MR DAVID MARSHALL

VACANT LAND TO THE REAR OF BELSFIELD GARDENS, JARROW. NE32 5QB

REPORT ON PHASE 2 GROUND INVESTIGATION

Contract: 30919

Date: April 2014

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REPORT ON PHASE 2 GROUND INVESTIGATION

Carried out at

VACANT LAND TO THE REAR OF

BELSFIELD GARDENS, JARROW. NE32 5QB

Prepared for

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EXECUTIVE SUMMARY

It is understood that the proposed development comprises the construction of five detached houses with a new detached double garage block with refurbishment of existing garage block with an increase in width to the existing access road to the site.

On the instructions of BW Architecture acting, on the behalf of Mr David Marshall of 13 Belsfield Gardens, a ground investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

A Preliminary Investigation Report (Phase 1 Desk Study) has not been commissioned as part of the scope of works, therefore the comments within this report are based solely on this intrusive phase of investigation.

The site is vacant land situated to the rear and east of Belsfield Gardens, Jarrow which is approximately 1.3km to the south of Jarrow Town centre and 7km east of Newcastle City centre and may be located by National Land-ranger Grid Reference NZ 326,638.

The geological maps indicates the site to be underlain by superficial deposits of Pelaw Clay which is predominately reddish-brown to dark brown clay containing well dispersed pebbles and cobbles.

The superficial deposits are underlain by Pennine Middle Coal Measures Formation from the Carboniferous Period. The Hebburn Dyke is indicated some 0.4km to the south of the site.

Although not indicated as present, the possibility that Made Ground could exist on site cannot be discounted.

The site work was carried out on the 13th March 2014 and consisted of three window sample probe borehole with the installation of gas and ground water monitoring standpipes.

A thin layer (0.45m thick) of Made Ground overlaid a glacial till deposit. Ground water was not recorded during drilling but near surface rest levels were found in the standpipes.

On the basis of observations made on site together with results of in-situ and laboratory tests, it is recommended that consideration could be given to the adoption of shallow spread foundations to support the proposed structures.

Outside the zone of influence of existing and proposed trees, it is recommended that conventional shallow spread footings should be taken through any Made Ground and placed in the underlying natural glacial till strata at a minimum depth of 1.0mbgl.

Within the zone of influence of recently removed, existing or proposed trees, foundations should be taken through the Made Ground and placed at depths recommended by the NHBC for soils of medium volume change potential. Compressible material should be placed on the inside faces of foundations as specified by the NHBC.

Such foundations may be designed to an allowable bearing pressure of 150kN/m^2 a figure which would provide an adequate factor of safety against shear failure and limit consolidation settlements to acceptable levels with differential settlements the order of less than 10mm, which will be acceptable.

Risk assessments have identified the presence of elevated vanadium and benzo(a)pyrene as well as elevated zinc and copper concentrations within the Made Ground, plus elevated leachate results. The Made Ground is considered to be contaminated and either removal of the Made Ground from areas of gardens or areas likely to be used for the growing of vegetables/fruit for consumption is suggested or alternatively, a capping layer of 'inert' material could be provided to break the pathway between the identified contamination and end users of the site. The required thickness of the capping layer could be determined using guidance provided by the BRE

It was found that the underlying glacial till all determinants were significantly below the generic guidance values and therefore for the proposed development, the glacial till deposit can be considered not to be contaminated.

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1.0 INTRODUCTION

1.1 It is understood that the proposed development comprises the construction of five detached houses with a new detached double garage block with refurbishment of existing garage block with an increase in width to the existing access road to the site.

1.2 On the instructions of BW Architecture acting, on the behalf of Mr David Marshall of 13 Belsfield Gardens, a ground investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

1.3 A Preliminary Investigation Report (Phase 1 Desk Study) has not been commissioned as part of the scope of works, therefore the comments within this report are based solely on this intrusive phase of investigation.

1.4 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.

1.5 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.6 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.7 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is vacant land situated to the rear and east of Belsfield Gardens, Jarrow which is approximately 1.3km to the south of Jarrow Town centre and 7km east of Newcastle City centre and may be located by National Land-ranger Grid Reference NZ 326,638.

2.1.2 A site location plan is included in Appendix 1, Figure A1.1.

2.2 Geological Setting

2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey Digital Mapping 1:50,000 scale.

2.2.2 The geological maps indicates the site to be underlain by superficial deposits of Pelaw Clay formed up to 2 million years ago in the Quaternary Period.

2.2.3 Pelaw Clay is predominately reddish-brown to dark brown clay containing well dispersed pebbles and cobbles. Clasts are mainly of Carboniferous lithologies (sandstone, mudstone, limestone, coal).

2.2.4 The superficial deposits are underlain by Pennine Middle Coal Measures Formation from the Carboniferous Period. The mapping indicated a sandstone bedrock underlain by mudstone, siltstone and further sandstone.

2.2.5 The Hebburn Dyke is indicated some 0.4km to the south of the site and consists of a Micro-gabbro igneous rock formed approximately 23 to 66 million years ago in the Palaeogene Period.

2.2.6 The site is within an urban area and, although not indicated as present on the site from the geological maps, the possibility that Made Ground could exist on site cannot be discounted.

3.0 SITE WORK

3.1 The site work was carried out on the 13th March 2014. The locations of exploratory holes have been planned, where possible, in general accordance with CLR 4, ref. 9.1 and the site work carried out on the basis of the practices set out in BS 10175:2011, ref. 9.2, BS 5930:2010 ref. 9.3 and ISO 1997:2007, ref 9.4.

3.2 A high pressure water main crosses the site in a west to east direction and a sterile zone is required 0.6m either side of this buried pipe. The borehole locations were positioned to avoid this service.

3.3 Additional references are noted within the table.

Exploratory Hole Type	Quantity	Hole Reference	Depths	Notes
Window sample boreholes	3	WS01 to WS03	All taken to 5.0mbgl	
Inspection pits – hand excavated	3	WS01 to WS03	1.20mbgl	To avoid services
Slotted standpipe installations	34	WS01 to WS03,	4.0mbgl	Installed into the Pelaw Clay to monitor groundwater and gas levels, each with gas valve and flush cover fitted.

3.4 The positions of the above are shown on the site plan, Appendix 1, Figure A1.2.

3.5 The depths of boreholes and trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the borehole and trial pit records, Appendix 2,

3.6 Representative disturbed samples were taken at the depths shown on the borehole records and were dispatched to the laboratory for examination and testing.

3.7 Standard (split-barrel and cone) penetration tests, refs. 9.6 were carried out in the light cable percussion boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records

3.8 Samples were collected for environmental purposes in amber glass jars and kept in a cool box.

3.9 Perforated standpipes, surrounded by pea shingle and protected by a stopcock cover were installed in the boreholes, as detailed in the borehole records.

3.10 The ground levels at the borehole locations were not determined.

3.11 Groundwater and gas monitoring visits were undertaken on three visits to date and are as detailed in Figure A6.1 in Appendix 6.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing

4.1.1 All soil samples were prepared in accordance with BS1377: Part One: 1990 ref. 9.6 and representative sub-samples were taken for testing. The following tests were carried out:

- 5 No. Moisture contents
- 5 No. Plasticity indices

4.1.2 The results of the testing are given in Appendix 3, Test Reports 30919/1.

4.2 Chemical Testing

4.2.1 The chemical analyses were carried out on five samples of natural clay and two samples of the overlying Made Ground. Leachate analysis was also conducted on one sample of natural clay. The nature of the analyses is detailed below:

4.2.2 **Metals Suite** - arsenic, beryllium, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, boron (water soluble), copper, nickel, vanadium and zinc

4.2.3 **Organic Suite** - polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite and phenols.

4.2.4 **Inorganics Suite** - cyanide (total)

4.2.5 **Others** - pH, organic matter content, hardness and sulphate aqueous extract.

4.2.6 The results of these tests are shown in Appendix 4, Certificate No: 14-01610.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Sequence

5.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

5.1.2 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m)		Strata Thickness (m)
	From	To	
Made Ground	0.00	0.30 to 0.45	0.30 to 0.45
Glacial Till	0.30 to 0.45	4.96 to 5.0	4.50 to 4.70
Laminated Clay	4.95	5.0	0.05

5.2 Made Ground

5.2.1 Made Ground consisted of an upper tarmacadam layer in WS1 and in WS2 and WS3 as clayey topsoil with inclusions of concrete, brick, wood, plastic, glass, tile and sandstone gravel.

5.2.2 This upper layer was underlain by a granular sand and gravel with similar gravel inclusions of concrete, brick, wood, plastic, glass, tile and sandstone with the addition of burnt shale, clinker and slag.

5.2.3 Made Ground extended to depths of between 0.30 and 0.45mbgl.

5.3 Glacial Till

5.3.1 Glacial till consisting of slightly sandy slightly gravelly clay was encountered below Made Ground in all boreholes and extended to a depth at least 4.95mbgl.

5.4 Laminated Clay

5.4.1 Laminated clay was only found in WS2 at 4.95mbgl and was only proved to a depth of 5.0mbgl.

5.4.2 Local laminations were also found within the glacial till below 4.10mbgl in WS1 and WS2 and at 2.3mbgl in WS3.

5.5 Groundwater

5.5.1 Groundwater was not encountered in any of the exploratory holes.

5.5.2 Monitoring of standpipes indicated the following ground water rest levels.

Borehole No	Water strike	Standpipe Readings mbgl		
		27/03/2014	02/04/2014	07/04/2014
1	None observed	0.10	2.82	0.1
2	None observed	3.70	2.80	0.1
3	None observed	3.85	3.44	3.60

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

6.1 Introduction

6.1.1 The intention of this assessment is to determine the geotechnical properties of the strata encountered, and to review their influence on the ground engineering options for the proposed development.

6.2 Structural Details

6.2.1 It is understood that the proposed development is to consist of construction of five detached houses with a new detached double garage block with refurbishment of existing garage block with an increase in width to the existing access road to the site.

6.2.2 Precise structural details were not provided at the time of preparation of this report, therefore the following recommendations fall outside of the Eurocode 7 legislation.

6.2.3 For the purpose of this assessment, it has been assumed that line loads of the region of up to 50 to 75kN/m run will be imparted by traditional masonry construction.

6.2.4 Based upon these assumptions it is recommended that spread foundations be employed.

6.3 Assessment of Soil Condition

6.3.1 The engineering parameters for the materials encountered have been based on the engineering descriptions, in-situ and laboratory tests, published data, and correlated with professional judgement.

6.3.2 Work undertaken by Stroud, ref. 9.7 determined a relationship between SPT 'N' values and the undrained shear strengths of many over-consolidated clays. Further work by Stroud and Butler, ref. 9.8, in which data was analysed from sites covering a wide range of glacial deposits, confirmed there to be a correlation between the 'N' value and undrained shear strength.

6.3.3 Within the cohesive materials, values such as c_u and m_v may be made with reasonable confidence based on the work carried out by Stroud and Butler together with assessment from laboratory testing.

6.3.4 The soils encountered on the site was principally cohesive in nature but contained lenses of sand.

6.4 Glacial Till (slightly sandy slightly gravelly clay)

6.4.1 Below is a summary of the geotechnical parameters derived from the laboratory and in-situ testing for the slightly sandy slightly gravelly clay during the investigation:

	Minimum	Maximum	Mean
Layer thickness (m)	4.50	4.70	4.62
Moisture Content (%)	12	16	14
Liquid Limit (%)	35	42	38
Plasticity Index (%)	20	24	22
Consistency Index (*Ic)*	1.0	1.25	1.09
Stroud Factor F_1 (4kN/m² for high plasticity and 6kN/m² for low)	5.0	5.3	5.1
SPT 'N' value	18	31	24
Derived Undrained Shear Strength, c_u (kPa) from SPT N values	90	160	125
Derived Compressibility, m_v (m^2/MN) from SPT N values	0.11	0.06	0.08
pH Value	8.1	8.6	8.4
Water Soluble Sulphate Content (mg/l)	27	190	86

6.4.2 The consistency index and the shear strengths derived from SPT testing have a reasonable correlation suggesting the strata to be generally of a stiff and occasionally very stiff consistency and suggesting a clay of high strength.

6.5 Foundation Design

6.5.1 The results of laboratory tests indicate the glacial till is of an intermediate plasticity and of medium volume change potential as defined by the National House Building Council, ref 9.9 and other published data, refs 9.10 and 9.11. Changes in moisture content will result in moderate changes in volume, seasonal changes being exacerbated by the presence of trees

6.5.2 On the basis of observations made on site together with results of in-situ and laboratory tests, it is recommended that consideration could be given to the adoption of shallow spread foundations to support the proposed structures.

6.5.3 Outside the zone of influence of existing and proposed trees, it is recommended that conventional shallow spread footings should be taken through any Made Ground and placed in the underlying natural glacial till strata at a minimum depth of 1.0mbgl.

6.5.4 Within the zone of influence of recently removed, existing or proposed trees, foundations should be taken through the Made Ground and placed at depths recommended by the NHBC for soils of medium volume change potential. Compressible material should be placed on the inside faces of foundations as specified by the NHBC.

6.5.5 Such foundations may be designed to an allowable bearing pressure of 150kN/m^2 a figure which would provide an adequate factor of safety against shear failure and limit consolidation settlements to acceptable levels with differential settlements the order of less than 10mm, which will be acceptable.

6.6 Ground Floor Slabs

6.6.1 On the basis of observation on site together with the results of laboratory tests it is recommended that, outside the zone of influence of trees, consideration is given to constructing the ground floor slab on formation prepared in the glacial till deposit.

6.6.2 Any soft or deleterious material should be removed and replaced with properly compacted granular fill.

6.6.3 Within the zone of influence of trees, the floor slabs should be suspended over a void, in accordance with NHBC guidelines.

6.7 Excavations

6.7.1 On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to less than 1.00m should stand unsupported in the short term.

6.7.2 Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations.

6.7.3 Groundwater should not be expected in shallow excavations for foundations or services. However the final rest levels in the standpipes might suggest that if excavations are left open for a while ground water entry may be likely. It is considered that this could be dealt with by the use of a pumping.

6.8 Road and Hard Standing Design

6.8.1 The structural design of a road or hard standing is based on the strength of the sub-grade, which is assessed on the California Bearing Ratio, **CBR**, scale.

6.8.2 Correlation given by the Highways Agency, ref. 9.12, has been used to determine a suitable CBR value rather than direct determination of the CBR.

6.8.3 On the basis of laboratory classification tests it is recommended that for formation prepared in the glacial till, a sub-grade CBR value of 4% be adopted for design purposes.

6.8.4 The assessment assumes there to be a low water table, average construction conditions and a thin pavement construction. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

6.9 Chemical Attack on Buried Concrete

6.9.1 The site has been classified in accordance with BRE Special Digest 1, ref. 9.13, as natural ground without the presence of pyrite and brownfield without the presence of pyrite and laboratory testing undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 9.13, be adopted.

6.9.2 The results of chemical tests in the natural non-pyritic soils (Glacial Till) indicate a sulphate concentration in the soil of between 27mg/l and 190mg/l as a 2:1 water/soil extract, with pH values in the range of 8.1 to 8.6.

6.9.3 The results of chemical tests in the brownfield non-pyritic soils (Made Ground) indicate a sulphate concentration in the soil of between 63mg/l and 230as a 2:1 water/soil extract, with pH values in the range of 8.5 to 11.4.

6.9.4 It is recommended that for conventional shallow foundations the groundwater should be regarded as mobile.

6.9.5 On the basis of the laboratory test results it is considered that a Design Sulphate Class for both the Glacial Till and Made Ground be taken as DS-1. The site conditions would suggest that an ACEC class for the site of AC-1 would be appropriate.

7.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

7.1 Contaminated Land

7.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 9.14, which was introduced by the Environment Act 1995, ref 9.15, as;

- 'Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –
- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

7.2 Risk Assessment

7.2.1 The definition of contaminated land is based on the principles of risk assessment. Risk is defined as a combination of:

- The probability, or frequency of exposure to a substance with the potential to cause harm, and:
- The seriousness of the consequence.

7.3 Pollutant Linkage

7.3.1 The basis of an environmental risk assessment involves identifying a 'source' of contamination, a 'pathway' along which the contamination may migrate and a 'receptor' at risk from the contamination.

7.3.2 Current legislation defines the various elements of the pollution linkage as:

- A contaminant is a substance which is in or under the ground and which has the potential to cause harm or to cause pollution of controlled waters.
- A pathway is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected.
- A receptor is either a living organism, an ecological system, a piece of land or property, or controlled water.

7.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 7.1 above.

7.3.4 The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification
- Hazard Assessment
- Risk Assessment
- Risk Evaluation

7.3.5 The hazard identification and hazard assessment is based upon the Phase 1 Desk Study which is not required as part of this investigation.

7.3.6 The risk assessment and evaluation stages are presented in this phase 2 interpretive report, after an intrusive ground investigation has taken place.

7.4 Risk Assessment – Human Health

7.4.1 The proposed development consists of domestic housing including garden areas. The risk assessment has therefore been based on guidelines for a residential end use. Should the proposed development be changed in the future then further risk assessment may be required, particularly should a more sensitive end-use be envisaged

7.4.2 The results of the soil analyses have been compared to CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, ref 9.17 and SC050021, ref 9.18, where available, and Generic Assessment Criteria (GAC), determined by LQM and CIEH, ref 9.19, as well as Assessment Criteria (AC) derived in-house using the CLEA Software Version 1.06, ref 9.20. The CLEA AC have been derived by Ian Farmer Associates in accordance with current legislation and guidance.

7.4.3 The guidance values used within this contamination assessment have been tabulated and are detailed within Appendix 5.

7.4.4 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 9.21.

7.4.5 Where the concentrations determined on site are at or below the respective Guidance Level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated. Those contaminants with observed concentrations above the Guidance Level are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
WS1	0.20	Vanadium	200	75
WS3	0.20	Vanadium	130	75
WS1	0.20	Benzo(a)pyrene	1.3	0.94

7.4.6 As can be seen from the tabulated results, Certificate No's 14-01610, in Appendix 4, the above elevated levels are to be found within the Made Ground Deposits where as in the underlying glacial till all determinants were significantly below the generic guidance values and therefore for the proposed development, the glacial till deposit can be considered not to be contaminated.

7.4.7 Only two samples of Made Ground were tested and both were found with elevated concentration of two contaminant above the Guidance Level however, further statistical analysis of the results has not been conducted due insufficient data. It can be therefore be assumed that the Made Ground is a contaminated material and should be removed from site.

7.5 Risk Assessment - Controlled Waters

7.5.1 The site is located on a Secondary A aquifer namely the underlying bedrock, is not within a groundwater source protection zone and there are no groundwater abstractions within 1km of the site, the closest is located 6km from the site at Cleadon.

7.5.2 The nearest surface watercourse is the Monkton Burn located approximately 130m to the east of the site.

7.5.3 An initial assessment of the risk to controlled waters has been carried out on the basis of the leachate results. The leachate results have been screened against the Water Supply (Water Quality) Regulations 2000, ref. 9.25, either the UK Drinking Water Quality Standards (DWQS) or the Environmental Quality Standards (EQS).

7.5.4 The relevant DWQS/EQS values are tabulated below together with the leachate test results:

Determinant	UK DWQS (µg/l)	Leachate Test Results (µg/l) Values Recorded
Arsenic	10	<0.16
Cadmium	5	<0.03
Chromium	50	<0.25
Copper	2000	6.60
Lead	10	0.09

Determinant	UK DWQS (µg/l)	Leachate Test Results (µg/l) Values Recorded
Mercury	1	<0.01
Nickel	50	0.70
Selenium	10	<0.25
Zinc	5000	16.7
Cyanide	50	<40
Benzo (a) pyrene	0.01	<0.01
PAH Total	0.1	0.75
Phenol	0.5	<0.5
Hardness	N/A	19.2

7.5.5 An initial assessment of the risk to controlled waters has been conducted on the basis of the leachate test results. The leachate results have been screened against the freshwater Environmental Quality Standards (EQS), ref. 9.26.

7.5.6 The results indicate that all the determinants, with the exception of PAH, were below the guidance values.

7.5.7 The above results show the total leachable PAH to be *slightly elevated* but not significantly so. It should be noted that the leachable benzo(a)pyrene was below the guidance value.

7.5.8 The total PAH concentration within the soils was generally found to be low with a maximum value of 17mg/kg determined for the Made Ground in WS1.

7.5.9 As previously indicated there are no groundwater abstractions within 1km of the site and the nearest surface watercourse is the Monkton Burn located approximately 130m to the east of the site.

7.5.10 It is considered that the risk of potential leachate migration of PAH off the site or vertically into the underlying aquifer to be *very low*. Also bearing in mind the low levels of PAH recorded and the horizontal and vertical distances over which migration would be required to occur to impinge on the aquatic environment it is concluded that a complete 'source – pathway – receptor' pollutant linkage does not exist and no remediation is required in respect to the PAH.

7.5.11 If the Made Ground were removed from site then the source of the PAH would be removed and there would be no potential risk to the aquatic environment.

7.5.12 It is recommended that the Environment Agency be consulted with regard to the significance of these results, particularly in light of the fact that there is no current guideline TPH parameter within the Water Supply Regulations 2000.

7.5.13 Given the ground conditions encountered at the site and the results of this contamination assessment, it is considered unlikely that further assessment of the risks to controlled waters may be required.

7.6 Gas Generation

7.6.1 Landfill gases are known to be produced at an historic landfill site at Burnside some 800m to the east of the site. Control measures are known to be in place.

7.6.2 Gas monitoring visits were undertaken on three subsequent visits to the site to date between 27th March and 7th April 2014, as detailed within Appendix 6, Figure A6.1.

7.6.3 A summary of these reading are given in the Table below:

	Date					
	27/03/2014	02/04/2014	07/04/2014			
BH No	Carbon Dioxide %v/v					
WS1	0.2	0.6	ND			
WS2	0.2	0.2	ND			
WS3	0.2	2.1	2.6			

7.6.4 The results of initial gas monitoring determined the absence of methane but the presence of carbon dioxide up to 2.1%v/v with no flow rate established. On the basis of these readings, remedial measures are unlikely to be required, see Appendix 6.

7.6.5 A further three sets of readings will be taken to confirm these findings.

7.7 Protection of Services

7.7.1 Guidance from the UKWIR, ref 9.27, sets out the material requirements for newly laid water supply pipes within Brownfield sites. However, the exact requirements should be clarified with the relevant local water utility supplier for the site.

7.7.2 An assessment of the contamination testing has been undertaken, which indicates no elevated levels of contaminants are present above UKWIR guidelines within the natural glacial till and therefore there are no specialist material requirements for newly laid water pipes within this deposit.

7.7.3 It would not be advisable to install such pipes within the Made Ground.

7.8 Risk Evaluation

7.8.1 A conceptual model to reflect the findings of the contamination risk assessment and detailing the relevant pollutant linkages, is tabulated below:

Source	Potential Pathways	Receptor Group
Made Ground (human health)	• Ingestion of contaminated soil by direct contact. • Ingestion of contaminants through vegetables. • Entry of contaminants by skin or eye contact with contaminated soils or dust. • Inhalation of contaminated dust.	Humans • Site occupants[1] • Site users[1] • Construction workers[2] • Maintenance workers[1] • Neighbouring site users[2]
Made Ground (flora and fauna)	• Direct uptake and accumulation of contaminants.	Flora and Fauna • Landscaped areas • Protected areas
Made Ground (buildings)	• Direct contact of contaminants with building materials.	Building Materials and Services • Plastic pipes and services
[1] – Assumes no remediation is undertaken [2] – Pathway exists only during the construction period		

7.9 Summary of Risk Evaluation

7.9.1 The above assessment identifies that the 'source – pathway – receptor' linkage potentially occurs with Made Ground impacting upon the identified receptors. Therefore, it would be necessary to manage the risk at this location by either eliminating one of the links or by minimising the potential effects.

7.9.2 Made Ground although thin is found to be extensive across the site.

7.10 Waste

7.10.1 An initial assessment of the likely waste classification for any material to be disposed of has been conducted on the basis of the chemical test results obtained as part of the contamination risk assessment.

7.10.2 This assessment has been conducted using the HazWasteOnline^{tm} tool, ref. 9.28, the summary output sheet from which is included within Appendix 4, Figure A4.1. A full copy of the output can be provided if required.

7.10.3 This initial assessment indicates that the majority of the Made Ground and underlying glacial till can be classified as non-hazardous waste.

7.10.4 However a sample of Made Ground from borehole WS3 at 0.2mbgl has been classified as hazardous due to the high concentrations of zinc and copper. This hot spot will need to be extracted from site and removed to a special waste tipping facility.

8.0 MANAGEMENT OF CONTAMINATION

8.1 Remediation and Verification

8.1.1 The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, ref. 9.29, is applicable to the redevelopment of sites that may be affected by contamination.

8.1.2 The risk management process set out in the Model Procedures has three main components:

- Risk assessment
- Options appraisal
- Implementation

8.1.3 This initial risk assessment has identified the presence of elevated vanadium and benzo(a)pyrene as well as elevated zinc and copper concentrations within the Made Ground. across the site, plus elevated leachate results. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.

8.1.4 The remediation strategy will need to review methods of reducing or controlling the identified unacceptable risks. This could be done by removing or treating the source of contamination, removing or modifying the pathway or removing or modifying the behaviour of the receptor, to ensure there is no significant risk of significant harm to either human health or controlled waters from the identified contamination, in relation to the proposed end use.

8.1.5 An important part of the risk management process is identifying and informing all stakeholders with an interest in the outcome of the risk management project. To this end, if the regulators have not yet been contacted with regard to the redevelopment of this site, it is recommended that they be supplied with a copy of this Phase 2 Ground Investigation report in order to enable liaison to be undertaken with them.

8.1.6 Following liaison with the relevant regulatory bodies, a remediation strategy could be formulated, which should incorporate an options appraisal and summarise in detail the chosen remedial approach, along with the verification proposals. The remediation strategy should then be approved by the relevant regulatory authorities prior to implementation.

8.1.7 Where remediation is required, a verification report will need to be formulated following implementation of the remediation strategy, which should provide a complete record of all remedial activities conducted on site and include all the data obtained to support the remedial objectives and demonstrate that the remediation has been effective. Any unexpected conditions encountered during the remedial works should also be detailed within the verification report.

8.1.8 A number of potential remedial options for dealing with the contamination identified at this site, by removing the contamination source.

8.1.9 In areas that are to be covered by buildings or hard standing, no pathway is likely to exist between any source of contamination and the human receptors by ingestion or dermal contact, therefore no further remedial action is likely to be required.

8.1.10 Removal of the Made Ground from areas of gardens or areas likely to be used for the growing of vegetables/fruit for consumption.

8.1.11 Alternatively, a capping layer of 'inert' material could be provided to break the pathway between the identified contamination and end users of the site. The required thickness of the capping layer could be determined using guidance provided by the BRE, ref 9.30.

8.1.12 In order to minimise the impact on future maintenance workers, where services are to be placed at a depth that puts them at or below the level of the source of contamination, it would be prudent to line the trenches and surround the services with clean inert material

8.1.13 The results of initial gas monitoring determined the presence of carbon dioxide of up to 2.6%v/v with no flow rate recorded.

8.1.14 On the basis of the levels of carbon dioxide, an initial screening puts the Traffic Light into green. Table A7.4. Recommended protective measures are given in Appendix 7, section A7.9.

8.1.15 These comments are based on three sets of readings over a period of less than one month which does not follow the recommended guidelines given in Appendix 7, Table A7.1. However, these results indicate consistently low emissions/flow rates and a continued programme of monitoring be carried out to comply more closely with these guidelines before final design is undertaken.

8.2 Management of Unidentified Sources of Contamination

8.2.1 There is the possibility that other sources of contamination may be present on the site, which was not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.

- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.

- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

8.3 Consultation

8.3.1 During the development of a contaminated site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.

- **Environment Agency.** Where a site is within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.

- **National House Building Council, NHBC.** Section 4.1 of the NHBC Standards requires land management to be addressed. For a new housing development to be approved by the NHBC, any remediation will require a validation report.

8.3.2 Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

8.4 Risk Management During Site Works

8.4.1 During ground works, some simple measures may have to be put in place to mitigate the risk of contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.

- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.

- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.

- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.

8.4.2 Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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For and on behalf of Ian Farmer Associates (1998) Limited

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APPENDIX 1

DRAWINGS

IAN FARMER ASSOCIATES

Contract: Vacant land to the rear of Belsfield Gardens, Jarrow
Contract No: 30919
Site Location Plan

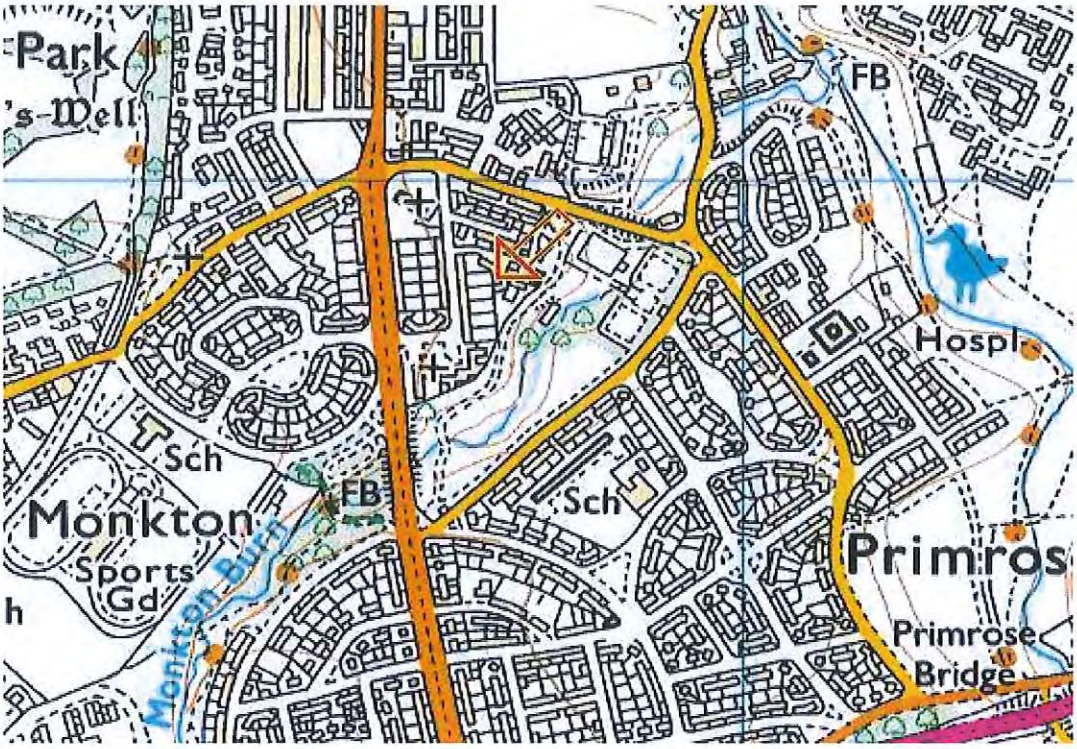
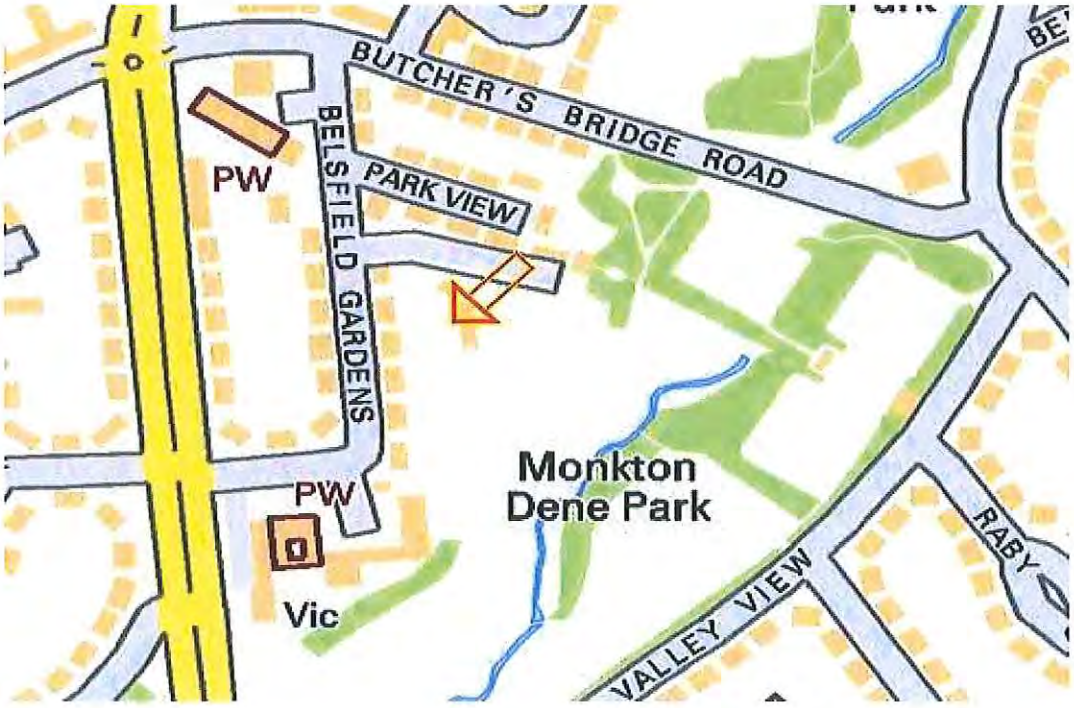


Fig. A1.1 Location plans

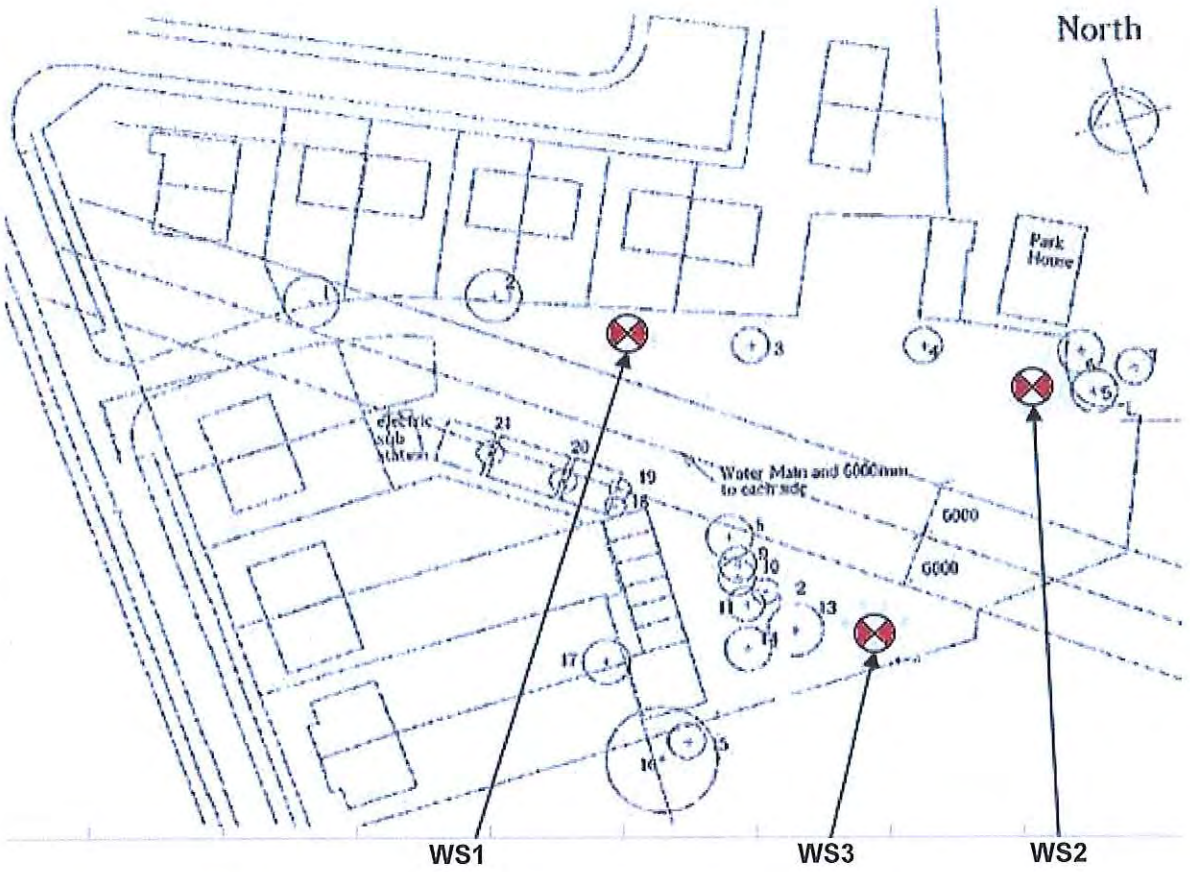


Licence No. 100031101

IAN FARMER ASSOCIATES

Contract: Vacant land to the rear of Belsfield Gardens, Jarrow
Contract No: 30919

Fig A1.3 Exploratory Hole Location Plan



APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 Drive-in Window Sampler

The drive-in window sampler, ref 9.5, consists generally of a track mounted window sampler and a series of cylindrical sample tubes, generally varying in diameter from 98mm to 35mm. A cutting shoe is fitted to the bottom of each tube, while a window, representing about a quarter of the circumference, is cut along the length of the tube. Soil samples are extracted through the window of the tube.

The borehole is extended by using progressively smaller diameter tubes.

Alternatively, undisturbed samples may be collected in plastic liners, known as *windowless sampling*.

A2.2 IN-SITU TESTS

A2.2.1 Standard Penetration Test

The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref 9.4, BS 1377, Part 9, 1990 ref 9.6.

The standard penetration test, **SPT**, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone replacing the split spoon sampler, **CPT.**

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of

300mm is achieved. The penetration for 50 blows is recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.

- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.

- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

A2.3 SAMPLES

B represents large bulk disturbed samples

D represents small disturbed sample

C represents environmental/chemical sample

W represents water sample

▽ respresents water strike

▼ represents level to which water rose

A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref **Error! Reference source not found.**, supplemented by section 6 of BS 5930, ref. 9.3 have been used in the soil descriptions contained within this report.

IAN FARMER ASSOCIATES

Site	Number
Vacant Land to the Rear of Belesfield Gardens	WS1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Mr David Marshall	30919
	Location	**Dates** 13/03/2014	**Engineer** BW Architecture	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					0.02	MADE GROUND: Tarmacadam.			
0.20	C1				(0.33)	MADE GROUND: Brown sandy GRAVEL with low cobble content of concrete. Gravel is fine to coarse angular to subrounded concrete, tarmacadam, clinker, brick, slag, siltstone and sandstone.			
0.50	C2				0.35	Stiff mottled brown and grey slightly sandy slightly gravelly CLAY with occasional sand lenses. Gravel is fine to coarse subangular to rounded of sandstone, siltstone, coal, limestone and mudstone.			
0.70-1.00	B3								
1.00-1.45	SPT N=20	DRY	2,3/4,5,5,6						
1.00-1.45	D4								
1.00-2.00	B5					By 1.70m: Locally very stiff.			
2.00-2.45	SPT N=27	DRY	3,4/5,7,7,8						
2.00-2.45	D6								
2.00-3.00	B7				(4.65)				
3.00-3.45	SPT N=29	DRY	3,4/6,7,8,8						
3.00-3.45	D8								
3.00-4.00	B9								
4.00-4.45	SPT N=29	DRY	3,5/6,7,8,8						
4.00-4.45	D10					By 4.10m: Brown. Locally hard and locally thinly laminated.			
4.00-5.00	B11	DRY			5.00				

Remarks
Inspection pit dug to 1.20m - no services encountered.
No groundwater observed.
Slotted standpipe installed to 4.00m.

Scale (approx)	Logged By
1:25	CH

Figure No. 30919.WS1

IAN FARMER ASSOCIATES

Site	Number
Vacant Land to the Rear of Belesfield Gardens	WS2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Mr David Marshall	30919
	Location	**Dates** 13/03/2014	**Engineer** BW Architecture	**Sheet** 1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.10) 0.10	MADE GROUND: Dark brown slightly sandy slightly gravelly very clayey TOPSOIL with many roots and rootlets. Gravel is fine to coarse angular to subrounded concrete, tarmacadam, glass, tile, brick, wood, plastic, sandstone and siltstone.			
					(0.35) 0.45	MADE GROUND: Grey clayey very gravelly fine to coarse SAND with some clay lenses, occasional roots and rootlets and medium cobble content of siltstone and concrete. Gravel is fine to coarse angular to subrounded clinker, brick, slag, burnt shale, siltstone and tarmacadam.			
0.50	C1								
0.70-1.00	B2					Stiff mottled brown and grey slightly sandy slightly gravelly CLAY with occasional sand lenses. Gravel is fine to coarse subangular to rounded sandstone, siltstone, coal, limestone and mudstone.			
1.00-1.45	SPT N=23	DRY	2,3/4,6,6,7						
1.00-1.45	D3								
1.00-2.00	B4								
2.00-2.45	SPT N=26	DRY	3,4/6,6,7,7						
2.00-2.45	D5								
2.00-3.00	B6					From 2.40m to 3.00m: Additional granite gravel.			
					(4.50)				
3.00-3.45	SPT N=23	DRY	3,4/5,5,6,7						
3.00-3.45	D7								
3.00-4.00	B8					By 3.10m: Brown. Locally very stiff.			
4.00-4.45	SPT N=23	DRY	3,4/4,6,6,7						
4.00-4.45	D9								
4.00-5.00	B10	DRY				Locally thinly laminated.			
					4.95				

Remarks
Inspection pit dug to 1.20m - no services encountered.
No groundwater observed.
Slotted standpipe installed to 4.00m.

Scale (approx)	Logged By
1:25	CH

Figure No. 30919.WS2

IAN FARMER ASSOCIATES

Site	Number
Vacant Land to the Rear of Belesfield Gardens	WS2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Mr David Marshall	30919
	Location	**Dates** 13/03/2014	**Engineer** BW Architecture	**Sheet** 2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					5.00	Very stiff grey thinly laminated CLAY.			
						Complete at 5.00m			

Remarks

Scale (approx)	Logged By
1:25	CH

Figure No. 30919.WS2

IAN FARMER ASSOCIATES

Site	Number
Vacant Land to the Rear of Belesfield Gardens	WS3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Mr David Marshall	30919
	Location	**Dates** 13/03/2014	**Engineer** BW Architecture	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					0.05				
					(0.25)	MADE GROUND: Dark brown slightly sandy slightly gravelly very clayey TOPSOIL with many roots and rootlets. Gravel is fine to coarse angular to subrounded concrete, tarmacadam, glass, tile, brick, wood, plastic, sandstone and siltstone.			
0.20	C1				0.30				
0.50	C2					MADE GROUND: Grey clayey very gravelly fine to coarse SAND with some clay lenses and occasional roots and rootlets. Gravel is fine to coarse angular to subrounded clinker, brick, slag, burnt shale, siltstone and tarmacadam.		
0.70-1.00	B3								
1.00-1.45	SPT N=18	DRY	2,3/3,4,5,6			Stiff mottled brown and grey slightly sandy slightly gravelly CLAY with occasional sand lenses. Gravel is fine to coarse subangular to rounded sandstone, siltstone, coal, limestone amd mudstone.			
1.00-1.45	D4					By 1.20m: Brown. Locally very stiff.			
1.00-2.00	B5					By 1.95m: Low cobble content of sandstone.			
						By 2.30m: Locally thinly laminated.			
2.00-2.45	SPT N=24	DRY	4,5/5,6,6,7						
2.00-2.45	D6								
2.00-3.00	B7								
					(4.70)				
						From 2.80 to 3.50m: Additional granite gravel.			
3.00-3.45	SPT N=21	DRY	3,4/4,5,6,6						
3.00-3.45	D8								
3.00-4.00	B9								
4.00-4.45	SPT N=31	DRY	4,5/6,8,8,9			By 4.00m: Very stiff.			
4.00-4.45	D10								
4.00-5.00	B11	DRY							
					5.00	Complete at 5.00m			

Remarks
Inspection pit dug to 1.20m - no services encountered.
No groundwater observed.
Slotted standpipe installed to 4.00m.

Scale (approx)	Logged By
1:50	CH

Figure No. 30919.WS3

APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are as below:

Test	British Standard Reference	Notes
Moisture Content	BS 1377: Part 2: Clause 3.2	For comparison with Atterberg limits (if required) the measured moisture content would have to be corrected to give the equivalent moisture content of the fraction passing the 425 micron sieve.
Atterberg Limits	BS 1377: Part 2: Clause 4.3	The plastic limit was determined for the same samples using the definitive method detailed in Clause 5.3. The samples were wet sieved in accordance with Clause 4.2.4 (marked with 's' in Table 1 of the results).
Water Soluble Sulphate in soil	BS 1377: Part 3: Clause 5.5	The samples prepared in accordance with Clause 5.3.
pH	BS 1377: Part 3: Clause 9.5	Samples prepared in accordance with Clause 9.4.

A3.2 SOIL CLASSIFICATION

A3.2.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.2.2 This line is defined from experimental evidence and does not represent a well defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.2.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90

Extremely High Plasticity (E) LL greater than 90

A3.2.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

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Unit 4 Faraday Close
Washington
Tyne and Wear
NE38 8QJ

F.A.O. Mr Steve Jackson

TEST REPORT - 30919/1

Site :	Belesfield Gardens
Job Number :	30919
Originating Client :	BW Architecture
Originating Reference :	30919
Date Sampled :	Not Given
Date Scheduled :	18/03/2014
Date Testing Started :	02/04/14
Date Testing Finished :	07/04/14
Remarks :	• First Report for above Job Number • Samples will be disposed of 28 days after the report is issued unless otherwise agreed • This report may contain results from tests which are not included within the scope of the UKAS accreditation. Please see final sheet for details.

Authorised By: D. Smith Daniel Smith

Position : Laboratory Supervisor Date : 07/04/14

IAN FARMER ASSOCIATES

Laboratory Test Report - 30919/1

Site : Belesfield Gardens

Client : BW Architecture

Job Number 30919

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Moisture Content %						
WS1	0.70	B3	Natural	16	94	17	40	16	24	0.04	CI	Brown sandy gravelly CLAY
WS1	2.00	B7	Natural	14	85	15	35	15	20	0.00	CL/CI	Brown sandy gravelly CLAY
WS2	1.00	B4	Natural	15	92	16	39	16	23	0.00	CI	Brown sandy gravelly CLAY
WS2	3.00	B8	Natural	12	92	13	42	18	24	-0.21	CI	Brown sandy gravelly CLAY
WS3	4.00	B11	Natural	13	91	14	36	15	21	-0.05	CI	Brown sandy gravelly CLAY

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3.2 Determination of moisture content 4.3 Determination of the liquid limit 5.3 Determination of the plastic limit and plasticity index

IAN FARMER ASSOCIATES

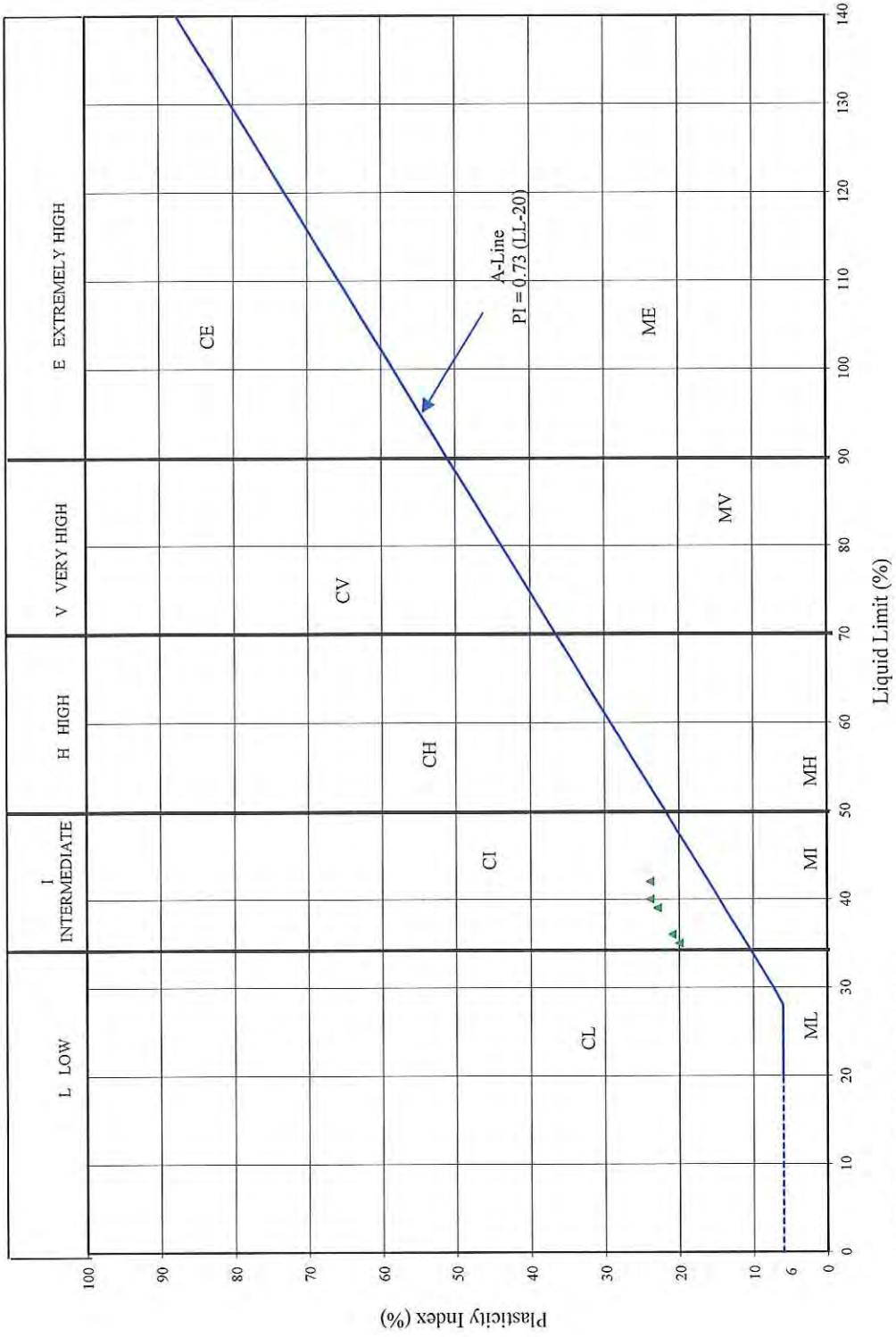
Test Report : **30919/1**

Site : Belesfield Gardens
Job Number : 30919
Originating Client : BW Architecture

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

The following tests contained within this report are not UKAS Accredited.

Date of Issued : 07/04/14



IAN FARMER ASSOCIATES	**PLASTICITY CLASSIFICATION CHART**	**Contract No. 30919**
	Site:Vacant land to the rear of Belsfield Gardens, Jarr	**Figure No. A3.1**

APPENDIX 4

CHEMICAL TESTS

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 14-01610

26-Mar-14

Client Ian Farmer Associates
Unit 1
Bamburgh Court
Team Valley
Gateshead
Tyne & Wear
NE11 0TX

Our Reference 14-01610

Client Reference 30919

Contract Title Belesfield Gardens

Description 7 Soil samples, 1 Leachate sample.

Date Received 18-Mar-14

Date Started 18-Mar-14

Date Completed 26-Mar-14

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS 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. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

MCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2139

Summary of Chemical Analysis
Matrix Descriptions

Our Ref 14-01610
Client Ref 30919
Contract Title Belesfield Gardens

Sample ID	Other ID	Depth	Lab No	Completed	Matrix Description
WS1	1	0.2	622188		Dark brown gravelly SAND (made ground includes brick)
WS1	2	0.5	622189		Brown gravelly sandy CLAY
WS2	1	0.5	622190		Brown gravelly sandy CLAY
WS3	1	0.2	622191		Dark brown clayey gravelly SAND
WS3	2	0.5	622192		Brown gravelly sandy CLAY
WS1	4	1.00-1.45	622193		Brown gravelly sandy CLAY
WS2	3	1.00-1.45	622194		Brown gravelly sandy CLAY

Summary of Chemical Analysis
Soil Samples

Our Ref 14-01610
Client Ref 30919
Contract Title Belesfield Gardens

			Lab No	622188	622189	622190	622191	622192	622193	622194
			Sample ID	WS1	WS1	WS2	WS3	WS3	WS1	WS2
			Depth	0.20	0.50	0.50	0.20	0.50	1.00-1.45	1.00-1.45
			Other ID	1	2	1	1	2	4	3
			Sample Type	C	C	C	C	C	D	D
			Sampling Date	13/03/14	13/03/14	13/03/14	13/03/14	13/03/14	13/03/14	13/03/14
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Metals										
Arsenic	DETSC2301#	0.2	mg/kg	12	7.4	7.2	20	6.0		
Beryllium	DETSC2301#	0.2	mg/kg	2.1	1.5	1.2	2.4	1.1		
Boron (water soluble)	DETSC2123#	0.2	mg/kg	2.3	1.7	1.7	2.2	1.5		
Cadmium	DETSC2301#	0.1	mg/kg	0.3	0.4	0.4	2.4	0.4		
Chromium	DETSC2301#	0.15	mg/kg	92	53	45	39	42		
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
Copper	DETSC2301#	0.2	mg/kg	37	20	20	1100	20		
Lead	DETSC2301#	0.3	mg/kg	72	32	21	260	15		
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		
Nickel	DETSC2301#	1	mg/kg	17	38	43	90	32		
Selenium	DETSC2301#	0.5	mg/kg	1.6	< 0.5	0.5	< 0.5	< 0.5		
Vanadium	DETSC2301	0.8	mg/kg	200	56	46	130	45		
Zinc	DETSC2301#	1	mg/kg	60	60	56	860	51		
Inorganics										
pH	DETSC 2008#			11.4	8.1	8.4	8.5	8.5	8.5	8.6
Cyanide total	DETSC 2130#	0.1	mg/kg	< 0.1	< 0.1	< 0.1	0.1	< 0.1		
Organic matter	DETSC 2002#	0.1	%	4.9	1.9	2.3	6.4	2.3		
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	230	190	73	63	27	95	46
PAHs										
Acenaphthene	DETSC 3301	0.1	mg/kg	0.4	< 0.1	< 0.1	< 0.1	< 0.1		
Acenaphthylene	DETSC 3301	0.1	mg/kg	0.3	< 0.1	< 0.1	< 0.1	< 0.1		
Anthracene	DETSC 3301	0.1	mg/kg	0.3	< 0.1	< 0.1	< 0.1	< 0.1		
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	0.9	< 0.1	< 0.1	< 0.1	< 0.1		
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	1.3	< 0.1	< 0.1	< 0.1	< 0.1		
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	1.0	< 0.1	< 0.1	< 0.1	< 0.1		
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	0.4	< 0.1	< 0.1	< 0.1	< 0.1		
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	1.8	< 0.1	< 0.1	< 0.1	< 0.1		
Chrysene	DETSC 3301	0.1	mg/kg	2.0	< 0.1	< 0.1	< 0.1	< 0.1		
Dibenzo(a,h)anthracene	DESTC 3301	0.1	mg/kg	0.3	< 0.1	< 0.1	< 0.1	< 0.1		
Fluoranthene	DETSC 3301	0.1	mg/kg	2.5	< 0.1	< 0.1	0.3	< 0.1		
Fluorene	DETSC 3301	0.1	mg/kg	0.2	< 0.1	< 0.1	< 0.1	< 0.1		
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	1.7	< 0.1	< 0.1	< 0.1	< 0.1		
Naphthalene	DETSC 3301	0.1	mg/kg	0.3	< 0.1	< 0.1	< 0.1	< 0.1		
Phenanthrene	DETSC 3301	0.1	mg/kg	0.5	< 0.1	< 0.1	< 0.1	< 0.1		
Pyrene	DETSC 3301	0.1	mg/kg	2.8	< 0.1	< 0.1	0.2	< 0.1		
PAH	DETSC 3301	1.6	mg/kg	17	< 1.6	< 1.6	< 1.6	< 1.6		
Phenols										
Phenol - Monohydric	DETSC 2130#	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3		

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Leachate Samples

Our Ref 14-01610
Client Ref 30919
Contract Title Belesfield Gardens

Lab No	622195
Sample ID	WS3
Depth	0.50
Other ID	2
Sample Type	C
Sampling Date	13/03/14
Sampling Time	n/s

Test	Method	LOD	Units	
Preparation				
NRA Leachate Preparation	DETS 036*			Y
Metals				
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	< 0.16
Beryllium, Dissolved	DETSC 2306*	0.1	ug/l	< 0.1
Boron	DETSC2123	100	ug/l	310
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	< 0.03
Chromium, Dissolved	DETSC 2306	0.25	ug/l	< 0.25
Hexavalent Chromium	DETSC 2203	10	ug/l	< 10
Copper, Dissolved	DETSC 2306	0.4	ug/l	6.6
Lead, Dissolved	DETSC 2306	0.09	ug/l	0.09
Mercury, Dissolved	DETSC 2306	0.01	ug/l	< 0.01
Nickel, Dissolved	DETSC 2306	0.5	ug/l	0.7
Selenium, Dissolved	DETSC 2306	0.25	ug/l	< 0.25
Vanadium, Dissolved	DETSC 2306	0.6	ug/l	< 0.6
Zinc, Dissolved	DETSC 2306	1.25	ug/l	16.7
Inorganics				
pH	DETSC 2008			8.7
Cyanide total	DETSC 2130	40	ug/l	< 40
Hardness	DETSC 2303*	0.1	mg/l	19.2
PAHs				
Acenaphthene	DETS 074*	0.01	ug/l	< 0.01
Acenaphthylene	DETS 074*	0.01	ug/l	< 0.01
Anthracene	DETS 074*	0.01	ug/l	0.05
Benzo(a)anthracene	DETS 074*	0.01	ug/l	< 0.01
Benzo(a)pyrene	DETS 074*	0.01	ug/l	< 0.01
Benzo(b)fluoranthene	DETS 074*	0.01	ug/l	< 0.01
Benzo(k)fluoranthene	DETS 074*	0.01	ug/l	< 0.01
Benzo(g,h,i)perylene	DETS 074*	0.01	ug/l	< 0.01
Chrysene	DETS 074*	0.01	ug/l	< 0.01
Dibenzo(a,h)anthracene	DETS 074*	0.01	ug/l	< 0.01
Fluoranthene	DETS 074*	0.01	ug/l	0.10
Fluorene	DETS 074*	0.01	ug/l	0.02
Indeno(1,2,3-c,d)pyrene	DETS 074*	0.01	ug/l	< 0.01
Naphthalene	DETS 074*	0.01	ug/l	0.19
Phenanthrene	DETS 074*	0.01	ug/l	0.27
Pyrene	DETS 074*	0.01	ug/l	0.11
PAH	DETS 074*	0.2	ug/l	0.75
Phenols				
Phenol	DETS 079*	0.5	ug/l	< 0.50

Key: * -not accredited. n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 14-01610
Client Ref 30919
Contract Belesfield Gardens

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
622188	WS1 0.20 SOIL	13/03/14	GJ 1L (1L), GJ 60ml (60ml), PT 1L (1kg)		
622189	WS1 0.50 SOIL	13/03/14	GJ 1L (1L), GJ 60ml (60ml), PT 1L (1kg)		
622190	WS2 0.50 SOIL	13/03/14	GJ 1L (1L), GJ 60ml (60ml), PT 1L (1kg)		
622191	WS3 0.20 SOIL	13/03/14	GJ 1L (1L), GJ 60ml (60ml), PT 1L (1kg)		
622192	WS3 0.50 SOIL	13/03/14	GJ 1L (1L), GJ 60ml (60ml), PT 1L (1kg)		
622193	WS1 1.00-1.45 SOIL	13/03/14	PT 1L (1kg)		
622194	WS2 1.00-1.45 SOIL	13/03/14	PT 1L (1kg)		
622195	WS3 0.50 LEACHATE	13/03/14	GJ 1L (1L)		

Key: G-Glass P-Plastic J-Jar T-Tub

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 and/or inappropriate containers 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.

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

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETSC 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETSC 2076	Sulphate Aqueous Extract as SO4	mg/l	10	Air Dried	No	Yes	Yes
DETSC 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate as SO4	%	0.01	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETSC2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETSC2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETSC2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETSC2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETSC2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETSC2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETSC2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETSC 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

Job name

Belesfield Gardens

Waste stream

Default Contaminated Land

Comments

Report

Created by: Challinor, Peter
Created date: 14/04/2014 14:28

Job summary

#	Sample name	Depth	Classification result	Hazardous properties
1	WS1	0.2	Non Hazardous	
2	WS1[1]	0.5	Non Hazardous	
3	WS2	0.5	Non Hazardous	
4	WS3	0.2	Hazardous	H7, H14
5	WS3[1]	0.5	Non Hazardous	
6	WS1[2]	1	Non Hazardous	
7	WS2[1]	1	Non Hazardous	

Classification

Hazardous Waste
Classified as **17 05 03 ***
in the European Waste Catalogue 2002

Classified by

Name:
Challinor, Peter
Date:
14/04/2014 14:27
Telephone:
024 7630 3422

Company:
Ian Farmer Associates
1 Fairfield Court, Seven Stars Industrial Estate
Coventy
CV3 4LJ

Sample details

Sample Name:
WS3
Site:

Project:

Sample Depth:
0.2 m
Dry Weight Moisture Content:
0%
Comments:

EWC 2002 code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 03 * (Soil and stones containing dangerous substances)

Hazard properties

H7: Carcinogenic "substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence."

Risk phrases hit:

R45 "May cause cancer"

Because of determinand:

Zinc chromate: (compound conc.:0.239%)

H14: Ecotoxic "waste which presents or may present immediate or delayed risks for one or more sectors of the environment."

Risk phrases hit:

R50/53 "Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment"

Because of determinands:

Copper (I) oxide: (compound conc.:0.124%)
Zinc chromate: (compound conc.:0.239%)

Additional: Additional Risk Phrases "This is an additional risk phrase and such a risk phrases alone will not cause a waste to be hazardous."

Risk phrases hit:

R14 "Reacts violently with water"

Because of determinand:

Boron tribromide/trichloride/trifluoride (combined risk phrases): (compound conc.:0.00295%)

R33 "Danger of cumulative effects"

Because of determinand:

Lead chromate: (compound conc.:0.0406%)

Determinands (Dry Weight Moisture Content: 0%)

Acenaphthene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Acenaphthylene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Anthracene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Arsenic trioxide: (Cation conc. entered: 20 mg/kg, converted to compound conc.:26.407 mg/kg or 0.00264%)
Benzo[a]anthracene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Benzo[a]pyrene; benzo[def]chrysene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Benzo[b]fluoranthene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Benzo[ghi]perylene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Benzo[k]fluoranthene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
beryllium oxide: (Cation conc. entered: 2.4 mg/kg, converted to compound conc.:6.661 mg/kg or 0.000666%)
Boron tribromide/trichloride/trifluoride (combined risk phrases): (Cation conc. entered: 2.2 mg/kg, converted to compound conc.:29.546 mg/kg or 0.00295%)
Cadmium sulphide: (Cation conc. entered: 2.4 mg/kg, converted to compound conc.:3.085 mg/kg or 0.000308%, "Note 1" conc.: 0.00024%)
Chromium(VI) oxide: (Cation conc. entered: <1 mg/kg, converted to compound conc.:<1.923 mg/kg or <0.000192%) IGNORED Because: "<LOD"
Chrysene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Copper (I) oxide: (Cation conc. entered: 1100 mg/kg, converted to compound conc.:1238.477 mg/kg or 0.124%)
Cyanides (with the exception of complex cyanides): (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Dibenz[a,h]anthracene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Fluoranthene: (Whole concentration entered as: 0.3 mg/kg or 0.00003%)
Fluorene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Indeno[123-cd]pyrene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Lead chromate: (Cation conc. entered: 260 mg/kg, converted to compound conc.:405.552 mg/kg or 0.0406%, "Note 1" conc.: 0.026%)
Mercury dichloride: (Cation conc. entered: <0.05 mg/kg, converted to compound conc.:<0.0677 mg/kg or <0.00000677%) IGNORED Because: "<LOD"
Naphthalene: (Whole concentration entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Nickel dihydroxide: (Cation conc. entered: 90 mg/kg, converted to compound conc.:142.155 mg/kg or 0.0142%)
pH: (Whole concentration entered as: 8.5 pH or 8.5 pH)
Phenol: (Whole concentration entered as: <0.3 mg/kg or <0.00003%) IGNORED Because: "<LOD"
Pyrene: (Whole concentration entered as: 0.2 mg/kg or 0.00002%)
Selenium compounds (with the exception of cadmium sulphoselenide and sodium selenite): (Cation conc. entered: <0.5 mg/kg, converted to compound conc.:<0.75 mg/kg or <0.000075%) IGNORED Because: "<LOD"
Zinc chromate: (Cation conc. entered: 860 mg/kg, converted to compound conc.:2385.766 mg/kg or 0.239%)

User Defined and non CLP Substances

Acenaphthene (CAS Number: 83-32-9)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=133563&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, N; R51/53, R36, R37, R38

Acenaphthylene (CAS Number: 208-96-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=59285&HarmOnly=no
Data source date: 16/07/2012
Classification: R22, R26, R27, R36, R37, R38

Anthracene (CAS Number: 120-12-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=101102&HarmOnly=no
Data source date: 08/03/2013
Classification: N; R50/53, R36, R37, R38, R43

Benzo[ghi]perylene (CAS Number: 191-24-2)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=15793&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53

Boron tribromide/trichloride/trifluoride (combined risk phrases)

Comments: Combines the risk phrases and the average of the conversion factors for Boron tribromide, Boron trichloride and Boron trifluoride
Data source: N/A
Data source date: 10/01/2011
Classification: T+; R26/28, C; R34, C; R35, R14

Fluoranthene (CAS Number: 206-44-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=56375&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R20, R22, R36

Fluorene (CAS Number: 86-73-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=81845&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R53

Indeno[123-cd]pyrene (CAS Number: 193-39-5)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=128806&HarmOnly=no
Data source date: 08/03/2013
Classification: R40

pH

Comments: Appendix C, C4.5
Data source: WM2 - Interpretation of the definition and classification of hazardous waste (Second Edition, version2.2), Environment Agency
Data source date: 30/05/2008
Classification: pH; pH

Pyrene (CAS Number: 129-00-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=87484&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R23

Notes utilised in assessment

Additional Risk Phrase Comments
from section: Table 2.2 in the document: "WM2 - Hazardous Waste Technical Guidance"
"This is an additional risk phrase and such a risk phrase alone will not cause a waste to be hazardous."

Note used on:

Test: "Additional on R14" for determinand: "Boron tribromide/trichloride/trifluoride (combined risk phrases)"
Test: "Additional on R33" for determinand: "Lead chromate"

C14.3: Step 4
from section: C14.3 in the document: "WM2 - Hazardous Waste Technical Guidance"
"identify whether any individual ecotoxic substance is present below a cut-off value shown in Table C14.1"

Note used on:

Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Cadmium sulphide"
Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Arsenic trioxide"
Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Fluoranthene"
Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Lead chromate"
Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Nickel dihydroxide"
Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Pyrene"

C14.3: Step 5, Equation 1
from section: C14.3 in the document: "WM2 - Hazardous Waste Technical Guidance"
"...only for the substances in the waste above the relevant generic cut-off value, use the four equations given in Table C14.2 to decide if the waste is hazardous by H14"

Note used on:

Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Copper (I) oxide"
Test: "H14 on R50, R52, R53, R50/53, R51/53, R52/53" for determinand: "Zinc chromate"

Substance notes

Note 1
from section: 1.1.3.2, Annex VI in the document: "CLP Regulations"
"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Note used on:

determinand: "Cadmium sulphide"
determinand: "Lead chromate"

Note A
from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"
"Without prejudice to Article 17(2), the name of the substance must appear on the label in the form of one of the designations given in Part 3. In Part 3, use is sometimes made of a general description such as '... compounds' or '... salts'. In this case, the supplier is required to state on the label the correct name, due account being taken of section 1.1.1.4."

Note used on:

determinand: "Zinc chromate"

Note E (Table 3.2)
from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"
"Substances with specific effects on human health (see Chapter 4 of Annex VI to Directive 67/548/EEC) that are classified as carcinogenic, mutagenic and/or toxic for reproduction in categories 1 or 2 are ascribed Note E if they are also classified as very toxic (T+), toxic (T) or harmful (Xn). For these substances, the risk phrases R20, R21, R22, R23, R24, R25, R26, R27, R28, R39, R68 (harmful), R48 and R65 and all combinations of these risk phrases shall be preceded by the word 'Also'."

Note used on:

determinand: "Arsenic trioxide"
determinand: "beryllium oxide"
determinand: "Cadmium sulphide"
determinand: "Nickel dihydroxide"
determinand: "Zinc chromate"

Version

Classification utilises the following:
WM2 - Hazardous Waste Technical Guidance, 3rd Edition, August 2013
CLP Regulations - Regulation (EC) No 1272/2008 of the European Parliament and of the Council: 16 December 2008
1st ATP - 1st Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 26 September 2009; binding date 1 Dec 2010
2nd ATP - 2nd Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 30 March 2011; binding date 1 Dec 2012 in respect of substances and 1 June 2015 in respect of mixtures
3rd ATP - 3rd Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 31 July 2012; binding date 1 Dec 2013
4th ATP - 4th Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 20 June 2013; binding date 1 Jun 2015
5th ATP - 5th Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 13 August 2013; binding date 13 Aug 2013

HazWasteOnline Engine: WM2 version 3 (Aug 2013)
HazWasteOnline Engine Version: 1.0.2429.5257 (14 Apr 2014)
HazWasteOnline Database: 1.0.2428.5256 (06 Apr 2014)

APPENDIX 5

CONTAMINATION ASSESSMENT

APPENDIX 5

GENERAL NOTES ON CONTAMINATION ASSESSMENT

A5.1 STATUTORY FRAMEWORK AND DEFINITIONS

A5.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 9.14, which was introduced by the Environment Act 1995, ref 9.15;

'Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.'

A5.1.2 The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the legislation was originally summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the final guidance document, CLR 11, ref 9.29 was published in 2004. CLR7 to 10 were withdrawn in 2008, with CLR 9 and 10 effectively replaced by the Environment Agency in the form of Science Reports SR2, ref 9.23 and SR3, ref 9.17. CLR11 remains valid and sets out the framework of the investigation process.

A5.1.3 In establishing whether a site fulfils the statutory definition of 'contaminated land' it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A5.1.4 A *'pollutant linkage'* may be defined as the link between a contaminant *'source'* and a *'receptor'* by means of a *'pathway'*.

A5.2 ASSESSMENT METHODOLOGY

A5.2.1 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A5.2.2 Stages 1 and 2 develop a *'conceptual model'* based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref 9.31. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A5.2.3 The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref 9.16. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. In the absence of specific information on contamination anticipated to be encountered, specific DoE 'Industry Profiles' provide guidance on the nature of contaminants relating to a variety of industrial processes and should be used as the basis for determining which contaminants are more likely to be present on a site.

A5.2.4 If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref 9.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a generic quantitative risk assessment (GQRA) to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A5.2.5 A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

A5.2.6 All site works should be in general accordance with the British Standards, BS 5930:2010, ref. 9.3, ISO 1997, ref 9.4 and BS 10175:2011, ref 9.2.

A5.2.7 The GQRA screens the results of the chemical analysis against generic guidance values, appropriate to the end-use of the site. Soils will be compared to Soil Guideline Values (SGV) where published, Generic Assessment Criteria (GAC) developed by LQM/CIEH, ref 9.19, or internal screening values generated using the Contaminated Land Exposure Assessment (CLEA) Software, Version 1.06, ref 9.20. Toxicological and physico-chemical/fate and transport data used to generate the AC has been derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs

   (DEFRA) documents;

2. Other documents produced by UK Government or state organisations;

3. European institution documents;

4. International organisation documents;

5. Foreign government institutions.

A5.2.8 For many of the contaminants considered, input data has been drawn from the relevant SGV where available, or existing toxicological reports published by the Environment Agency which have not yet been withdrawn/replaced. Fate and transport data has been derived in the first instance from Environment Agency (2008), ref 9.32.

A5.2.9 Recommendations for tolerable intakes of lead are based on evaluation of the relationship between exposure and blood lead levels. The existing toxicological report for lead considers a health criteria value based on an uptake dose, whereas the CLEA model estimates exposure in terms of an intake dose. At present, the CLEA model is not considered appropriate for determining a screening value for lead. In the absence of a current published assessment criterion, the SGV for lead reported in R&D Publication CLR 10 ref 9.24 have been used in this assessment. This will be updated in due course in light of any further published information.

A5.2.10 Chemical laboratory test results are processed as follows. A statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 9.21. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

A5.2.11 Initially the distribution of the data set is tested using the Shapiro-Wilk normality test, ref 9.22 to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the

mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.

A5.2.12 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

A5.2.13 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

A5.2.14 The potential receptors include:

1) Humans – current site occupants, construction workers, future site users and neighbouring site users.

2) Controlled Waters – surface water and groundwater resources

3) Plants – current and future site vegetation

4) Building materials

A5.2.15 The potential hazards to be considered in relation to contamination are:

a) Ingestion and inhalation.

b) Uptake of contaminants via cultivated vegetables.

c) Dermal contact

d) Phytotoxicity (the prevention or inhibition of plant growth)

e) Contamination of water resources

f) Chemical attack on building materials and services

g) Fire and explosion

A5.2.16 Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

A5.3 Generic Guidance Values Used Within Contamination Risk Assessment

Residential End Use

	Determinant	Guidance Value (mg/kg) 1% SOM	Guidance Value (mg/kg) 2.5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
PAH	Acenaphthene	210	480	1000	LQM CIEH GAC
	Acenaphthylene	170	400	850	
	Anthracene	2300	4900	9200	
	Benz(a)anthracene	3.1	4.7	5.9	
	Benzo(a)pyrene	0.83	0.94	1	
	Benzo(b)fluoranthene	5.6	6.5	7	
	Benzo(ghi)perylene	44	46	47	
	Benzo(k)fluoranthene	8.5	9.6	10	
	Chrysene	6	8	9.3	
	Dibenzo(ah)anthracene	0.76	0.86	0.90	
	Fluoranthene	260	460	670	
	Fluorene	160	380	780	
	Indeno(123-cd)pyrene	3.2	3.9	4.2	
	Napthalene	1.5	3.7	8.7	
	Phenanthrene	92	200	380	
	Pyrene	560	1000	1600	
Other Organics	Phenol	210	390	780	LQM CIEH GAC
Metals	Arsenic	32			EA 2009
	Beryllium	51			LQM CIEH GAC
	Boron	291			LQM CIEH GAC
	Cadmium	10			EA 2009
	Chromium (III)	3000			LQM CIEH GAC
	Chromium (VI)	4.3			LQM CIEH GAC
	Copper	2330			LQM CIEH GAC
	Lead	450			CLEA SGV 10
	Inorganic Mercury	169			EA 2009
	Nickel	130			EA 2009
	Selenium	350			EA 2009
	Vanadium	75			LQM CIEH GAC
	Zinc	3750			LQM CIEH GAC

[1] SOM – Soil Organic Matter

Generic Assessment Criteria for Petroleum Hydrocarbons

Residential	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	2.5% SOM	6% SOM	
Aliphatic				
EC 5-6	30	55	110	LQM CIEH GAC
EC >6-8	73	160	370	
EC >8-10	19	46	110	
EC >10-12	93 (48)	230 (120)	540 (280)	
EC >12-16	740 (24)	1700 (60)	3000 (140)	
EC >16-35	45000 (8.5)	64000 (21)	76000	
EC >35-44				
Aromatic				
EC 5-7 (benzene)	65	130	280	LQM CIEH GAC
EC >7-8 (toluene)	120	270	611	
EC >8-10	27	65	151	
EC >10-12	69	160	346	
EC >12-16	140	310	593	
EC >16-21	250	480	770	
EC >21-35	890	1100	1230	
EC >35-44				
Aliphatic and Aromatic				
EC >44-70	1200	1300		LQM CIEH GAC
BTEX				
Benzene	0.08	0.18	0.33	EA 2009
Toluene	120	320	610	EA 2009
Ethylbenzene	65	180	350	EA 2009
Xylenes	45	130	230	EA 2009

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC
Residential xylene screening values are based on data for p-xylene

APPENDIX 6

GAS GENERATION

APPENDIX 6

GENERAL NOTES ON GAS GENERATION

A6.1 GENERAL

A6.1.1 In the past, a series of guidance documents were published by CIRIA, ref. 9.33, providing advice on hazards associated with methane. This earlier guidance was consolidated in CIRIA Document C659 to provide a risk based approach to gas contaminated land. This was subsequently re-issued as CIRIA Document C665, ref 9.34. In 2007, British Standard, BS8485, ref 9.35, dealing with ground gas was published. It is recommended that guidance in C665 and BS8485 is adopted to provide a consistent approach in dealing with ground gas contamination, the principal details being as follows.

A6.1.2 This guidance is based on a similar approach to that for dealing with contaminated soil. The presence of hazardous gases could be deemed to be the 'source' in a 'pollutant linkage' that could lead to the conclusion that significant harm is or could be caused to people, buildings or the environment. In such circumstances the land could be deemed 'contaminated', ref. 9.14.

A6.1.3 Should a potential source of gas be identified in the conceptual model, a gas risk assessment should be carried out, sufficient to demonstrate to the local authority that the proposals mitigate any hazards associated with ground gas. The authority enforces compliance with Approved Document Part C of the Building Regulations, ref. 9.36.

A6.2 APPROACH

A6.2.1 A flow chart detailing the approach to assessing a site is given in CIRIA document C665, Figure 1.1. This may be summarised as follows.

- Carry out Phase 1 desk study, including initial conceptual model
- Assess site, potential presence of gas / potential unacceptable risk / identify further action, if necessary
- Monitor gas concentrations
- Assessment of Risk
- Recommendations / remediation
- Validation

A6.3 POLLUTANT LINKAGE ASSESSMENT

A6.3.1 A pollutant linkage assessment is presented in Appendix 3 of the Phase 1 Desk Study Report.

A6.3.2 Using the risk model in the desk study, the pollutant linkage can be identified and a preliminary estimate of risk undertaken. If there is no relevant pollutant linkage identified there is no risk. If there is a very low risk, it is likely that no further assessment is required. If further assessment is necessary, then gas monitoring is required.

A6.4 SITE MONITORING

A6.4.1 For sites with low generation potential, giving consistently low concentrations of soil gas under the worst-case conditions, a limited programme of monitoring would be appropriate. Where high or variable concentrations are anticipated or recorded, an extended programme of monitoring would be appropriate. The following guideline has been proposed, ref. 9.38.

Table A6.1

		Generation potential of source				
Sensitivity of development		**Very low**	**Low**	**Moderate**	**High**	**Very high**
	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with gardens)	6/3*	9/6	12/6	24/12	24/24

Notes

1. First number is minimum number of readings and second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.

2. At least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions (see Boyle and Witherington, 2006).

3. The frequency and period stated are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required (e.g. any such variation subject to site specific justification). * The NHBC guidance is also recommending these periods/frequency of monitoring (Boyle and Witherington, 2006)

4. Historical data can be used as part of the data set.

5. Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.

6. Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long-term monitoring may not be appropriate or required.

A6.4.2 Before taking any readings, zero the instrument, record atmospheric pressure and temperature.

A6.4.3 Gas flow should be recorded, giving the range of pressures, ensuring positive or negative flow is recorded.

A6.4.4 Record gas levels, recording peak and steady. Where steady state not obtained within 3 minutes, record change in concentration, where concentrations are decreasing, always record peak value. For very high concentrations, record for longer period of up to 10 minutes.

A6.5 ASSESSMENT OF RISK AND RECOMMENDATIONS

A6.5.1 The main method of characterising a site is the method described by Wilson and Card, ref. 9.39 and is termed Situation A. This can be used for all types of development except conventional low-rise housing with suspended ground floor and ventilated underfloor void.

A6.5.2 Low rise housing, Situation B, was developed by Boyle and Witherington, ref. 9.40 and was developed for the NHBC for classifying gassing sites for houses with suspended ground floor slab with ventilated void.

A6.5.3 Although the Code of Practice, ref 9.35, assesses the characteristic gas situation as CIRIA recommend for Situation A, see Table A6.2 below, their solution for gas protection systems is different, see section A6.10.

A6.6 SITUATION A - ASSESSMENT

A6.6.1 This system proposed by Wilson and Card, ref. 9.39 was originally developed in CIRIA Report 149, ref. 9.33.

A6.6.2 The method uses both gas concentrations and borehole flow rate for methane and carbon dioxide to define a Characteristic Situation for a site.

A6.6.3 Gas Screening Value (litre/hr) = borehole flow rate (litre/hr) x gas concentration (%). The GSV is determined for methane and carbon dioxide and the worst case adopted. The Characteristic Situation can then be determined from the table below. The GSV can be exceeded if the conceptual model indicates it is safe to do so, and other factors may lead to a change in the Characteristic Situation.

Table A6.2

Characteristic Situation	Risk Classification	Gas screening value (CH_4 or CO_2(1/hr)[1]	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and/or carbon dioxide ≤5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" Made Ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to Characteristic Situation 3	Natural soil, high peat/organic content. "Typical" Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table A6.1
2. Source of gas and generation potential/performance must be identified.

3. If there is no detectable flow use the limit of detection of the instrument.

A6.7 SITUATION A – SOLUTION

A6.7.1 The Characteristic Situation can be used to define the scope of gas protective measures required.

A6.7.2 The CIRIA approach uses the characteristic situation to define the level of gas protection as follows:

Table A6.3

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
	Number of levels of protection	Typical scope of protective measures	Number of levels of protection	Typical scope of protective measures
1	None	No special precautions	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended non-suspended or raft) with at least 1200g DPM and underfloor venting b) Beam and block or pre-cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM b) Beam and block or pre cast concrete slab and minimum 2000g DPM/reinforced gas membrane c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use All joints and penetrations sealed
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
4	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in ground venting layer	2 to 3	All types of floor slab as above. All joints and penetration sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility
5	4	Reinforced concrete cast in situ floor slab	3 to 4	Reinforced concrete cast in-situ floor slab

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
		(suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers		(suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

1. Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.

2. Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414, ref. 9.37.

3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

4. Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs.

5. Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for characteristic situations 3 and 4.

6. Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block and beam floor is used it should be well

detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m^3 and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membrane).

7. The gas-resistant membrane can also act as the damp-proof membrane.

A6.8 SITUATION B -ASSESSMENT

A6.8.1 The NHBC has developed a characterisation system that is similar to Situation A but is specific to low-rise housing development with a clear ventilated underfloor void. The gas emission rates are compared to generic 'Traffic Lights'.

A6.8.2 The Traffic Lights include a Typical Maximum Concentration that is used for initial screening purposes. Where the Typical Maximum Concentration is exceeded the risk-based Gas Screening Value, GSV, should be adopted. The GSVs are determined for the 'model' low rise development and where they differ from this model, the GSV should be reassessed, ref. 9.34.

A6.8.3 The calculations should be made for both methane and carbon dioxide, and the worst case adopted. The GSV is only a guideline.

Table A6.4

Traffic light	Methane		Carbon dioxide	
	Typical maximum concentration[2] (% v/v)	Gas screening value (GSV)[3] (litres per hour)	Typical maximum concentration[2] (% v/v)	Gas screening value (GSV)[1,2] (litres per hour)
Green	1	**0.16**	5	**0.78**
Amber 1	5	**0.63**	10	**1.56**
Amber 2	20	**1.56**	30	**3.13**
Red				

1. Generic GSVs are based on guidance contained within latest revision of Department of the Environment and the Welsh Office (2004 edition)

"The Building Regulations: Approved Document C" and used a sub-floor void of 150mm thickness.

2. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgement will be required, based on a thorough understanding of the gas-regime identified at the site where monitoring in the worst temporal conditions has occurred.

3. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

A6.9 SITUATION B – SOLUTION

A6.9.1 On the basis of this Traffic Light classification the following protection should be applied to low-rise housing.

Table A6.5

Traffic Light Classification	Protection measures required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. A specialist contractor should always fit membranes. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

A6.10 CODE OF PRACTICE – SOLUTIONS

A6.10.1 The Characteristic Gas Situation is determine in a similar manner to that recommended by CIRIA, see Table A6.2 above.

A6.10.2 Having selected the Characteristic Gas Situation, the appropriate gas protection could be selected for the building. The tables below give a guide as to the relative performance of the various designs and systems.

A6.10.3 A guidance value for the required gas protection, in the range 0 to 7 should be obtained from Table A6.6 below. Then, a combination of ventilation and/or barrier system should be chosen from Table A6.7 to meet that requirement.

Table A6.6

Characteristic gas situation, CS	NHBC *traffic light*	Required gas protection			
		Non-managed property, e.g. private housing	Public building A)	Commercial buildings	Industrial buildings B)
1	*Green*	0	0	0	0
2	*Amber 1*	3	3	2	1 C)
3	*Amber 2*	4	3	2	2
4	*Red*	6 D)	5 D)	4	3
			6 E)	5	4
				7	6

NOTE: Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

A) Public buildings include, for example, managed apartments, schools and hospitals.
B) Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.
C) Maximum methane concentration 20% otherwise consider an increase to CS3.
D) Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.
E) Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any protection scheme.

A6.10.4 Having determined the appropriate guidance value from Table A6.6, an element or combination of elements from a), b), c) or d) in Table A6.7, should be chosen to achieve the required level of protection.

Table A6.7

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A)]	Very good performance	2.5	*Ventilation performance in accordance with Annex A, ref. 9.35*
	Good performance	1	*If passive ventilation is poor this is generally unacceptable and some form of active system will be required*
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A)]		2.5	*There have to be robust management systems in place to ensure the continued maintenance of any ventilation system.* *Active ventilation can always be designed to meet good performance.* *Mechanically assisted systems come in two main forms: extraction and positive pressurization.*
Ventilated car park (basement or undercroft)		4	*Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IstructE guidance*
b) Barriers			
Floor slabs			
Block and beam floor slab		0	*It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum.* *Breached in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances*
Reinforced concrete ground bearing floor slab		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation[B), C)]		0.5	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints*
Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA)[B), C)]		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation		2	

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	
Permanent monitoring and alarm system[A)]	Installed in the underfloor venting/ dilution system	2	*Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.*
	Installed in the building	1	
e) Pathway intervention			
Pathway intervention		-	*This can consist of site protection measures for off-site or on-site sources (see Annex A, ref. 9.35)*
NOTE: In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection			

A) It is possible to test ventilation systems by installing monitoring probes for post installation validation.

B) If a 1200 g DPM material is to function as a gas barrier it should be installed according to BRE 414, ref. 9.37 being taped and sealed to all penetrations.

C) Polymeric Materials >1200g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1200g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.