Remediation and Validation Strategy

SWALLOW LANE
GOLCAR
PHASE 2

for

Jones Homes (Yorkshire) Limited

Report Number 4112

March 2021

Michael D Joyce Associates LLP
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Remediation and Validation Strategy

SWALLOW LANE, GOLCAR - PHASE 2

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1 INTRODUCTION

1.1 On behalf of Jones Homes (Yorkshire) Limited, a Remediation and Validation Strategy has been prepared for a development site at Swallow Lane in Golcar (Phase 2). It is proposed to construct 19 houses and is illustrated on figure 1. This document sets out how contaminants on the site are to be dealt with, and how the subsequent remedial works will be validated.

1.2 At the request of Jones Homes (Yorkshire) Limited, a Phase I Geoenvironmental and Geotechnical Assessment (Desk Study) and a Phase II Intrusive Investigation have been carried out at land off Swallow Lane in Golcar. The site lies immediately to the West of a current Jones Homes development and is therefore referred to as Phase 2.

1.3 The purpose of the desk study was to review and assess published information on the site including geological, mining and hydrogeological data. It was also to review the past history of the site and its environmental setting.

1.4 The intrusive investigation comprised window sampling, rotary drilling and trial pitting, with associated in-situ and laboratory testing. Recommendations are made for the safe and economic development of the site.

2 THE SITE

2.1 The Phase 2 site covers an area of approximately 0.75 hectares. It is located to the South side of Swallow Lane in Golcar, approximately 5 km West of the centre of Huddersfield. The Ordnance Survey National Grid Reference is 409300, 416000. It lies at approximately 240 mAOD in the Northwest of the site, falling gently to around 225 mAOD in the Southeast corner.

2.2 The site was initially inspected on 31st October 2019. The site is bounded to the North by terraced housing on Swallow Lane, whilst to the West there is more recent housing. To the East is the current Jones Homes Phase 1 development and to the South are fields.

2.3 The site originally comprised two discrete parcels of land situated behind the properties on Swallow Lane. The Eastern strip of land comprised an access track from Swallow Lane and a works unit with rough ground to the South and an area where rubbish and building materials have been burnt. Immediately West of the works unit the ground is boggy, which is assumed to be due to poor drainage of surface run-off from the works unit and from land to the West.

2.4 The Western parcel of land is occupied as a builder's yard and is accessed via a locked metal gate. It contains construction materials and plant along with several above ground diesel tanks, two of which appeared to be empty and simply kept at the site.

2.5 It is not proposed to repeat the findings of the Phases 1 and 2 investigations, and as such this document should be read in conjunction with the original investigations.

2.6 This document also addresses comments made by the Environmental Health Department of Kirklees Council in its consultation response dated 17th February 2021 (Ref: WK/202102458). In particular, it addresses issues relating to gas monitoring and the requirement for a Remediation Strategy (CLC3).

3 REMEDIATION PROPOSALS

3.1 The laboratory testing during the original investigation recorded no significant contamination. However, an area of Made Ground was identified in boreholes WS6, WS11, WS13 and trial pit TP2. This Made Ground was found to contain some contamination. These locations correspond to proposed Plots 15 to 19.

3.2 Since the topsoil has been found to be uncontaminated, it was recommended that this be stripped and stockpiled for reuse. Following removal of the topsoil, areas of Made Ground should be removed down to natural ground and the excavated material removed from site, or used as infill inside foundation areas.

3.3 In view of the presence of the above ground diesel tanks, it was also recommended that once these have been removed and the surface stripped, an inspection is carried out in respect of any localised hydrocarbon spillages. If necessary, removal and validation testing would be required.

3.4 Subsequent to the original investigation, suspected asbestos containing materials (ACM) were encountered below the surface, along the central section of the eastern boundary, and corresponding to Plots 15 to 19. Two samples of the suspected ACMs (Samples 1 and 2) were taken and laboratory testing confirmed the presence of Amosite (brown asbestos) and Chrysotile (white asbestos). The asbestos appears to be contained primarily in pieces of asbestos cement sheeting and a fibreboard type material.

3.5 In addition, three samples of the surrounding soils were taken (samples 3-5), although no ACMs or fibres were detected.

3.6 It can be concluded that in all probability any asbestos is contained within broken pieces of asbestos cement sheeting and fibreboard.

Gas Monitoring

3.7 The original investigation report was provided prior to the results of the on-going gas monitoring were available. These results are presented in full in Appendix 2, and summarised below.

Date	Peak Methane (%)	Carbon Dioxide (%)	Peak Flow (l/hr)
01.11.19	0	2.3	0.1
21.11.19	0	2.4	0
31.12.19	0	2.3	0
21.01.20	0	2.0	0
10.02.20	0	1.8	0
28.02.20	0	1.9	0

3.8 The monitoring recorded no methane, carbon monoxide or hydrogen sulphide. The peak carboin dioxide level was 2.4% and the peak flow rate was 0.1 l/hour.

Hazardous Gas Flow = 0.1 x (2.4/100) = 0.002

3.9 This corresponds to a Characteristic Gas Screening Value of CS1, where carbon dioxide is consistently less than 5%.

3.10 However, Jones Homes' preferred option is to install basic gas protection measures in accordance with Characteristic Gas Screening Value of CS2. This is a precautionary measure.

4 REMEDIATION METHOD STATEMENT

4.1 In view of the original and latest findings, the following remediation strategy is to be adopted.

Removal of Made Ground (Plots 15 to 19)

4.2 Initially the topsoil from Plots 1 to 14 should be removed and stockpiled for reuse. A watching brief will be required for any asbestos containing materials.

4.3 The topsoil and Made Ground around Plots 15 to 19 is to be carefully removed in thin layers. In conjunction with this, the groundworker should hand pick visible pieces of asbestos containing materials from the Made Ground and topsoil of present. This shall be double bagged and securely stored prior to disposal to a landfill site which is licensed to accept asbestos containing materials.

4.4 The excavation shall continue until natural ground is encountered. Once all the Made Ground has been removed, the natural ground will be inspected by Michael D Joyce Associates LLP to confirm the removal of the Made Ground, and any asbestos containing materials.

4.5 Once asbestos containing materials have been removed from the Made Ground, the Made Ground and topsoil shall be disposed off to a suitable waste site. It is anticipated that once the ACMs have been removed, the Made Ground will **not** be classified as hazardous waste.

Area of Existing Buildings

4.6 The existing buildings on the site currently occupy an area which has been designated as Public Open Space.

4.7 Once the buildings and hardstanding have been removed, the area shall be inspected. Samples shall be taken for contamination testing. Should any ACMs be observed, the area shall be treated in accordance with Sections 4.2 to 4.4 above. As a precautionary measure, a check shall also be made to confirm that any Made Ground does not extend onto Plot 14.

Reinstatement of Plots 15 to 19

4.8 The garden areas of Plots 15 to 19 shall be brought up to finished levels using clean natural materials from drainage and foundation excavations, and topsoil stripped from the site.

4.9 These materials are known to be uncontaminated and as such shall not constitute a formal clean cover and will need not to be validated as a clean cover would normally.

4.10 This procedure shall also be adopted for the Public Open Space and Plot 14 if necessary.

Reporting

4.11 The purpose of verification documentation is to provide transparent reasoning as to why the remediation strategy was required, a methodology about how it was to be

undertaken and proof that the specified works have been undertaken so as to provide confirmation that the site is 'suitable for its intended use'.

4.12 The document is utilised not only to satisfy conditions of planning permissions but also is to be kept on record by the Local Authority should queries be raised during the lifetime of the development and to confirm to future purchasers that the site is suitable for use. The report should be carried out by Michael D Joyce Associates LLP.

Protection of Site Personnel

4.13 All groundworkers shall undergo site specific health and safety induction prior to commencing on site, in particular to be aware of the presence of ACMs. Personnel shall be provided with appropriate protective clothing, footwear, eyewear and gloves and all work shall be carried out in accordance with HSE Document, *"Protection of Workers and the General Public during the Redevelopment of Contaminated Land".* Personnel involved in the hand-picking of ACMs should be trained and qualified in carrying out this activity. There shall be no entry into confined spaces without appropriate training and monitoring. The site should be secured against general access to public.

4.14 In general, a watching brief is recommended across the site. Should any ACMs or any contaminated soils be encountered elsewhere on the site, this should be referred to Michael D Joyce Associates LLP for further advice.

Dust

4.15 It is essential that dust is not created during the removal of the Made Ground around Plots 15 to 19. (Section 4.2 to 4.4) As such, excavations in this material should be dampened in advance. In the event that dust is created on site during dry weather, damping should be carried out. In wet weather, vehicle and wheel washing may be necessary to prevent the movement of contaminants off site. All vehicles carrying spoil should be sheeted.

4.16 Materials which are stored, handled or transported on site should also be kept damp to prevent the generation of dust. Stockpiles should be sited in non-sensitive locations, and take into account the proximity of adjacent properties.

4.17 Stockpile should be compacted and the sides smoothed to ensure run-off of rainwater. Consideration should be given to where the run-off will go to. In the case of contaminated materials, bunding should be provided to prevent the spread of potentially contaminated materials. Any long term stockpile should be seeded.

Site Roads and Vehicles

4.18 The condition of site and surrounding roads should be monitored on an on-going basis. In order to minimise dust there should be a 15 mph speed limit on surfaced roads, and 10 mph on unsurfaced roads. A wheel-washing plant and a road sweeper should be provided if considered necessary, using a mains water supply.

4.19 A written daily record of site activities and conditions should be maintained and available to the local authority on request. Site staff should be briefed on dust issues as part of the site induction.

4.20 The site manager should be responsible for establishing a complaints procedure in respect of complaints.

4.21 The required mitigation measures are as follows;

Required Mitigation Measures
Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
Display the head or regional office contact information.
Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken. Make the log available to LPA if required.
Record any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation in the log book.
Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks or surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary.
Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.
Avoid site run-off of water or mud.
Keep site fencing, barriers and scaffolding clean using wet methods.
Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on site cover as described below.
Cover, seed or fence stockpiles to prevent wind whipping.
Ensure all NRMM meet the highest emission standards, where applicable.
Ensure all vehicles switch off engines when stationary – No idling vehicles.
Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.
Impose and signpost a maximum speed limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).
Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).
Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.

Measure
Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
Ensure equipment is readily available on site to clean and dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
Avoid bonfires and burning of waste materials.
CONSTRUCTION SPECIFIC
All contractors and sub-contractors to be made aware of any sign-up to the Dust Management Scheme.
Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
TRACKOUT SPECIFIC
Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any materials tracked out of the site. This may require the sweeper being continuously in use.
Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
Record all inspections of haul routes and any subsequent action in a site log book.
Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
Implement a wheel washing systems (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).

Further Monitoring and Inspection including Contingency Planning

4.22 Should any unforeseen conditions arise on site, or if ground conditions are different from those predicted, they should be referred back to Michael D Joyce Associates LLP for appropriate advice.

4.23 It is envisaged that should any significantly impacted contaminated soils be encountered, then these will be excavated and stockpiled on an impermeable area and quarantined. A watching brief is required for asbestos and hydrocarbons across the site. The material will be tested to determine whether it can be retained on site or has to be disposed of. Validation of the excavation faces may be necessary to demonstrate none has been left in-situ.

5 METHOD STATEMENT FOR GAS PROTECTION MEASURES

5.1 Basic Gas Protection Measures are preferred for new properties in line with Characteristic Situation 2 conditions.

5.2 British Standard BS8485: 2015 "Guide of Practice for the Design of Protective Measures from Methane and Carbon Dioxide Ground Gases for New Buildings" uses a gas protection scoring system to ensure sufficient protection is provided. The scoring system is dependent on the building type. In this instance the residential dwellings would be classed as Type A, and would need to obtain a gas protection score of 3.5 points.

5.3 The exact gas protective measures needed will be dependent upon the sub floor design of the proposed new structures but would normally include at least two of the following to achieve the required level of protection;

- Cast in-situ ground bearing floor slab or reinforced cast in-situ suspended floor slab with minimal penetrations
- Provision of proprietary gas resistant membrane lapped and sealed and spanning cavity walls
- Provision of a passive sub-floor dispersal layer i.e. ventilated clear sub-floor void, polystyrene void former blanket, no fines gravel layer with gas drains, no fines gravel layer

The gas resistant membrane shall meet all of the following criteria;

- Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m^2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method)
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions

- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab)
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc)
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- Verified in accordance with CIRIA C735 [N1]
- Span the DPC
- Sealed around service entries

5.4 British Standard BS8485: 2015 "Code of practice for the design of protective measures from methane and carbon dioxide ground gases for new buildings", and Building Research Establishment Report BR414 "Protective Measures for Housing on Gas Contaminated Land", together with the CIRIA Report 149 "Protecting Development from Methane", all give construction advice for preventing gases entering buildings, the principles of which are incorporated in the above guidance. Advice is also given in respect of sealing services where they pass through impermeable membranes. All works to be carried out in accordance with the Building Regulations 2010 England, "Approved Document C - Site Preparation and resistance to contaminates and moisture (2004 Edition incorporating 2010 and 2013 amendments)".

5.5 The supervision of the installation will need to be undertaken by a consultant or by a suitably qualified and experienced installer in accordance with CIRIA Report C735, "Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases". Detailed records and photographs of the installations should be made. The installation and verification of the membrane shall

also be in accordance with YALPAG, “Verification of Gas Protection Systems” Version 1.1 December 2016.

A D Joyce

BSc MSc ARSM CEng CGeol CEnv MICE FGS SiLC SQP

March 2021

Procedure Notes

The desk study and/or ground investigation have been carried out using reasonable skill and care in accordance with the principles of Ground Investigation and Testing", BS5930: 2013 and BS10175:2011+A1:2013, and the terms of the client's brief. The report has been prepared for the specific purposes notified at the time of the initial enquiry.

By its very nature any ground investigation only encounters and samples a small percentage of the ground. Consequently changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimize such risks. Conclusions and recommendations are based on the information presented in this report, but unforeseen features may exist. No liability can be accepted for conditions not revealed by the exploratory holes. Therefore, actual ground conditions should be noted during construction and further advice sought if they differ from those predicted. Michael D. Joyce LLP reserves the right to amend the conclusions and recommendations in the light of further information. Actual methods of construction or alternative designs should be notified to Michael D. Joyce Associates LLP, such that the recommendations made can be reconsidered in the light of any changes.

Further investigation can be carried out to further reduce uncertainty and risk but ultimately these risks cannot be eliminated. Similarly a desk study normally only considers readily available information and further information could be held by other sources. In commissioning further research or investigation the cost/benefit of doing so must be considered.

It is assumed that groundlevels will not change significantly from those at present. The groundwater conditions are based on observations made at the time of the investigation, unless stated otherwise. It should be noted that the observations are subject to the method of the boring or excavation and that groundwater levels will vary due to seasonal or other effects.

Where buildings are present on a site, structural and asbestos surveys have not been carried out, unless specifically stated. An Unexploded Ordnance Survey has not been carried out unless specifically stated. In relevant situations it would be prudent to commission such surveys.

Where information has been obtained from Third Parties, no liability can be accepted for the accuracy or completeness of this information. Where anecdotal evidence or speculations are presented, they must be treated as such and cannot be relied upon.

Swallow Lane, Golcar – Phase 2

Site Plan and Proposed Planning Layout

Michael D Joyce Associates LLP

Geotechnical and Geoenvironmental Consultants

Scale: As shown

Figure: 1

Appendix 1

Laboratory Testing of ACM

ANALYTICAL TEST REPORT

Contract no: 94163

Contract name: Swallow Lane, Golcar

Client reference: -

Clients name: Michael D Joyce Associates

Clients address: Charnock Court
6 South Parade
Wakefield
WF1 1LR

Samples received: 08 March 2021

Analysis started: 08 March 2021

Analysis completed: 10 March 2021

Report issued: 10 March 2021

Notes:
Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key:
U UKAS accredited test
M MCERTS & UKAS accredited test
$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing

Approved by:
Rachael Burton
Customer Support Squad Leader

Chemtech Environmental Limited

SOILS

Lab number			94163-3	94163-4	94163-5
Sample id			Sample 3	Sample 4	Sample 5
Depth (m)			-	-	-
Date sampled			05/03/2021	05/03/2021	05/03/2021
Test	**Method**	**Units**			
Subcontracted analysis					
Asbestos (qualitative)	$	-	NAD	NAD	NAD

Chemtech Environmental Limited

SOLIDS

Lab number			94163-1	94163-2
Sample id			Sample 1	Sample 2
Depth (m)			-	-
Date sampled			05/03/2021	05/03/2021
Test	**Method**	**Units**		
Subcontracted analysis				
Asbestos (qualitative)	$	-	Amosite, Chrysotile	Amosite, Chrysotile

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOLIDS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

Appendix 2

Gas Monitoring Results

Michael D Joyce Associates LLP Geotechnical and Geoenvironmental Consultants	**GAS MEASUREMENTS** **Date:** 1st November 2019
Client Jones Homes (Yorkshire) Limited	**Report No**: 3974
Site Swallow Lane	
Location Golcar	
Barometric Pressure 995 mB falling	**Air Temperature:** 6°C
Weather Wet and cold	
Instrument Gas Data GFM436	

Borehole No.	Groundwater Depth (m)	Methane (% gas)	Carbon Dioxide (% gas)	Oxygen (% gas)	Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Flow (l/h)
WS9	Dry	0.0	0.2	19.6	0	0	0.0
WS11	Dry	0.0	0.3	19.7	0	0	0.0
WS12	Dry	0.0	2.3	16.3	0	0	0.1

L.E.L. = Lower Explosive Limit, equivalent to 5% methane in air, i.e. 20% LEL is 1% gas
Normal Oxygen concentration is 20.9% of air

***NR = NOT RECORDED**

Michael D Joyce Associates LLP Geotechnical and Geoenvironmental Consultants	**GAS MEASUREMENTS**
	Date: 21st November 2019
Client Jones Homes (Yorkshire) Limited	**Report No**: 3974
Site Swallow Lane	
Location Golcar	
Barometric Pressure 1002 mB falling	**Air Temperature:** 4°C
Weather Wet and cold	
Instrument Gas Data GFM436	

Borehole No.	Groundwater Depth (m)	Methane (% gas)	Carbon Dioxide (% gas)	Oxygen (% gas)	Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Flow (l/h)
WS9	Dry	0.0	0.2	19.5	0	0	0.0
WS11	Dry	0.0	0.1	20.3	0	0	0.0
WS12	Dry	0.0	2.4	16.3	0	0	0.0

L.E.L. = Lower Explosive Limit, equivalent to 5% methane in air, i.e. 20% LEL is 1% gas
Normal Oxygen concentration is 20.9% of air

***NR = NOT RECORDED**

Michael D Joyce Associates LLP Geotechnical and Geoenvironmental Consultants	**GAS MEASUREMENTS**
	Date: 31st December 2019
Client Jones Homes (Yorkshire) Limited	**Report No**: 3974
Site Swallow Lane	
Location Golcar	
Barometric Pressure 1025 mB stable	**Air Temperature:** 4°C
Weather Wet and cold	
Instrument Gas Data GFM436	

Borehole No.	Groundwater Depth (m)	Methane (% gas)	Carbon Dioxide (% gas)	Oxygen (% gas)	Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Flow (l/h)
WS9	Dry	0.0	0.3	19.0	0	0	0.0
WS11	Dry	0.0	0.4	15.8	0	0	0.0
WS12	Dry	0.0	2.3	16.5	0	0	0.0

L.E.L. = Lower Explosive Limit, equivalent to 5% methane in air, i.e. 20% LEL is 1% gas
Normal Oxygen concentration is 20.9% of air

***NR = NOT RECORDED**

Michael D Joyce Associates LLP Geotechnical and Geoenvironmental Consultants	**GAS MEASUREMENTS** **Date:** 21st January 2020
Client Jones Homes (Yorkshire) Limited	**Report No**: 3974
Site Swallow Lane	
Location Golcar	
Barometric Pressure 1039 mB falling	**Air Temperature:** 7°C
Weather Dry and sunny	
Instrument Gas Data GFM436	

Borehole No.	Groundwater Depth (m)	Methane (% gas)	Carbon Dioxide (% gas)	Oxygen (% gas)	Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Flow (l/h)
WS9	Dry	0.0	0.4	18.0	0	0	0.0
WS11	Dry	0.0	0.2	17.0	0	0	0.0
WS12	Dry	0.0	2.0	17.0	0	0	0.0

L.E.L. = Lower Explosive Limit, equivalent to 5% methane in air, i.e. 20% LEL is 1% gas
Normal Oxygen concentration is 20.9% of air

***NR = NOT RECORDED**

Michael D Joyce Associates LLP Geotechnical and Geoenvironmental Consultants	**GAS MEASUREMENTS**
	Date: 10th February 2020
Client Jones Homes (Yorkshire) Limited	**Report No**: 3974
Site Swallow Lane	
Location Golcar	
Barometric Pressure 990 mB rising	**Air Temperature:** 4°C
Weather Dry and cold	
Instrument Gas Data GFM436	

Borehole No.	Groundwater Depth (m)	Methane (% gas)	Carbon Dioxide (% gas)	Oxygen (% gas)	Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Flow (l/h)
WS9	Dry	0.0	0.1	17.6	0	0	0.0
WS11	Dry	0.0	0.4	18.9	0	0	0.0
WS12	Dry	0.0	1.8	17.9	0	0	0.0

L.E.L. = Lower Explosive Limit, equivalent to 5% methane in air, i.e. 20% LEL is 1% gas
Normal Oxygen concentration is 20.9% of air

***NR = NOT RECORDED**

Michael D Joyce Associates LLP Geotechnical and Geoenvironmental Consultants	**GAS MEASUREMENTS**
	Date: 28th February 2020
Client Jones Homes (Yorkshire) Limited	**Report No**: 3974
Site Swallow Lane	
Location Golcar	
Barometric Pressure 999 mB falling	**Air Temperature:** 5°C
Weather Dry and cold	
Instrument Gas Data GFM436	

Borehole No.	Groundwater Depth (m)	Methane (% gas)	Carbon Dioxide (% gas)	Oxygen (% gas)	Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Flow (l/h)
WS9	Dry	0.0	0.1	17.6	0	0	0.0
WS11	Dry	0.0	0.4	18.9	0	0	0.0
WS12	Dry	0.0	1.9	17.6	0	0	0.0

L.E.L. = Lower Explosive Limit, equivalent to 5% methane in air, i.e. 20% LEL is 1% gas
Normal Oxygen concentration is 20.9% of air

***NR = NOT RECORDED**

Standard Appendices A and B

STANDARD APPENDIX A

NOTES ON SITE INVESTIGATION PROCEDURE (October 2019)

1. **GENERAL.** The ground investigation has been carried out in accordance with the principles of British Standards BS EN ISO 14688-1 and 2 "Geotechnical Investigation and testing – Identification and Classification of Soil" Parts 1 and 2 and BS EN ISO 14689: 2018 "Geotechnical Investigation and Testing – Identification and Classification of Rock". BS 5930: 2015 the Code of Practice for Site Investigation is partly superseded. This appendix briefly describes the nature of the work carried out. It also gives a brief description of the more important tests, which are made for engineering purposes on rocks and soils (see also BS 1377: 2016). By its very nature, any ground investigation only samples a small percentage of the ground. Consequently, changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimise such risks but they cannot be eliminated.

2. **GROUND INVESTIGATION.**

2.1 **BOREHOLE AND TRIAL PIT RECORDS.** These illustrate the ground conditions only at the location of the particular borehole or trial pit. Correlation between boreholes is for guidance only and its accuracy cannot be guaranteed.

2.2 **SHELL AND AUGER BORING.** This technique uses a tripod winch and an essentially percussive action using a variety of tools. Disturbed and undisturbed samples can be taken. This is the most suitable method for soft ground investigation, enabling the maximum amount of information to be obtained. However, minor changes in lithology may be overlooked unless continuous undisturbed sampling is used.

2.3 **GROUNDWATER**. Groundwater levels vary seasonally and the details given on the borehole logs relate only to the dates and the conditions described in the borehole records. The rate of boring may not have allowed an equilibrium water level to be established and the use of casing may seal off certain seepages.

2.4 **SAMPLING.** Disturbed samples of soils are taken for identification and classification purposes. In cohesive soils 'undisturbed' samples 100mm in diameter are taken by open drive sampler for laboratory testing of strength, permeability and consolidation characteristics.

2.5 **STANDARD PENETRATION TESTS**. S.P.T tests are used in granular and cohesive materials and in soft or weathered rocks. Difficulties in obtaining true 'N' values mean they must only be used as a guide and not as an absolute value in foundation design.

2.6 **ROTARY DRILLING.** Two main types of rotary drilling are carried out in rock. Rock coring using diamond or tungsten carbide tipped core bits provides samples and information on rock types, fissuring and weathering. Openhole drilling only produces small particles for identification purposes and the information gained is therefore limited. The latter is, however, useful as a quick method for detecting major strata changes and for the location of coal seams and old workings. Water, air, foam or drilling muds may be used as the flushing medium in either case.

2.7 **PERMEABILITY TESTS.** These can be carried out in boreholes or trial pits and gives a good indication of in-situ permeability.

2.8 **TRIAL PITTING.** This enables soil conditions to be closely examined at any specific point and samples taken. It also gives useful information on the stability of excavations and ingress of water.

2.9 **WINDOW SAMPLING**. Window sampling consists of driving a series of 1m-long tubes into the ground using a dropping weight. On completion of each 1m run, the tube is withdrawn. The next tube is then inserted and the process repeated to provide a continuous profile of the ground. On each run the tube diameter is reduced in order to assist in its recovery.

2.10 **GAS MONITORING.** This is routinely carried out in trial pits or probe holes to check for elevated levels of methane and carbon dioxide or oxygen deficiency, particularly since risks can exist from natural gases, landfill sites and rising groundwater levels in mine workings below ground. Longer term monitoring is carried out with gas monitoring standpipes.

3. **SOIL DESCRIPTION.** Samples from borings or trial pits are described as specified in the standard procedure outlined in the British Standards. The description includes colour, consistency, structure, weathering, lithological type, inclusions and origin. All descriptions are based on visual and manual identification.

Fire Soils (Cohesive Soils)

The following field terms are used:

Soil Type	Description
Very soft	Exudes between fingers
Soft	Moulded by light finger pressure
Firm	Cannot be moulded by the fingers but can be rolled in hand to 3mm threads.
Stiff	Crumbles and breaks when rolled to 3mm threads but can be remoulded to a lump.
Very stiff	No longer moulded but crumbles under pressure. Can be indented with thumbs.

The following terms are used in accordance with the results of laboratory and field tests.

Description	Undrained Shear Strength Cu (kPa)
Extremely Low	<10
Very Low	10 - 20
Low	20 - 40
Medium	40 - 75
High	75 - 150
Very High	150 - 300
Extremely High	>300

Fine soils can also be classified according to their sensitivity, which is the ratio between undisturbed and remoulded undrained shear strength.

Sensitivity	Ratio
Low	8
Medium	8 - 30
High	>30
Quick	>50

Granular Soils (Non-Cohesive)

The following descriptions are used for granular soils.

Description	Normalised Blow Count (N_1) 60
Very Loose	0 - 3
Loose	3 - 8
Medium	8 - 25
Dense	25 - 42
Very Dense	42 - 58

4. **NATURAL OR IN-SITU MOISTURE CONTENT**. The natural or in-situ moisture content of a soil is defined as the weight of water contained in the pore space, expressed as a percentage of the dry weight of solid matter present in the soil. Soil properties are greatly affected by the moisture content and the test can help to give an indication of likely engineering behaviour.

5. **LIQUID AND PLASTIC LIMITS**. Two simple classification tests are known as the liquid and plastic limits. If a cohesive soil is remoulded with increasing amounts of water, a point will be reached at which it ceases to behave as a plastic material and becomes essentially a viscous fluid. The moisture content corresponding to this change is arbitrarily determined by the liquid limit test. 'Fat' clays, which have high contents of colloidal particles, have high liquid limits; 'lean' clays, having low colloidal particle contents have correspondingly low liquid limits. An increase in the organic content of a clay is reflected by an increase in the liquid and plastic limits.

   If a cohesive soil is allowed to dry progressively, a point is reached at which it ceases to behave as a plastic material, which can be moulded in the fingers, and it becomes friable. The moisture content of the soil at this point is known as the 'plastic limit' of the soil.

   The range of water content over which a cohesive soil behaves plastically, i.e. the range lying between the liquid and plastic limits, is defined as the plasticity index.

   A cohesive soil with a natural water content towards its liquid limit will, in general, be an extremely soft material whereas a cohesive soil with a natural water content below its plastic limit will tend to be a stiff material.

6. **PARTICLE-SIZE DISTRIBUTION.** A knowledge of particle-size distribution is used to classify soils and to indicate likely engineering behaviour. British Standards define soils in relation to their particle-size as shown below:-

Boulders	>200mm	Coarse Sand	2.0 to 0.63mm
Cobbles	200 to 63mm	Medium Sand	0.63 to 0.2mm
		Fine Sand	0.2 to 0.063mm
Coarse Gravel	63 to 20mm	Coarse Silt	0.063 to 0.02mm
Medium Gravel	20 to 6.3mm	Medium Silt	0.02 to 0.0063mm
Fine Gravel	6.3 to 2mm	Fine Silt	0.0063 to 0.002mm
		Clay	<0.002mm

7. **BULK DENSITY.** The bulk density of a material is the weight of that material per unit volume and includes the effects of voids whether filled with air or water. The 'dry density' of a soil is defined as the weight of solids contained in a unit volume of the soil.

8. **PERMEABILITY.** The permeability of a material is defined as the rate at which water flows through it per unit area of soil under unit hydraulic gradient.

9. **CONSOLIDATION CHARACTERISTICS.** When subjected to pressure, a soil tends to consolidate as the air or water in the pore space is forced out and the grains assume a denser state of packing. The decrease in volume per unit of pressure is defined as the 'compressibility' of the soil, and a measure of the rate at which consolidation proceeds is given by the 'coefficient of consolidation' of the soil. These two characteristics Mv and Cv are determined in the consolidation test and the results are used to determine settlement of structures or earthworks.

10. **STRENGTH CHARACTERISTICS.** The strength of geological materials is generally expressed as the maximum resistance that they offer to deformation or fracture by applied shear or compressive stress. The strength characteristics of geological materials depend to an important degree on their previous history and on the conditions under which they will be stressed in practice. Consequently, it is necessary to simulate in the laboratory tests the conditions under which the material will be stressed in the field.

In general, the only test carried out on hard rocks is the determination of their compressive strength but consideration must be given to fissuring, jointing and bedding planes.

The tests at present in use for soils and soft rocks fall into two main categories. Firstly, those in which the material is stressed under conditions of no moisture content change, and secondly those in which full opportunity is permitted for moisture content changes under the applied stresses. Tests in the first category are known as undrained (immediate or quick) tests, while those in the second category are known as drained (slow or equilibrium) tests. The tests are normally carried out in the triaxial compression apparatus but granular materials may be tested in the shear box apparatus.

The undrained triaxial test gives the apparent cohesion C_u and the angle of shearing resistance $\emptyset_u$. In dry sands, $C_u = 0$ and $\emptyset_u$ is equal to the angle of internal friction whereas with saturated non-fissured clays Øu tends to 0 and the apparent cohesion C_u is equal to one-half the unconfined compression strength qu. On site the vane test gives an approximate measure of shear strength.

For some stability problems use is made of a variant of the undrained triaxial test in which the specimen is allowed to consolidate fully under the hydrostatic pressure and is then tested to failure under conditions of no moisture content change. This is known as the consolidated undrained triaxial test. Pore water pressures may be measured during this test or a fully drained test may be carried out. In either case the effective shear strength parameters C' and Ø' can be obtained which can be used to calculate shear strength at any given pore water pressure.

11. **COMPACTION.** The density at which any soil can be placed in an earth dam, embankment or road depends on its moisture content and on the amount of work which is used in compaction. The influence of these two factors can be studied in compaction tests, which can determine the maximum dry density (MDD) achievable at a certain optimum moisture content (OMC).

12. **CALIFORNIA BEARING RATIO TEST.** In flexible pavement design a knowledge of the bearing capacity of the subgrade is necessary to enable the thickness of pavement for any particular combination of traffic and site conditions to be determined. The quality of the subgrade can be assessed by means of the California Bearing Ratio Test or approximately by the MEXE cone penetrometer.

13. **ROCK DESCRIPTION.** This is based on;

i. Colour (minor then principal colour).
ii. Grain Size.

Description	Predominate Grain Size (mm)
Very Coarse - grained	>63
Coarse - grained	63 - 2
Medium - grained	2 - 0.063
Fine - grained	0.063 - 0.002
Very Fine - grained	<0.002

iii. Matrix.
iv. Weathering.

Term	Description
Fresh	No visible sign of weathering/alteration of the rock material.
Discoloured	The colour of the original fresh rock material is changed and is evidence of weathering/alteration. The degree of change from the original colour should be indicated. If the colour change is confined to particular mineral constituents, this should be mentioned.
Disintegrated	The rock material is broken up by physical weathering, so that bonding between grains is lost and the rock is weathered/altered towards the condition of a soil in which the original material fabric is still intact. The rock material is friable but the grains are not decomposed.
Decomposed	The rock material is weathered by the chemical alteration of the mineral grains to the condition of a sol in which the original material fabric is still intact; some or all of the grains are decomposed.

v. Carbonate Content.
vi. Stability of Rock Material.

Stable indicates no changes when sample left in water for 24 hours. Fairly stable indicates fissuring and crumbling of surfaces. Unstable indicates complete disintegration of the sample.

vii. Unconfined Compressive Strength.

Term	Field Identification	Unconfined Compressive Strength (MPa)
Extremely Weak[a]	Indented by thumbnail.	Less than 1
Very Weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	1 to 5
Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	5 to 25
Medium Strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	25 to 50
Strong	Specimen required more than one blow of geological hammer to fracture it.	50 to 100
Very Strong	Specimen requires many blows of geological hammer to fracture it.	100 to 250
Extremely Strong	Specimen can only be chipped with geological hammer.	Greater than 250

[a] Some extremely weak rocks will behave as soils and should be described as soils.

viii. Structure.

Sedimentary	Metamorphic	Igneous
Bedded	Cleaved	Massive
Interbedded	Foliated	Flowbanded
Laminated	Schistose	Folded
Folded	Banded	Lineated
Massive	Lineated	
Graded	Gneissose	
	Folded	

ix. Discontinuities.

x. Discontinuity Spacing, persistence and roughness, infilling and seepage.

xi. Weathering of the Rock Mass.

Term	Description	Grades
Fresh	No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surfaces.	0
Slightly weathered	Discolouration indicates weathering of rock material and discontinuity surfaces.	1
Moderately weathered	Less than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	2
Highly weathered	More than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	3
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	4
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soils has not been significantly transported.	5

xii. Rock Mass Permeability

14. **CHEMICAL TESTS.** A knowledge of total soluble sulphate content and pH of soils and groundwater is important in determining the protection required for concrete or steel in contact with the ground. Other specialist tests may be carried out on sites suspected of being contaminated by toxic materials (see standard appendix B).

15. **REFERENCES** (where applicable)

ICE: Effective Site Investigation (2013)
The Coal Authority: Guidance on Managing the Risk of Hazardous Gases when Drilling or Piling Near Coal, 2013
Site Investigation Practice by Michael D Joyce; E & F N Spon 1982.

BRITISH STANDARDS

BS3882: 2015 British Standard Specification for Topsoil
BS5930: 2015 British Standard Code of Practice for Site Investigations
BS8485: 2015 British Standard Code of Practice for the design and protective measures from methane and carbon dioxide ground gases for new buildings
BS10175: 2011+A1:2013 British Standard Code of Practice for the Investigation of Potentially Contaminated Sites

STANDARD APPENDIX B

NOTES ON CONTAMINATION INVESTIGATION PROCEDURE (October 2019)

1. **GENERAL.** The desk study and/or intrusive ground investigation is typically carried out in accordance with the requirements of BS5930: 2015 and BS10175: 2011+A1: 2013. In relation to contamination the desk study is referred to as the preliminary investigation in BS10175 and the intrusive ground investigation is referred to as the Exploratory Investigation. This appendix briefly describes the nature of the work carried out and explains the standards against which contamination data has been assessed. The nature of any contamination investigation is such that only a small percentage of the ground, and therefore potential contamination, is sampled. Consequently variations in both ground conditions and contaminant levels can occur between any two sampling positions. The contamination investigation is designed to minimise such risks, but they cannot be eliminated.

2. **REVIEW OF CONTAMINATION ISSUES –** The National Planning Policy Framework (NPPF) and Part 2A of the Environmental Protection Act 1990 create a new regime for the identification and remediation of contaminated land. It introduced a definition of contaminated land described in Section 78A(2) of the Act of:

"any 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) significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused:

Both Part 2A and the planning regime embrace the "suitable for use" approach. In the context of Part IIA, action is necessary only where there are unacceptable risks to health or to the environment, taking into account the current use of the land and its environmental setting.

For humans, significant harm is defined as "death, disease, serious injury ". Specifically, disease is taken to mean an unhealthy condition of the body or part of it. "Significant possibility of significant harm" is described as health effects arising from the intake of a contaminant or other direct bodily contact with the contaminant where the intake or exposure is unacceptable. The assessment should also take into account the total intake from all sources, the relative contribution of the pollutant linkage in question, and the duration of intake or exposure. The various statutory definitions are given overleaf.

The presence of unnatural substances does not automatically constitute a risk unless there is a link or pathway between the contamination (the hazard) and the receptor (the target) be it humans, the environment or property. Therefore the assessment needs to determine whether a hazard is present and whether the necessary pathway exists the so-called "pollution linkage" or “conceptual site model”.

The effect of any hazard on a site depends primarily on the site use and groundwater conditions since these determine who and what may be at risk and the routes by which they may be exposed to the hazard. Site uses can include allotments, domestic gardens on residential developments, amenity and recreational areas, public open space and industrial and commercial buildings. On any site, the potential contaminants have to be identified together with the potential receptors. The pathway for that contaminant to reach its target has then to be considered.

3. **PRELIMINARY INVESTIGATION.** The preliminary Phase I Geoenvironmental Assessment (desk study) report normally considers the following key sections:

Introduction	
The Site	Contaminated Land
Site History	Radon
Geology and Mining	Geoenvironmental Risk Assessment
Hydrogeology	Geotechnical Assessment
Groundsure Geo-Insight and Enviro-Insight	Ground Investigation (Recommendations)

The report will summarise the findings and also relate our opinions to the potential for a site to be geoenvironmentally impaired, at levels likely to warrant mitigation or further consideration appropriate to the current or future use.

Findings are based on information obtained and described during the desk study and site inspection without intrusive ground investigation. It is possible that further information exists. The absence of indicators of impairment does not mean that such impairment does not exist. Additional investigation including intrusive methods can reduce the risks but cannot eliminate them and may not be cost effective. We can advise on the additional research opportunities, their cost and their possible impact on mitigating risk. Recommendations are normally given based on the redevelopment proposals for the site.

Type of Receptor	Description of harm that is to be regarded as significant harm	Conditions For There Being A Significant Possibility Of Significant Harm
1. Human beings	Death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned.	If the amount of the pollutant in the pollutant linkage represents an unacceptable intake or direct bodily contact, assessed on the basis of relevant information on the toxicological properties of that pollutant. Such an assessment should take into account: • the likely total intake of, or exposure to, the substance or substances which form the pollutant, from all sources including that from the pollutant linkage in question; • the relative contribution of the pollutant linkage in question to the likely aggregate intake of, or exposure to, the relevant substance or substances; and • the duration of intake or exposure resulting from the pollutant linkage in question. The question of whether an intake or exposure is unacceptable is independent of the number of people who might experience or be affected by that intake or exposure. Toxicological properties should be taken to include carcinogenic, mutagenic, teratogenic, pathogenic, endocrine-disrupting and other similar properties.
2. All other human health effects (particularly by way of explosion or fire)		If the probability, or frequency, of significant harm of that description is unacceptable. The pollutant linkage might cause "significant harm which" • would be irreversible or incapable of being treated; • would affect a substantial number of people; • would result from a single incident such as a fire or an explosion; or • would be likely to result from a short-term (lees than 24-hour) exposure to the pollutant.
3. Any ecological system, or living organism forming part of such a system, within a location which is protected.	For any protected location: • harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or • harm which affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location.	If either: • significant harm of that description is more likely than not to result from the pollutant linkage; or • there is a reasonable possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration.
4. Property in the form of: • crops, including timber; • produce grown domestically, or on allotments, for consumption; • livestock; • other owned or domesticated animals; • wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in the value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage.	If significant harm of that description is more likely than not to result from the pollutant linkage in question.
5. Property in the form of buildings.	Structural failure, substantial damage or substantial interference with any right of occupation.	If significant harm of that description is more likely than not to result from the pollutant linkage in question during the expected economic life of the building.
6. Controlled waters.		

4. **INTRUSIVE INVESTIGATION.** BS10175 describes this as an exploratory investigation. Intrusive ground investigation is described in Standard Appendix A. During the investigation representative or indicative samples are obtained for testing by an accredited laboratory. The aim is to determine (with a degree of confidence appropriate to the objectives), the presence, concentration and distribution of contaminants in respect of those points investigated. The extent of any necessary intrusive investigation will depend on the size of the site and any hazards, either known or suspected.

5. **ASSESSMENT OF CONTAMINATION.** The assessment of contaminated land under the terms of Part II A of the Environmental Protection Act 1990 is based upon pollution linkage (source - pathway - receptor model).

The Contaminated Land Report (CLR) series of documents have been produced by the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency, to provide regulators with "relevant, appropriate, authoritative and scientifically based information and advice on the assessment of risk from contamination in soils".

The Environment Agency issued a number of Soil Guideline Values (SGVs), which whilst non-binding, were used as guidance in the assessment of land and in setting remediation targets. They should only be applied to human health assessments. It should however be noted that these have now officially been withdrawn.

The SGVs were derived using the Contaminated Land Exposure Assessment Model (CLEA) and are based on assumptions relating to soil conditions, pollutant type and behaviour, land use patterns and the availability of receptors. SGVs were also subject to statistical assessment. The CLR documentation requires that the results of laboratory testing are subject to statistical analysis to remove uncertainty over a so-called 'averaging area'.

To date only selective SGVs were issued for the following land-uses

- Residential with and without plant uptake
- Allotments
- Commercial/Industrial

Soil Guideline Values (mg/kg)(1)			
Analyte	**Residential (with home grown produce)**	**Allotments**	**Commercial**
Arsenic	32 (37)	49	(640)
Cadmium	10 (22)	3.9	230 (410)
Chromium (total)	130 (21 for Cr vi)	170 (for Cr vi)	5000
Mercury	170	80	3600
Nickel	130	230	1800
Selenium	350	120	13000
Lead (2)	450 (82)	(80)	(2300)
Toluene	610	120	4400
Ethylbenzene	350	90	2800
Phenol	420	280	3200
Benzene	0.33 (0.87)	0.07	95
o-xylene	250	160	2600
m-xylene	240	180	3500
p-xylene	230	160	3200
Copper (2)	2330	524	71,700
Zinc (2)	3750	618	665,000
Benzo(a)pyrene (2)	1.0 (5.0)	2.1	14
Naphthalene (2)	8.7	23	1100
Flourene (2)	780	160	71,000

(1) Now officially withdrawn
(2) Generic Assessment Criteria (mg/kg) derived by LQM / CIEH
(3) Geometric mean value across site
(4) The figures in brackets are the latest C4SLs (see later in text)

DEFRA previously issued "Outcome of the Way Forward Exercise on Soil Guideline Values". This document was intended to provide guidance to determine if there is a Significant Possibility of Significant Harm (SPOSH) i.e. whether land meets the legal trigger of being contaminated land.

In the context of Part 2A, a risk assessor using an SGV would conclude the following (DEFRA, 2008).

- At a representative average soil concentration at or below an SGV, it is very unlikely that there will be a *significant possibility of significant harm (SPOSH)*.

- At a representative average soil concentration above an SGV, there *might* be a *significant possibility of significant harm* with the significance linked to the margin of exceedance, the duration and frequency of exposure, and other site-specific factors that the enforcing authority may wish to take into account. Further investigation and/or detailed evaluation will usually be required.

It should be stressed that where there is any uncertainty as to whether or not there is a SPOSH, it was the policy of this practice to adopt a conservative approach, particularly in the adoption of clean cover systems.

In April 2012, Defra both published new Statutory Guidance which forms a major part of their contaminated land regimes under Part 2A of the Environment Protection Act 1990. The regime provides a means of dealing with contaminated land which poses a significant risk to human health or the environment where there is no alternative solution. It also works alongside planning rules and building regulations to help ensure that affected land is made suitable for use when it is redeveloped.

Since the regime was introduced in 2000 there has been considerable uncertainty over how to decide when land is, and is not contaminated land on grounds of the legal test of *significant possibility of significant harm to human health or the environment*.

To help address this, one of the main changes set out in the new Statutory Guidance, is the introduction of a new four category test to help decide when land is, and is not, contaminated land on grounds of *significant possibility of significant harm to human health*. Under the new four category test:

- Category 1 describes land that is clearly contaminated land, for example because similar land is known to have caused significant harm in the past.

- Categories 2 and 3 cover less straightforward land where more detailed consideration is needed before the regulator can decide either: (a) that there is a strong case for regulatory action, in which case the land would be in Category 2 and be classified as contaminated land under Part 2A; or (b) that such a case does not exist, in which case the land would be in Category 3 and not be classified as contaminated land under Part 2A.

- Category 4 describes land that is clearly not contaminated land, as discussed below.

One of the main purposes of including the Categories in the Statutory Guidance is to provide a legal framework against which new technical tools can be developed by the land contamination sector to describe the Categories in more detail with regard to specific substances and/or situations.

The new Category 4 test is particularly important in terms of reducing uncertainty over when land is definitely not caught by the regime.

The new Statutory Guidance makes clear what land should be placed into Category 4, for example:

(a) Land where no relevant contaminant linkage has been established.

(b) Land where there are only normal levels of contaminants in soil (as explained in Section 3 of the guidance), unless there is a particular reason to consider otherwise. In other words land with normal background concentrations in the soil.

(c) Land that has been excluded from the need for further inspection and assessment under Part 2A because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of the guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of the guidance, e.g. Category 4 Screening Levels.

(d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed to in the normal course of their lives).

The guidance clarifies how generic assessment criteria (including the currently available SGVs/GACs) should and should not be used. It states that:

3.27 It is common practice in contaminated land risk assessment to use "generic assessment criteria" (GACs) as screening tools in generic quantitative human health risk assessment to help assessors decide when land can be excluded from the need for further inspection and assessment, or when further work may be warranted.

3.28 Local authorities may use GACs and other technical tools to inform certain decisions under the Part 2A regime, provided: (i) they understand how they were derived and how they can be used appropriately; (ii) they have been produced in an objective, scientifically robust and expert manner by reputable organizations; and (iii) they are only used in a manner that is in accordance with Part 2A and this Guidance.

3.29 GACs relating to human health risk assessment represent cautious estimates of levels of contaminants in soil at which there is considered to be no risk to health or, at most, a minimal risk to health. With regard to such GACs:

(a) They may be used to indicate when land is very unlikely to pose a significant possibility of significant harm to human health. This is on the basis that they are designed to estimate levels of contamination at which risks are likely to be negligible or minimal and far from posing a significant possibility of significant harm to human health.

(b) They should not be used as direct indicators of whether a significant possibility of significant harm to human health may exist. Also, the local authority should not view the degree by which GACs are exceeded (in itself) as being particularly relevant to this consideration, given that the degree of risk posed by land would normally depend on many factors other than simply the amount of contaminants in soil.

(c) They should not be seen as screening levels which describe the boundary between Categories 3 and 4 in terms of Section 4 (i.e. the two Categories in which land would not be contaminated land on grounds of risks to human health). In the very large majority of cases, these SGVs/GACs describe levels of contamination from which risks should be considered to be comfortably within Category 4.

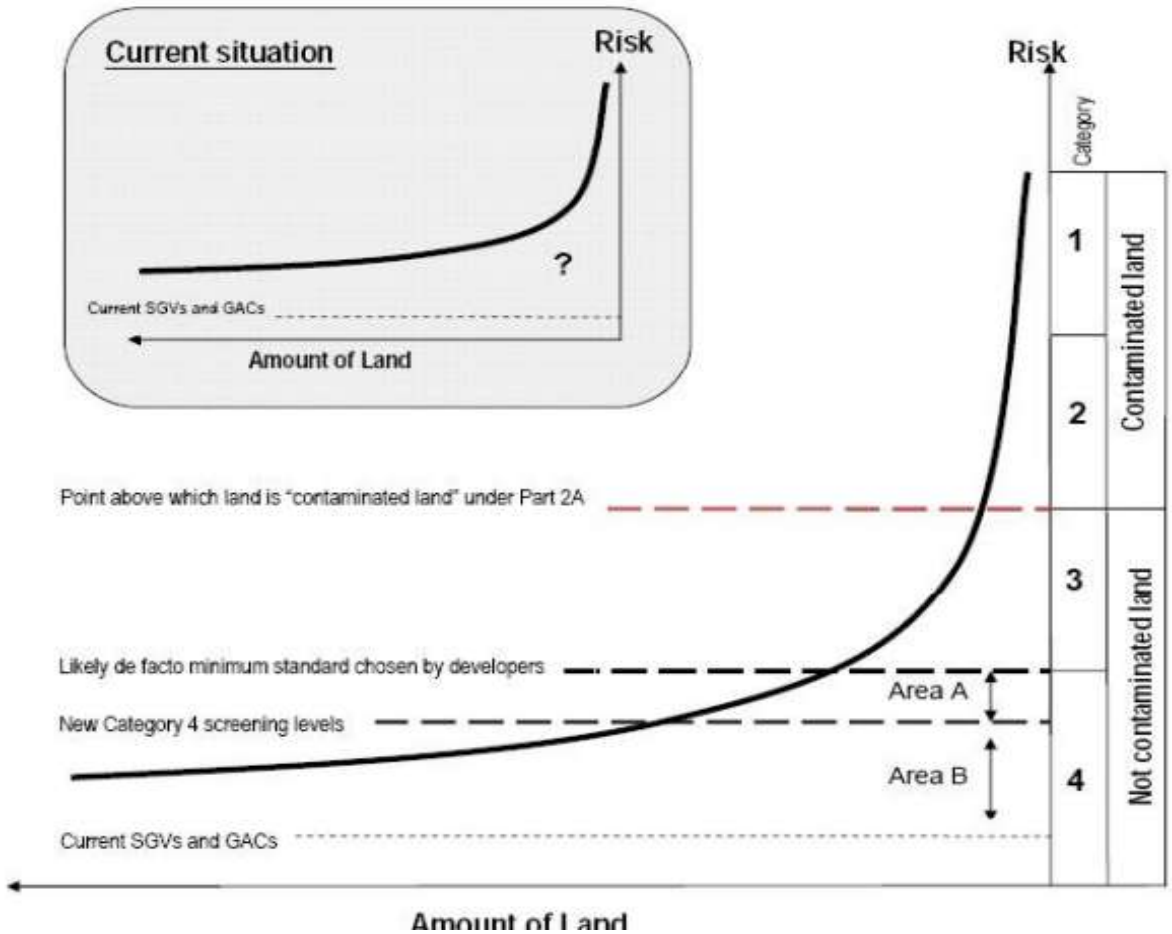
(d) They should not be viewed as indicators of levels of contamination above which detailed risk assessment would automatically be required under Part 2A.

(e) They should not be used as generic remediation targets under the Part 2A regime. Nor should they be used in this way under the planning system, for example in relation to ensuring that land affected by contamination does not meet the Part 2A definition of contaminated land after it has been developed.

The way in which the new four category system is intended to operate and the place of the C4SLs within that system, was explained in detail in the Impact Assessment which accompanied the Statutory Guidance. Please note that although the detail of the Impact Assessment is included here to provide clarity on the job expected of C4SLs, the Statutory Guidance, itself, sets out the regime that needs to be delivered under Part 2A.

Paragraph 47 of the Impact Assessment describes the diagram in detail. Of particular relevance to this project is the description of the overall diagram (sub-paragraph a), description of category 4 (sub-paragraphs c (part iv) and h) and the description of how the monetised benefits of the new system will be realised (sub-paragraph h). These sub-paragraphs are reproduced below.

Diagram showing the new Category 1-4 system (compared to current situation)



The diagram above seeks to illustrate, in a simplified manner, broadly what the changes to the statutory guidance on significant possibility of significant harm to human health are intended to achieve. To explain:

(a) The curved line and axes illustrate the spectrum of risk presented by land contamination. The idea is to show that a very large amount of land is low risk, and only a small amount of land would pose sufficient risk to be contaminated land in the legal sense. The axes and lines in the diagrams are not to scale, and they have been compressed for the purposes of illustration (in reality the risks on Category 1 land would probably be orders of magnitude above Category 4 risks, and vastly more land would be in Category 4 compared to the other Categories).

(b) The smaller diagram summarizes the current situation. In the area below the SGV/GACs there is near certainty that land is not contaminated land, however, above the line there is increasing uncertainty. As explained above, currently remediation usually occurs to just below the SGV/GAC level because they are perceived as offering the only cast-iron guarantee of when land is definitely not contaminated land. Sometimes consultants are employed to justify remediating to levels above the SGV/GACs, however the further they go away from the SGV/GACs the more legal risk they and their clients are exposed to.

(c) The new statutory guidance will end the current situation, and it would not be legally possible e.g. for individual regulators to ignore the changes being made. For example, as explained above, the new statutory guidance will specifically say:

(i) that Part 2A cannot be used to force remediation to below a point where it ceases to be contaminated land in the legal sense i.e. the Category 2/3 border in terms of the diagram), although responsible parties can choose to go further;

(ii) that SGV/GACs cannot be used as one size fits all remediation thresholds under either Part 2A of the planning system;

(iii) that normal background levels of contamination are not caught by Part 2A; and

(iv) that SGV/GACs are well into Category 4, sometimes by only a few times and sometimes by orders of magnitude. These changes and others also provide the legal backing for the development e.g. of Category 4 screening levels, as discussed below.

(d) The new Category 1-4 system divides the spectrum of risk posed by contaminated land into four different categories, and the statutory guidance will explain how to decide when land falls into each Category. This is more sophisticated than the current statutory guidance, which in effect has only two categories (contaminated land or not) and does not explain how to decide which category land falls into. The new Category 1-4 system reflects what assessors find when they investigate real sites i.e. some are clearly contaminated land (Category 1) ; some clearly are not (Category 4) and some are less-straightforward and need some level of detailed assessment before a decision can be taken as to whether or not they are contaminated land (Categories 2 and 3).

(e) In the case of Category 2 and 3 sites, the regulator will have flexibility to take decisions within the parameters set by the new Guidance. There would be less flexibility for Category 2 and 3 sites that clearly pose either a high or low risk. However, the regulator will have considerable flexibility for sites closer to the Category 2/3 border to judge which side of the border a site would fall (e.g. taking account of their understanding of the risks, uncertainties and the interests of the local community). These are often complex decisions which need to be taken case-by-case given the many factors involved.

(f) In the case of Categories 1 and 4 the regulator will have far less flexibility. For example, if a regulator claimed that a site matching the Category 1 description was not contaminated land, or that a site matching the Category 4 description was contaminated land, they would be acting directly against the statutory guidance which the Act requires that they follow, and decisions could be challenged (e.g. in a law court) with a high chance that the challenge would be successful. Among other things, the intention of doing this is to create far more legal certainty around when land is definitely not contaminated land in the legal sense. With the specific wording of the new statutory guidance, and the supporting tools such as the new Category 4 screening levels, it would be very difficult for a regulator e.g. to threaten landowners with the Part 2A regime, and if they tried to determine land as contaminated land they would be operating in direct opposition to the statutory guidance.

(g) In the many consultation meetings held in developing the Category 1-4 system, all the developers, landowners and consultants we spoke to were strongly of the view that they would want the ensure their land is safely within Category 4 (even though in theory they could remediate to a level within Category 3 and still satisfy Part 2A and planning rules). They would do this for various reasons, including the fact that the flexibility granted to regulators in Categories 2 and 3 means that the further into Category 3 a site gets, the greater the risk that the regulator might decide it is in Category 2. Also they would want to be in Category 4 for reasons of marketability, future proofing etc. So developers and others would have a strong incentive to seek the regulatory certainty of being safely within Category 4. Thus, as far as development taking place under the planning system is concerned, Category 3 would, in effect, normally be a buffer which provides added reassurance that development falling within Category 4 will not be caught by the Part 2A regime.

(h) The new statutory guidance will bring about a situation where the current SGV/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. Above the C4SLs, in Area A on the diagram, there will be much stronger legal backing for experts to use their judgement to make sensible and precautionary decisions on when land should be considered to be towards the top end of Category 4, without fear that land may be caught as contaminated land. This recognizes that the generic C4SLs will not be able to describe the Category 3/4 border itself because they are generic and would therefore have to err on the side of caution whilst a detailed site specific assessment would be able to push further by looking at specific circumstances relating to a specific site.

(i) The very large majority of the monetized benefits of the changes to the regime discussed in this Impact Assessment manifest themselves in Category 4, and in particular in Areas A and B on the diagram. The main effects of moving to the new system would include Low risk land falling within Area B (pre-development) on the diagram would no longer have to be remediated because it would fall below the new C4SLs. Similarly land which is in Area A pre-development would no longer need to be remediated if justified by a detailed site-specific assessment. For these sites the cost of remediation would be removed altogether. The cost of remediating land which is initially in Categories 3, 2 or 1 would fall because it would be remediated to the new C4SL levels (or somewhere within Area A if there has been a detailed assessment) rather than the SGV/GAC level. This will have the overall effect of reducing the cost of remediation, with the effect varying according to specific site circumstances, the type of remediation etc. Generally the cost of remediation would fall for many affected brownfield land sites. This would have the general effect of making such land more economically viable for development. It would also mean that some land that is not currently economically viable to develop becomes reduce pressure to develop Greenfield land in some cases. The C4SLs will also speed up regulatory decisions on the reuse of brownfield land by providing a simple remediation standard.

The C4SLs are intended as "*relevant technical tools*" (in relation to Paragraph 4.2.1(c)) provides to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

> *"The new statutory guidance with bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land".*

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):

> *"SGVs are guidelines on the level of long-term human exposure to individual chemicals in soils that, unless stated otherwise, are tolerable or pose a minimal risk to human health".*

C4SLs, therefore, should not be viewed as "SPOSH levels" and they should not be used as a legal trigger for the determination of land under Part 2A.

CL:AIRE (Contaminated Land: Application in Real Environments) has published "*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*". In it a series of C4SLs were proposed as follows;

Analyte	Residential (with home grown produce) (mg/kg)	Residential (without home grown produce) (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)	POS (mg/kg)
Arsenic	37	40	49	640	79
Benzene	0.87	3.3	0.18	98	140
Benzo(a)Pyrene	5	5.3	5.7	77	10
Cadmium	22	150	3.9	410	880
Chromium (vi)	21	21	170	49	21
Lead	200	310	80	2300	630

6. GEOENVIRONMENTAL RISK ASSESSMENT

6.1 **Potential Hazard Sources.** Ground contamination can occur through several causes, particularly from historical use of the site and is often linked to the processes of waste disposal, underground storage, open storage, process pipework, leaks, spillages, tanks, site filling and various other reasons. The contamination can either arise from site sources or be the result of migration from other sources off site.

6.2 **Potential Migratory Pathways.** The primary pathways are considered to be laterally or vertically downward through underlying strata or upward to the ground surface. Such pathways also provide the potential for contaminants to migrate towards local watercourses and groundwater.

6.3 **Potential Targets At Risk.** Potential environmental liabilities related to current legislation associated with contaminated land with regard to existing ownership and redevelopment are summarised.

The probability of a hazard, linked with its consequences, can be used to assess risk in accordance with the tables below for use in decision making.

Consequence of Pollution Linkage

Severe	Damage to human health. Substantial pollution of controlled waters. Significant change in ecosystem population. Irreparable damage to property.
Moderate	Non-permanent damage to human health. Minor pollution of controlled waters. Change in ecosystem. Damage to property.
Mild	Short term health effects. Slight pollution of controlled waters. Slight effect on ecosystem. Minor repairable damage to property.
Near Zero	No noticeable effect on human health. No significant pollution to controlled waters. No measurable effect on ecosystem densities. Non-structural cosmetic damage to property.

Decision Making

Probability of a hazard and an associated linkage	Consequences of a pollution linkage (hazard-pathway-target)			
	Severe	Moderate	Mild	Near Zero
High	High	High	Medium/low	Negligible
Medium	High	Medium	Low	Negligible
Low	High/medium	Medium/low	Low	Negligible
Unlikely	High/medium/low	Medium/low	Low	Negligible

Final overall risk is based on an assessment of probability of a hazard and its consequences. Risk categories are shown shaded in the table above and defined below.

Risk	Description
High	Site probably or certainly unsuitable for present use or environmental setting. Contamination probably or certainly present and likely to have an unacceptable impact on key targets. Urgent action needed.
Medium/ Moderate	Site may not be suitable for present use or environmental setting. Contamination may be present, and likely to have unacceptable impact on key targets. Action may be needed on the medium term.
Low	Site considered suitable for present use and environmental setting. Contamination may be present but unlikely to have unacceptable impacts on key targets. Action unlikely to be needed in present use.
Negligible	Site considered suitable for present use and environmental setting. Contamination may be present but unlikely to have unacceptable impacts on key targets. No action needed while site remains in present use.

The review of the information from the exploratory investigation may be such that a decision is made that there is no need for further investigation. Alternatively, it may be necessary to carry out a further main investigation.

The Environment Agency has set out guidance as to the classification of waste arising from construction sites in its document "The Definition of Waste" dated April 2006. This document outlines how waste is to be handled

The following activities are not regarded as a waste management activity requiring licencing.

1) Construction activities carried out for the purpose of producing a suitably engineered soil e.g. lime stabilisation, vibro-replacement and piling.

2) Uncontaminated materials produced on site (including excavated soils and materials from demolition) which can be reused without further treatment. Examples include site regrading and footing excavations.

   These must be done in accordance with the Planning Permission. Demolition material must be used in accordance with the quality protocols for the production of aggregates from inert waste, subject to appropriate testing and the lack of any harmful constituents. Uses include pipe bedding, backfill and sub-base.

3) Contaminated soils can be moved on-site providing they do not require treatment or containment. There should be no risk to the environment i.e. non-leachable and in accordance with Planning Permission. Relevant activities can include site regarding and use of materials below clean cover systems, capping, buildings and hardstanding.

Where contaminated materials have to be placed in an engineered cell to prevent pollution, then this would be classed as landfilling and require PPC permits. Any material taken off site is considered to be waste. However, this is under review. If material is waste, then there is a duty of care including ensuring material is transported by a registered carrier. The destination of material leaving the site should be regularly checked and Waste Transfer Notes kept.

Clean Cover Systems

According to the Environment Agency's Remediation Position Statements of May 2006, the placement of a cover system using "clean" material is not treatment of waste. Consequently, no licensing/permitting position statements are applicable to this type of remediation. If the cover system uses 'waste materials' in its construction, waste management licensing exemption paragraph 9A may be applicable to its installation. If the installation of the proposed cover system does not meet the criteria for registration of this exemption, the activity may be regulated through a waste management site licence.

7. WASTE ACCEPTANCE CRITERIA (WAC)

The main objective of the Landfill Directive is to prevent or reduce as far as possible the negative effects of landfilling waste on the environment and on human health. It is intended to reduce the disposal of waste materials to landfills and to encourage more sustainable approaches to dealing with wastes. It bans the landfill of liquids and certain solid wastes, introduces requirements for the treatment of wastes prior to landfill and provides for the classification of landfills as sites for inert, hazardous or non-hazardous waste and prohibits co-disposal.

It sets out procedures for waste acceptance at landfills and the types of waste for each class of landfill as specified by Waste Acceptance Criteria (WAC). The WAC are predominantly lists of "limit values" for certain parameters obtained from standard leaching tests of wastes going to landfills. WAC are set out in the Landfill Directive itself. Full details can be found in the Environment Agency document "Guidance for waste destined for disposal in landfills" Version 3.1:2010.

8. MAIN REFERENCES

British Standards	BS3882: 2015 British Standard Specification for Topsoil BS5930: 2015 British Standard Code of Practice for Site Investigations BS8485: 2015 British Standard Code of Practice for the design and protective measures from methane and carbon dioxide ground gases for new buildings BS10175: 2011+A1:2013 British Standard Code of Practice for the Investigation of Potentially Contaminated Sites
BRE	Radon: Guidance on protective measures for new dwellings, BR211, 2015 Protective measures for housing on gas-contaminated land, BR414, 2015 Cover systems for land regeneration, 2004 Concrete in aggressive ground. Special Digest SD1, 3rd Edition, 2005 Soakaway Design (DG365)
CIEH	The LQM / CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)
CIRIA	Assessing risks posed by hazardous ground gases to buildings, CIRIA C665 Asbestos in Soil and Made Ground: a guide to understanding and managing risks, CIRIAC733, 2014 Good Practice on the testing and verification of protection systems for buildings against hazardous ground gases. C735:2014
CL:AIRE	Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, SP1010, 2013
DEFRA	Contaminated Land Report CLR 11, 2002 (7-10 withdrawn) R & D Publications TOX 1 – 12, 14, 16 – 25 R & D Publications SGV 1, 3, 4, 5, 7, 8, 9, 10, 15 and 16 (withdrawn) Improvements to Contaminated Land Guidance - "Outcome of the "Way Forward", 2008 Exercise on Soil Guideline Values. July 2008 Guidance on the Legal Definition of Contaminated Land. July 2008 Simplification of the Contaminated Land Regime Impact Assessment No: Defra 1133
DETR	Circular 02/2000. Contaminated Land, 2000 Guidelines for Environmental Risk Assessment and Management, 2000
Environment Agency	Guidance for the Safe Development of Housing on Land Affected by Contamination, 2000 Guidance for waste destined for disposal in landfills, 2010 Protective measures for housing on gas-contaminated land Remediation Position Statements, May 2006 Guidance and monitoring of landfill leachate, groundwater and surface water Human health toxicological assessment of contaminants in soil (Science Report SC050021/SR2) 2008 Updated technical background in the CLEA model (Science Report SC0520021/SR3)
HMSO	Part 2A of the Environmental Protection Act Part 2A Statutory Guidance – April 2012 Contaminated Land (England) Regulations 2006 The Contaminated Land (England) (Amendment) Regulations 2012 The Water Act 2003 (Commencement No. 11) Order 2012
Institution of Civil Engineers	Contaminated Land: Investigation, Assessment and Remediation, 2nd Edition
NHBC	Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present, 2007

This list is not intended to be exhaustive.

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