v/v). Concentrations of Carbon Dioxide have been recorded ranging between 0.6% v/v and 4.3% v/v, along with variable Oxygen concentrations ranging between 15.6% v/v and 20.4% v/v. Negligible flow rates (<0.1l/hr) have been recorded during the monitoring visits completed. Further consideration has also given to the presence of other hazardous gases, such as Carbon Monoxide, Hydrogren Sulphide, volatile vapours, as well as the presence of depleted Oxygen, and no abnormal readings have been identified.

Based on these results, and for the purposes of the assessing the proposed development in accordance with Tables 8.5 & 8.7 in CIRIA C665 and Table 2 in BS8485:2015 + A1:2019, the site is characterised based on the limiting borehole hazardous gas flow rate (*Qhg*) for Methane & Carbon Dioxide, known as the Gas Screening Value (GSV). The GSV equates to a Characteristic Situation classification which in turn determines the level of any gas protection measures required in accordance with Table 4 in BS8485:2015 + A1:2019. The GSV is calculated as follows;

- Due to the lack of Methane recorded, a GSV cannot be calculated.
- ▼ Multiply the maximum Carbon Dioxide concentration (taken as 4.3% (0.043)) by the maximum flow rate (0.11/hr), which gives a GSV value of 0.00431/hr.

The GSV calculated indicates that hazardous ground gases do not exceed the GSV assessment value of 0.07 l/hr (Characteristic Situation 1) or 0.16 l/hr. for Methane and 0.78l/hr. for Carbon Dioxide (Green Classification for Situation B – Low rise housing with a ventilated underfloor void, NHBC Traffic Light System). Furthermore, neither the maximum concentration for Methane or Carbon Dioxide exceeds the action trigger level of 1% v/v or 5% v/v respectively, indicating that gas protection measures would not be required for the proposed residential development. As there are 4 no. outstanding monitoring visits to be completed, this risk assessment and characteristion will need to be reassessed with the results issued as an addendum report.

In addition, from the results of the Phase I preliminary contamination risk assessment completed for this site, the Radon assessment has confirmed that no protection measures are required for this proposed development.



All the monitoring wells were recorded to be dry on the first monitoring visit, however water levels were noted to have risen significantly by the second visit to depths of between 0.30m and 1.17m below current ground levels, which coincided with periods of heavy rainfall. All the boreholes were purged of the standing water so that the response zones were no longer flooded. The increase in water levels is felt to be attributable to the ingress of surface water infiltration rather than representing a continuous groundwater surface, particularly when considering the nature of the drift deposits. It would therefore be considered prudent, within deeper excavations, to allow for the introduction of temporary groundwater control measures (i.e. sump pumping equipment) and adequate shoring should, perched groundwater be encountered, to take care of any potential future shallow water ingresses within the underlying deposits, particularly where open excavations are present and are to remain open to the natural elements.





Gas Monitoring Certificate







Vicit	Data	Time	Equipment	Weather	Site	Commente	Borehole Position	Gas Flow Prossure (m	Gas Flow	Atmospheric	Atmospheric	tmospheric Atmospheric Meti	eric Atmospheric		e (% v/v)	Methane	(% LEL)	(%	v/v)	Oxyger	ı (% v/v)	(GFM 4	35 only)	Other G	iases (PPN	A)	Depth to Water	Depth to
VISIC	Date	11110	Equipment	Weather	Engineer	Commenta	Position	(l/hr)	Pressure (mb)	Pressure Trend	Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	Hex %	PID Cf	PID (Isobutylene)	H <sub>2</sub> S	со	(m bgl)	Base (m bgl)			
							BH02	<0.1	1011			0.0		0.0		0.6		20.4				0	0	Dry	3.00			
1	30/08/2019	10.30am	GFM436		RS		BH06	<0.1	1011	Falling (1021-1015)		0.0		0.0		1.4		19.7				0	0	Dry	2.00			
							BH15	<0.1	1011			0.0		0.0		1.6		19.5				0	0	Dry	2.72			
						BH02 flooded All	BH02																	0.30	3.00			
2	02/10/2019	13.30pm	GFM436	Dry, sunny, slight breeze	SP	boreholes bailed of	BH06	<0.1	1004	Rising (996-1018)		0.0		0.0		4.3		15.6				0	0	1.17	1.91			
						Water.	BH15	<0.1	1006			0.0		0.0		1.9		18.7				0	0	0.28	2.71			
3																												
4																												
5																												
6																												

Atmospheric pressure trend taken from www.weatheronline.co.uk for Bingley.