PHASE I DESK STUDY REPORT FOR LAND AT BROADWAY/PETERBOROUGH ROAD, CROWLAND, PE6 0AX

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Prepared for

Mr S Littlechild

This report has been prepared under the framework of BS EN 9001:2008

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EXECUTIVE SUMMARY

A Phase I Desk Study Report (which includes a preliminarily risk assessment) was required by South Holland District Council under the National Planning Policy Framework (introduced March 2012 and updated July 2018), and CLR 11. This report is required for the partial discharge of a contaminated land planning condition attached to the decision notice for the proposed development at the site. South Holland District Council requires the report to satisfy the National Planning Policy Framework in which it is stated that:

1. "a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

2. "after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990"; and

3. "adequate site investigation information, prepared by a competent person, is available to inform these assessments."

In order for the partial discharge of a contaminated land planning condition attached to the decision notice for the proposed development at the site, ***Mr S Littlechild*** commissioned ***Demeter Environmental Ltd*** to undertake a Phase I Desk Study Report (which includes a preliminarily risk assessment) for land at Junction of Broadway/Peterborough Road, Crowland, PE6 0AX, to support the planning application for the erection of a dwelling.

The report has been completed to fulfil the requirements of a preliminary risk assessment in accordance with CLR11 "Model Procedures for the Management of Land Contamination", "National Policy Planning Framework" and "Guiding Principles for Land Contamination" and the documents referred to in Appendix A.

These procedures relate to 'past' contamination, and assume that legislative controls such as Pollution Prevention and Control authorisations control current potentially polluting activities. Emphasis is therefore upon historic site use and how this may affect potential future users of the site should the proposed development plans be realised.

The project has been carried out within the existing legislative framework, which is outlined in Appendix B.

It should be noted that the table below only offers a brief summary of the information presented in this report and is for briefing purposes only. Reference should be made to the main report for detailed analysis undertaken.

Table 1: Executive Summary

	SUBJECT		DATA
SITE INFORMATION AND SETTING	Client		Mr S Littlechild
	Site		Land at Junction of Broadway/Peterborough Road
	Site location		Land at Junction of Broadway/Peterborough Road, Crowland, PE6 0AX
	Proposed development		The erection of a dwelling
	Planning Reference		H02-0187-18
	Grid Reference		524112E, 309837N
	Current Land Use		Garden
	Access		Via track off Broadway
CONCEPTUAL SITE MODEL	History		Initially (1886) the site appeared to form part of the grounds of a property on the southern boundary, the 1887 map indicated the site comprised of a larger part of open land. It is unclear when the site was developed but by 1973 the site formed part of the garden of the property on the southern boundary.
	Geology	Drift	Abbey Sand And Gravel.
		Solid	Oxford Clay Formation (mudstone) of the Oxfordian Age - Callovian Age
	Radon		Less than 1% of properties are above the action level. No radon protective measures are required.
	Hydrology		A watercourse is approximately 108m E of the site, which is a very low sensitivity water body. There are a further 2 water bodies within 250m all of which are very low sensitivity water bodies
	Hydrogeology	Drift	The drift is regarded as a low sensitivity aquifer
		Solid	The solid is regarded as a very low sensitivity aquifer
	Previous Site Investigation		N/A
	Potential Sources of Contamination		Made Ground
	Potential Contaminants of Concern		Wide range of contaminants in the made ground (if present)
	Potential Receptors		Human beings (construction workers) Human beings (future residents) Human beings (trespassers / transient users) Human beings (residents of adjacent properties) Property in the form of buildings (on site) Potable water mains (on site)

Table 1(continued): Executive Summary

PPL ID	AIM(S) / OBJECTIVES(S)	Proposed Further Investigation	Proposed Remediation In Lieu of Site Investigation
2 to 5	To determine if made ground is present on the site and if present, is it impacted by elevated levels of contamination:	Given the site investigation undertaken by others has demonstrated that made ground is not present across the majority of the site no further intrusive works are proposed.	Based on the discussion in Clause 8 remediation in lieu of site investigation is suitable for the site, the proposals are given hereunder: **Garden/ Landscaped Areas:** Removal of all made ground from garden/landscaped areas up to a maximum of 600mm, where the made ground is present at depths of greater than 0.60mbgl, a 600mm cover underlain by a geotextile will be placed.
Watching Brief	This report has identified a number of potential sources of contamination (Table 12) where the overall risk was low, and further works were not justified. This assessment is based on the information within this report; hence, it is proposed that a watching brief be undertaken during the development. Site Building: As the development commences if there is any visual or olfactory evidence of contamination further works should be undertaken.		
This sheet is intended as a summary of the report; it does not provide a definitive analysis and should not be treated as an independent document.			

1.0 INTRODUCTION

1.1 Desk Study Terms of Reference

1.1.1 This report presents the results of a Phase I Desk Study carried out within the grounds of for land at Junction of Broadway/Peterborough Road, Crowland, PE6 0AX, performed for ***Mr S Littlechild***. This report was written in March 2019 and should be read in the light of any subsequent changes in legislation, statutory requirements or industry practices.

1.1.2 The works were carried out in accordance with the standard terms of contract of ***Demeter Environmental Ltd***.

1.1.3 The aim of the report is to partly discharge of a contaminated land planning condition attached to the decision notice for the proposed development at the site, for the site.

1.1.4 This report has been prepared in accordance to the Demeter Environmental Limited Quality Management System.

1.2 Aims and Objectives of Desk Study

1.2.1 The objectives of the desk study are as follows:

- To provide information on past and current uses of the site and surrounding area and the nature of any hazards and physical constraints;
- To determine the risks associated with hazardous ground gas, including radon;
- To identify current and likely future receptors, potential sources of contamination and likely pathways and any features of immediate concern, including those that could be introduced in the future;
- To provide information on the geology, geochemistry, soil, hydrogeology and hydrology of the site;
- To identify potentially different sub-areas (zones) of a site, based on differing ground conditions; potential contamination; and past, present and future uses;
- To produce an initial conceptual model for the site as a whole and/or for zones within the site;
- To provide information for the preliminary risk assessment;
- To provide data to assist in the design of potential subsequent exploratory and main investigations and to give an early indication of possible remedial requirements;

- To provide information relevant to worker health and safety and to the protection of the environment during field investigations;
- To identify the need to involve regulatory bodies prior to intrusive investigation.

1.2.2 The primary objective of the desk study is to identify potential environmental issues that may represent a constraint to the proposed redevelopment of the site. The findings of this assessment can be used to determine, if required, the scope of a follow on Phase II intrusive site investigation.

1.2.3 The desk top study provides an initial view in respect of the status of the site with regard to:

- The potential impact on the site of interest from surrounding land uses and other environmental factors;
- Potential contamination of the site strata by historical and or current use;
- The potential impact on the wider environment by historical and or current use of the site of interest;
- Potential problems associated with geological features such as faulting, mineral extraction, mining and land instability;
- The location of above-surface features that may affect the proposed redevelopment.

1.2.4 This study includes a review of the available geological, historical and environmental information in order to establish the likely ground conditions at the site. The review is based on the following information:

- Align any report to the requirements of relevant guidance;
- To assess historical activities, referring to past Ordnance Survey maps, at the site with respect to their potential impact on the site environment;
- To characterise the environmental setting of the site, identify migration pathways and vulnerable receptors for contamination originating at the site, focusing on potential soil and groundwater liabilities;
- To assess historical and current surrounding land use, referring to past Ordnance Survey maps, in relation to known or potential off-site contamination issues that may impact the subject property;

- To identify likely ground conditions at the site and the potential geotechnical and environmental constraints to development;
- To establish development abnormals prior to site development;
- Assessment of the potential risks to both on and off site receptors;
- To develop a preliminary conceptual model.

1.2.5 The data collated in this study has been undertaken to allow the construction of a preliminary conceptual model, which represents the potential contaminant linkages that have been identified on the site. This is used as a basis to develop a strategy for an intrusive investigation where required.

1.3 Scope of Desk Study

1.3.1 The scope of work for this report comprises of the following:

- Procurement of Groundsure GeoInsight Report;
- Procurement of Groundsure EnviroInsight Report;
- Procurement of Ordnance Survey maps;
- Review of published geology;
- Review of data available in the public domain (borehole section sheets etc.);
- Review of planning history and any associated documents using information in the public domain;
- Site walkover survey;
- Preparation of a preliminarily risk assessment.

1.4 Proposed Development

1.4.1 It is proposed that a dwelling is erected on the site. The proposed site development plan is shown on Sharman Architecture drawings in Appendix D.

1.4.2 The development is subject to Planning Reference H02-0187-18.

1.5 Basis of Risk Assessment

1.5.1 This assessment has been undertaken with due regard to the Environmental Protection Act 1990, associated statutory guidance (NPPF, PAN 33 etc.), 'Guidance for the Safe

Development of Housing on Land Affected by Contamination', 'CLR 11 (Model Procedures for the Management of Land Contamination)', the Contaminated Land Guidance Documents issued by the Environment Agency and the documents referred to in Appendix A. The methods used follow a risk based approach with the potential risk assessed using the 'Source – pathway – receptor contaminant linkage concept introduced by the Environmental Protection Act.

1.6 Limitations and Exceptions of this Report

1.6.1 This report was undertaken for ***Mr S Littlechild*** and as such should not be entrusted to any third party without written permission of ***Demeter Environmental Ltd***.

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a) The date on which this assessment was undertaken;
b) The date on which the final report is delivered.

1.6.4 This report has been compiled from a number of sources, within the time constraints of the programme, which ***Demeter Environmental Ltd*** believes to be trustworthy. However ***Demeter Environmental Ltd*** is unable to guarantee the accuracy of information provided by third parties.

1.6.5 The findings and opinions provided in this document are made in good faith and are based on data provided by third parties (Groundsure, Environment Agency, The Coal Authority, and Regulatory Bodies) and the report should be read in conjunction with the limitations on the document control form. The accuracy of map extracts cannot be guaranteed and it should be recognised that different conditions on /adjacent to the site may have existed between and subsequent to the various map surveys.

1.6.6 This report is prepared and written in the context of the purposes stated above and should not be used in a different context. Furthermore, new information, improved practices and legislation may necessitate an alteration to this report in whole or in part after its submission. Therefore with any change in circumstances or after the expiry of one year from the date of this Report, the report should be referred to ***Demeter Environmental Ltd*** for reappraisal.

1.6.7 The conclusions and recommendations of this report are based on the development described in Clause 1.4, for any other development the report may require revision.

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1.6.10 The report should be read in its entirety, including all associated drawings and appendices. ***Demeter Environmental Ltd*** cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context.

1.6.11 This report does not comprise a geotechnical assessment of the strata underlying the site.

1.6.12 Any borehole data from the British Geological Survey sources is included on the following basis: 'The British Geological Survey accept no responsibility for omissions or misinterpretations of the data from their Data Bank as this may be old or obtained from non-BGS sources and may not represent current interpretation'.

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1.6.15 Any risks identified in a Phase I Desk Study Report are perceived risks. Actual risks can only be assessed following a physical investigation of the site. ***Mr S Littlechild*** should be aware that this report is based on information available at the time. Where a site investigation has been undertaken, the ground conditions can only be defined precisely at the exploratory positions, whilst an intermediate positions they can only be inferred. It is possible that factors may vary due to seasonal effects or other climatic effects, and may at times differ from those measured during the investigation. While every attempt is made to assess the likelihood and extent of such variations, conditions may nevertheless exist which are undisclosed by this investigation.

1.6.16 The findings of this report are based on finite information obtained from research and consultations. Demeter Environmental Ltd cannot guarantee the reliability of all such information and the searches should not be considered exhaustive. The findings of the report may need to be reviewed as any future exploratory investigations progress and in the event that additional archive information becomes available.

1.6.17 Notwithstanding the findings of this study (and any subsequent investigations), if any indication of contaminated soil (visual or olfactory) is encountered at any stage of the development further investigation may be required.

1.6.18 Arboricultural Survey and advice on arboricultural issues are considered to be outside the scope of this report except for their effect on the foundations to the proposed buildings. Where identification of any species is made, especially invasive plants such as Japanese Knotweed, Himalayan Balsam or Giant Hogweed, this should only be considered as a preliminary assessment and subject to confirmation by a professional Arboriculturist. Demeter Environmental Ltd takes no responsibility for failing to identify, or the incorrect identification of, any tree or plant species on site.

1.6.19 Our investigations exclude surveys to identify the presence injurious and invasive weeds. Under the Weeds Act 1959, the Secretary of State may serve an enforcement notice on the occupier of land on which injurious weeds are growing, requiring the occupier to take action to prevent the spread of injurious weeds. The Weeds Act specifies five Injurious weeds: Common Ragwort, Spear Thistle, Creeping of Field Thistle, Broad-leaved Dock and Curled Dock. The Wildlife and Countryside act 1981 provides the primary controls on the release of non-native species into the wild in Great Britain. It is an offence under section 14(2) of the act to 'plant or otherwise cause to grow in the wild' any plants listed in schedule 9, part II. The only flowering plants currently listed are Japanese Knotweed and Giant Knotweed. The presence of such weeds on site may have considerable effects on the cost / timescale in developing the site.

1.6.20 Good guidance on injurious and invasive weeds is provided on DEFRA and Environment Agency web sites.

1.6.21 Our investigations exclude surveys to identify the presence or indeed absence of asbestos in buildings/infrastructure on site. If asbestos is suspected to be present, we recommend specialists in the identification and control / disposal of asbestos are appointed prior to commencement of any works on site or, if appropriate, purchase of the site. The presence of asbestos on site may have considerable effects on the cost / timescale in developing the site. There is good guidance in relation to Asbestos available on the Health and Safety Executive (HSE) web site.

1.6.22 The scope of this investigation does not include an assessment for the presence of asbestos containing materials within or below the buildings or in associated infrastructure in the ground at the site. Should there be a requirement under Regulation 4 of the Control of Asbestos at Work Regulations 2002 for any part of the site to be deemed 'non-domestic premises' the duty holders should prepare an asbestos risk management plan and this may require technical survey works as described in the HSE Guidance HSG264.

1.6.23 The Health and Safety at Work Act requires that Employers provide safe places of work for their employees. The Control of Asbestos at Work Regulations (CAWR) place very heavy specific duties on those who commission and carry out work on asbestos containing materials. Construction work that is likely to involve exposure of workers to hazards associated with asbestos in existing buildings will be subject to the Construction (Design and Management) Regulations which impose duties upon Clients, Designers and the Contractors carrying out the work. Other health and safety and welfare regulations place duties on Employers to undertake risk assessments and prepare hazard management plans which, in the case of a building likely to contain asbestos, could involve the commissioning of surveys, hazardous materials location registers and proposals for remedial work.

1.6.24 Whilst a site walkover has been undertaken as part of this report, the survey does not constitute either an asbestos or structural survey and all areas of the site may not have been visited / inspected.

1.6.25 Consideration of occupational health and safety issues are beyond the scope of this report.

1.6.26 All assessments and recommendations should be forwarded to the relevant planning authorities for comment and approval prior to implementation.

1.7 Principal Sources of Information

1.7.1 Documents that were available or have been obtained for reference or obtaining data are given in Appendix A. Further information on data used in this report and dates the data was obtained/accessed is given below:

Table 2: Summary of Information Obtained

Source	Data Provided	Date Obtained
Groundsure	Ordnance Survey Maps Groundsure GeoInsight Report Groundsure EnviroInsight Report	4th March 2019
South Holland District Council	Planning history	5th March 2019
British Geological Survey	1:50,000 Geological Maps 1:10,000 Geological maps Borehole Section sheets	5th March 2019
Environment Agency	Historic Landfill Data (last updated 5th April 2016) Authorised Landfills (5th April 2016)	5th March 2019
MAGIC Database	Nitrate Vulnerable Zones Aquifer Details Groundwater vulnerability Water Safeguard Zones Groundwater Source Protection Zone	5th March 2019
Coal Authority	Interactive Map Viewer Coalfield Plans	5th March 2019
Google Earth©	Aerial plates	5th March 2019
Google Streetview©	Street level imagery	5th March 2019

2 SITE CONTEXT

2.1 Site Location

2.1.1 The site is located at the Junction of Broadway/Peterborough Road, Crowland, the approximate grid reference is 524112E, 309837N, as shown on Drawing 1 and Plate 2 in Appendix D.

2.1.2 The site is located within the administrative jurisdiction of South Holland District Council.

2.2 Site Description & Site Reconnaissance Visit

2.2.1 The aims of the walkover were to determine whether there were any obvious potential sources of contamination, pathways and receptors on or near the site and whether there were any obvious geotechnical difficulties with the site. In addition, access routes into the site were investigated in order to establish the feasibility of further site investigation.

2.2.2 A site walkover survey was undertaken in March 2019 by a consultant from Demeter Environmental Ltd, in general accordance with CLEA CLR 2, on completion of a review of relevant historical and environmental data. The observations of the walkover are presented hereunder:

Table 3: Summary of Walkover Survey

Topic		Discussion
Site Description / Use		The site extended to an area of approximately 0.04Ha and the site topography was approximately level. The site is at a lower elevation than the street. The site comprised of a part grassed, roughly landscaped garden area. As part of the walkover survey, it was noted that cement sheeted Nissen style hut was present approximately 20m north of the site.
Description of surrounding area		Residential surroundings
Surrounding Land Uses	North	Road (the junction of Broadway and Peterborough Road)
	East	Road (the junction of Broadway and Peterborough Road), the houses
	South	House and garden
	West	Track then house and Nissen Hut
Access		Via track off Broadway
Structures		No structures were present on the site.
Surfacing		The entire site was surfaced with soft landscaping and grass.
Made Ground		Occasional made ground was noted on the site as inclusions of brick and concrete gravels and cobbles on the surface of the site.
Vegetation / Trees		Bushes and grass were noted on the site. Arboricultural Survey and advice on arboricultural issues are considered to be outside the scope of this report except for their effect on the foundations to the proposed buildings. Where identification of any species is made this should only be considered as a preliminary assessment and subject to confirmation by a professional Arboriculturist. Demeter Environmental Ltd takes no responsibility for failing to identify, or the incorrect identification of, any tree or plant species on site.
Invasive Species		During the site walkover, we did not notice the presence of any Japanese Knotweed, however this plant can be difficult to identify in the early stages of growth and therefore it is not always possible to identify its presence at certain times of the year. It should be noted that we are not qualified ecologists and as such cannot guarantee the absence of Knotweed or other invasive vegetation. It is recommended that if it is suspected that this species or other similarly invasive plants are present at the site, a specialist contractor should be commissioned to make a detailed assessment.
Storage Tanks		Two bins were noted on the site, they were possibly associated with burning. No other evidence of either historical or current underground or aboveground storage tanks was noted at the site.
Raw Material and Chemical Use and Storage		No evidence of significant raw material or chemical use or storage was observed at the site.
Solid Wastes		No significant observations were made of solid waste storage at the site.
Hazardous and Industrial Wastes		No evidence of significant hazardous and industrial waste storage was observed at the site.
Air Emissions		No significant sources of were observed at the site.
Asbestos Containing Materials		Asbestos has not been identified on site during our site walkover. However, asbestos may be present in the made ground at the site associated with past historical use. In the event that any asbestos is identified in the future or if it is considered that there is a risk that asbestos exists in the building, a full asbestos survey should be carried out. Guidance on the need for asbestos surveys and the method of carrying them out are given in HSE Publication MDHS100. It should be noted that we are not qualified asbestos surveyors and as such cannot guarantee the presence or absence of ACM's.
Spills and Releases		No evidence of any spills or releases of substances which may contain potentially polluting materials was noted at the site.
Fly Tipping		No evidence of fly tipping was noted at the site.

2.2.3 A plan of the site in its current configuration is presented on Drawing 3 in Appendix D.

2.2.4 Photographs of the site and a photograph key plan are presented in Appendix E.

3 SITE HISTORY

3.1 Historical O.S. Maps, Aerial Plates and Street View Images

3.1.1 The historical usage of both the site and the surrounds has been researched by reference to historical maps (maps presented in Appendix F, Old Maps Online, and National Library of Scotland), street plans, street directories, historical aerial photographs (Google Earth, Britain From Above, historical street level imagery and plates in the public domain. The historical O.S. maps are presented in Appendix F and are summarised hereunder in Table 4.

Table 4: Summary of Review of Historical Maps And Aerial Plates

Area	Summary of Historical Review
Site	Initially (1886) the site appeared to form part of the grounds of a property on the southern boundary, the 1887 map indicated the site comprised of a larger part of open land. It is unclear when the site was developed but by 1973 the site formed part of the garden of the property on the southern boundary. Aerial plates identify a small building on the south western corner of the site, based on the layout is likely a residential garage. The street level imagery from April 2009 confirms a shed is present on the south western boundary and the site appears to be used to grow produce.
Area adjacent to the site	Initially the site boundaries were formed by Broadway to the north. Peterborough Road to the east and open land to the south and west. By 1950 the western boundary was formed by dwellings and by 1973 the southern boundary was formed by dwellings. A number of buildings were present on the south western boundary but their use is not identified. The buildings are identified on all aerial plates and street level imagery.
Area within 100m (250m for in-filled land)	A number of potentially contaminative land uses have been identified on the historical O.S. maps, which are discussed below by order of date. **1890:** Pond 220m north east – in-filled prior to the 1973 map Pond 115m south west - in-filled prior to the 1973 map

3.2 Anecdotal Evidence

3.2.1 No additional information on the site history could be sourced.

3.3 Archaeological Considerations

3.3.1 No known archaeological considerations have currently been identified.

3.3.2 Archaeological information has not been sought as part of this desk study and has not been identified as an issue by the Client. Some Local Authorities require at least an initial archaeological appraisal for development sites.

3.3.3 Archaeological investigations occasionally reveal ground-related problems from ancient times (prior to the 1st Edition O.S. maps) and can occasionally cause foundation and contamination development hazards.

3.3.4 The Local Authority archaeological officer has not been contacted at this stage.

3.4 Planning Information

3.4.1 A search of on-line planning information held by South Holland District Council was undertaken, no salient information was sourced.

3.5 Previous Reports

3.5.1 A site investigation report was provided by the client, which is presented in Appendix H. The site investigation comprised of the excavation of two trial pits The trial pits were excavated outside the area of made ground identified during the walkover survey. Made ground was not recorded in either location.

4 ENVIRONMENTAL SETTING

4.1 Published Geology – 1:10,000 Geological Maps

4.1.1 The documented geology has been ascertained by the examination of British Geological Survey 1:10,000 Sheet and the appropriate geological memoir is summarised hereunder.

4.1.2 The drift geology is given as Abbey Sand And Gravel.

4.1.3 The solid geology is given as Oxford Clay Formation (mudstone) of the Oxfordian Age - Callovian Age.

4.2 Published Geology – 1:50,000 Geological Maps

4.2.1 The documented geology has been ascertained by the examination of British Geological Survey 1:50,000 Sheet 158 (Peterborough) and the appropriate geological memoir is summarised hereunder.

4.2.2 The drift geology is given as Abbey Sand And Gravel.

4.2.3 The solid geology is given as Oxford Clay Formation (mudstone) of the Callovian epoch.

4.3 Data From The Coal Authority

4.3.1 The Coal Authority interactive map viewer was accessed, the map indicates the site is not within a "Development High Risk Area".

4.3.2 The Development High Risk Area is defined as 'The Development High Risk Area is the part of the coal mining reporting area which contains one or more recorded coal mining related

features which have the potential for instability or a degree of risk to the surface from the legacy of coal mining operations. The combination of features includes mine entries; shallow coal workings (recorded and probable); recorded coal mining related hazards; recorded mine gas sites; fissures and breaklines and previous surface mining sites. New development in this defined area needs to demonstrate that the development will be safe and stable taking full account of former coal mining activities. This area was formally known as the Development Referral Area'.

4.4 Borehole Records

4.4.1 The BGS Borehole map indicates that there are no borehole records available within 50m of the site.

4.5 Geological Hazards

4.5.1 Potential natural geological hazards which may represent a risk to the proposed development on the site could include the following:

Table 5: Summary of Potential Natural Geological Hazards Identified in the Groundsure© Reports

Potential Hazard	Assessed Risk on the Site			
Radon	The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level. No radon protective measures are necessary.			
Background Soil Chemistry	Element	Estimated Geometric Mean (mg/kg)	Residential Threshold(mg/kg)	Industrial / Commercial Threshold (mg/kg)
	Arsenic	15-25	37 (S4UL)	640 (S4UL)
	Cadmium	<1.8	10 (S4UL)	230 (S4UL)
	Chromium	60-90	620 (S4UL)	30,400 (S4UL)
	Nickel	30-45	130 (S4UL)	1,700 (S4UL)
	Lead	<100	200 (C4SL)	750 (C4SL)

4.6 Review Of Data Obtained From Geology and Ground Stability Groundsure Report

4.6.1 A geology and ground stability report has been procured from Groundsure©, which is presented in Appendix G, and is summarised hereunder.

Table 6: Summary of Data within Groundsure© Geology and Ground Stability Report

Data	Distance	Comments	Significance
Faults	<50m	No data	-
Historical Surface Ground Workings (Potentially In-filled Land)	<250m	No data	-
Historical Underground Workings	<250m	No data	-
Current Ground Workings	<250m	No data	-
Historical Mining	<1000m	No data	-

5 HYDROLOGY AND HYDROGEOLOGY

5.1.1 The geological succession underlying the site may be regarded as a series of discrete units in terms of their hydrogeological significance, as illustrated hereunder:

Table 7: Hydrogeological Interpretation

UNIT	PROPERTIES	AQUIFER TYPE	FLOW TYPE	PERMEABILITY
Made Ground	Likely to be generally granular and permeable and will permit vertical and lateral transmission of groundwater. Where underlain by an aquiclude perched groundwater may be present in depressions at the interface.	N/A	N/A	N/A
Sand and Gravels	Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.	Secondary A	Intergranular	High to very high
Mudstone	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.	Unproductive Strata	Fractured	Very low to low

5.2 Assessment of Vulnerability of Surface Water Receptors

5.2.1 The sensitivity of the surface water bodies within 250m has been assessed in line with the methodology in Appendix C based on the information presented below:

Table 8: Assessment of Vulnerability of Surface Water Receptors

INFORMATION	DISCUSSION
Are there any Watercourses within 250m of the site?	108m E 154m SW 200m S
Current Ecological / Chemical Quality	No data
Predicted Ecological / Chemical Quality	No data
Are there any current surface water abstractions within 1000m of the site?	788m SE – spray irrigation 84m W - spray irrigation
Is the site within a Surface Water Safeguard Zone? (Environment Agency website)	No
Sensitivity of Surface Water	L2 – very low

5.3 Assessment of Vulnerability of Groundwater

5.3.1 The sensitivity of the underlying groundwater in both the drift deposits and bedrock has been assessed in line with the methodology in Appendix C based on the information presented below. Where the vulnerability of groundwater is regarded as low or very low the receptor will not be regarded as a credible receptor and will not be assessed further.

Table 9: Assessment of Vulnerability of Groundwater in Drift and Solid Deposits

INFORMATION	DISCUSSION – Sand and Gravels	DISCUSSION - Mudstone
Aquifer Designation	Secondary A	Unproductive
Depth of drift cover	Unknown	
Groundwater Vulnerability	Minor Aquifer Intermediate	
Is Site In A Source Protection Zone?	No – none within 500m	
Are There Any Current Groundwater Abstractions Within 1000m Of The Site?	No	
Are There Any Potable Abstractions Within 1000m Of The Site?	No	
Is the site within a Groundwater Safeguard Zone?	No	
What Is The Sensitivity Of Watercourses That May Be Fed By Groundwater	L2 – very low	
Sensitivity of Groundwater	L1 - low	L2 – very low

6 DATA OBTAINED FROM REGULATORY BODIES AND OTHERS

6.1 Data From Groundsure

6.1.1 An Environmental Data Report was procured from Groundsure©. Groundsure© reports contain a broad spectrum of environmental data collated from many sources, including the Environment Agency and the relevant local authority. The report is contained in Appendix G.

6.1.2 Relevant data on potentially contaminative land uses within the report, covering an area within a radius of 50m (250m for landfill and other waste sites) from the site is summarised hereunder:

Table 10: Summary of Groundsure© Environmental Data Report

Data	Distance	Comments	Significance
AUTHORISATIONS, INCIDENTS AND REGISTERS			
Historical Land Use	On Site	No data	-
	<50m	No data	-
Environmental Permits, Incidents and Registers	On Site	No data	-
	<50m	No data	-
Landfill and Other Waste Sites	On Site	No data	-
	<250m	No data	-
Current Industrial Sites Data	On Site	No data	-
	<50m	No data	-
Records of Petrol and Fuel Sites	On Site	No data	-
	<50m	No data	-
Underground High Pressure Oil and Gas Pipelines	On Site	No data	-
	<50m	No data	-

6.2 Ecological Designated Sites

6.2.1 Data on ecological designated sites with the Groundsure© report covering an area within a radius of 50m from the site are summarised hereunder:

Table 11: Summary of Groundsure© Environmental Data Report

Data	Distance	Comments
ECOLOGICAL DESIGNATED SITES		
Records of Sites of Special Scientific Interest (SSSI):	<50m	No data
Records of National Nature Reserves (NNR):	<50m	No data
Records of Special Areas of Conservation (SAC):	<50m	No data
Records of Special Protection Areas (SPA):	<50m	No data
Records of RAMSAR Sites:	<50m	No data
Records of Local Nature Reserves (LNR):	<50m	No data
Records of World Heritage Sites:	<50m	No data
Records of Environmentally Sensitive Areas:	<50m	No data
Records of Areas Of Outstanding Natural Beauty (AONB)	<50m	No data
Records of National Parks (NP)	<50m	No data
Records of Ancient Woodland:	<50m	No data

6.2.2 The site is designated as within a Nitrate Vulnerable Zone (NVZ), which the Environment Agency detail as "land draining into waters polluted by nitrates from agriculture." This is a designation aimed at farmers to tackle nitrate loss as a mandatory requirement. This designation is therefore unlikely to be applicable or limit the intended development.

6.2.3 If a full assessment of Environmental or Ecological aspects is required, it is recommended that appropriate specialists be consulted.

7 PRELIMINARY CONCEPTUAL MODEL AND PRELIMINARILY RISK ASSESSMENT

7.1 Introduction

7.1.1 The findings of the desk study have been used to develop a preliminary conceptual model of the site, which identifies potential contaminant linkages. The scope of the model is intended primarily to identify potential impacts to human health and environmental receptors from potential on site and off-site contamination sources. More generalised comments may be included with respect to potential impacts to the wider ecosystem if relevant.

7.1.2 Contaminated land is defined under Section 78A(2) of the Environmental Protection Act 1990 IIA, as "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:

- Significant harm is being caused, or there is significant possibility of such harm being caused, or
- Pollution of controlled waters is being or is likely to be caused"

7.1.3 Thus land can be defined as contaminated if it is causing significant harm; or where substances in, on or under the land are polluting a controlled water, or there is a significant risk of this happening.

7.1.4 Current approaches (CLR11- 'Model Procedures for the Management of Land Contamination', Part IIA of the Environmental Protection Act 1990 and the National Planning Policy Framework) to risk assessment of contaminated land suggest the construction of a Preliminary Conceptual Model. The purpose of this model is to define all possible complete contaminant linkages, where the requisite source – pathway – target elements are present, and these elements being defined as:

- a contaminant (source) is a hazardous substance or agent, present at levels that have the potential to cause harm or damage a receptor
- a pathway is the means by or through which a contaminant comes into contact with, or otherwise affects, the receptor
- a receptor (target) is an entity (human being, aquatic environment, flora and fauna etc.) that is vulnerable to the adverse effects of the contaminant

7.1.5 This relationship is termed a "contaminant linkage". It should be recognised that for a health or environmental risk to exist, all three elements of the relationship or linkage must be present, i.e.

- if there is no contaminant, or contaminant present at levels below those considered to be harmful or damaging to a receptor, then there can be no adverse effect on a receptor
- if there is no receptor present that can be adversely affected by a contaminant, no harm or damage can arise
- even where both a contaminant and a receptor are present, no harm or damage will occur if there is no pathway by or through which a linkage between the two can be established

7.1.6 The information collated in the desk study was assessed hereunder to determine the potential contaminant linkage(s) existing on this site, and the likelihood of the linkage being present, allowing the construction of a preliminary conceptual model, as discussed hereunder.

7.2 Assessment of Potential Sources of Contamination

7.2.1 The potential sources of contamination identified in the desk study summarised hereunder:

Table 12: Potential Sources of Contamination

Potential Source of Contamination	Distance to Site	Dates Identified on Historical Maps	Discussion	Probability	Consequence	Risk	Does source warrant further assessment?
Made ground	On site	N/A	Walkover observations: Made ground was observed on the site as inclusions of gravels and cobbles of brick and concrete on the surface of the site soils. Based on the site investigation undertaken by others (the absence of made ground across the site) the probability of risk occurring is regarded as low	Low	Medium – chronic effect on human health	Moderate / low	Yes
Made ground	On site	N/A	As there is no evidence the made ground on the site is in excess of 1m (no evidence to suggest made ground is up to 5m thick or has an average thickness of 3m) thick with low organic matter the made ground is not regarded as a credible source of ground gases. It is also unlikely that there will be sufficient organic matter to generate ground gases (SOM is likely to be <5%). The gas generation potential is regarded as very low, the risk of lateral migration as negligible and the risk for development on site is regarded as low. Where the SOM is between 5% and 15% the level of risk for on site development is regarded as low to moderate.	None – not a credible source	Severe – acute risk to human health	None Moderate	No Yes
Site buildings	On site	N/A	Whilst no buildings on site at the time of the walkover, street level imagery identified a shed on the south western area. It is unlikely that this has impacted site soils.	Unlikely	Medium – chronic effect on human health	Low	No
Asbestos	On site	N/A	Based on street level imagery the site on site comprised of cement sheeting, based on the information the probability of risk occurring is regarded as unlikely as there is no evidence of damage to the sheeting.	Unlikely	Medium – chronic effect on human health	Low	No
Use / storage of chemicals and/or fuel on the site	On site and within 15m of the site	N/A	Based on the information within this desk study report it is unlikely that chemicals / fuel have been used and/or stored either on the site or within 15m of the site.	Unlikely	Medium – ingress of contaminants through plastic potable water pipes	Low	No
Potential for mobile contamination (VOC's, fuels etc.)	On site	N/A	Based on the information within this desk study report it is unlikely that mobile contamination will be present on the site	Unlikely	Medium – chronic effect on human health	Low	No
Pond	115m south west	1890 - 1973	Whilst the in-filled ponds have the potential to generate ground gases, in-filled ponds do not generally pose a significant risk of lateral gas migration (Ground Gas Handbook).	None – no credible pathways	Severe – acute risk to human health	None	No
Pond	220m north east	1890 – 1973		None – no credible pathways	Severe – acute risk to human health	None	No

7.3 Identification of Potential Receptors

7.3.1 Potential receptors of contamination on this site may be represented as tabulated hereunder:

Table 13: Potential Receptors

ID	POTENTIAL RECEPTOR	IS THE RECEPTOR PRESENT?	JUSTIFICATION
A	Human beings (construction workers)	**Yes**	Will be on site during the construction phase
B	Human beings (future residents)	**Yes**	The proposed development is residential
C	Human beings (future worker occupants)	**No**	
D	Human beings (trespassers / transient users)	**Yes**	May be present on the proposed development
E	Human beings (worker occupants of adjacent properties)	**No**	Commercial buildings do not adjoin the site
F	Human beings (residents of adjacent properties)	**Yes**	Dwellings adjoin the site
G	Designated ecological systems	**No**	None have been identified
H	On site flora and fauna	**No**	No sensitive species have been identified
I	Property in the form of buildings (on site)	**Yes**	The development includes the erection of dwellings/buildings
J	Property in the form of buildings (adjacent)	**No**	No buildings form the site boundaries
K	Property in the form of crops/livestock (on site)	**No**	Will not form part of the development
L	Property in the form of crops/livestock (adjacent)	**No**	None have been identified
M	Potable water mains (on site)	**Yes**	The site will be served by potable water mains
N	Potable water mains (off site)	**No**	It is unlikely that water mains for nearby sites will run through the subject site.
O	Groundwater (underlying aquifer)	**No**	The site is underlain by low/ sensitivity aquifers
P	Surface water bodies	**No**	No high/moderate sensitivity water bodies within 250m

7.4 Potential Pathways

7.4.1 Taking account of the intended use of the site, the pathways by which the above sources and receptors may be linked may be summarised as follows:

Table 14: Potential Pathways

ID	POTENTIAL RECEPTOR	ASSOCIATED POTENTIAL PATHWAYS	JUSTIFICATION FOR EXCLUSION
A	Human beings (construction workers)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust ~~Migration of ground gases through permeable strata / preferential pathways~~	 No credible sources of ground gases
B	Human beings (future residents)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust Dermal contact with soil / soil dust outdoors Dermal contact with soil dust indoors Ingestion of home-grown produce Ingestion of soil attached to home-grown produce Inhalation of soil dust indoors Inhalation of soil dust outdoors ~~Inhalation of soil vapours indoors~~ ~~Inhalation of soil vapours outdoors~~ ~~Migration of ground gases through permeable strata / preferential pathways~~	 No potential source of volatile contamination No potential source of volatile contamination No credible sources of ground gases
D	Human beings (trespassers / transient users)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust	
F	Human beings (residents of adjacent properties)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust Dermal contact with soil / soil dust outdoors Dermal contact with soil dust indoors Ingestion of home-grown produce Ingestion of soil attached to home-grown produce Inhalation of soil dust indoors Inhalation of soil dust outdoors ~~Inhalation of soil vapours indoors~~ ~~Inhalation of soil vapours outdoors~~ ~~Migration of ground gases through permeable strata / preferential pathways~~	 No potential source of volatile contamination No potential source of volatile contamination No credible sources of ground gases
I	Property in the form of buildings (on site)	Direct contact with aggressive ground conditions ~~Migration of ground gases through permeable strata / preferential pathways~~	 No credible sources of ground gases
M	Potable water mains (on site)	Direct contact with aggressive ground conditions Direct contact with organic contamination	

7.5 Preliminarily Qualitative Risk Assessment

7.5.1 In accordance with the current UK Government of 'suitable for use' approach to the assessment of contaminated land, a preliminarily qualitative risk assessment has been undertaken on the potential contaminant linkages identified above, which considers the magnitude of the potential consequence of the risk occurring, the magnitude of the probability of the risk occurring and provides an overall risk classification.

7.5.2 The following sections discuss all the identified potential on and off site sources which warrant further consideration (see Clause 7.2), pathways and receptors in the context of the proposed development and plausible pollutant linkages which may represent a risk to identified receptors such as human health and/or controlled waters from the data gained from the desk study. At this stage the assessment is qualitative and aimed to determine all pollutant linkages, irrespective of significance or allowing for uncertainty.

7.5.3 The purpose of the PQRA is to:

- Refine and update the conceptual model;
- Confirm the presence of actual pollutant linkages;
- Evaluate potentially unacceptable risks; and
- Provide the basis for the options appraisal when unacceptable risks are identified at the site.

7.5.4 The methodology used in the 2001 CIRIA report C552 – "Contaminated Land Risk Assessment. A Guide to Good Practice' and 'Guidance for the Safe Development of Housing on Land Affected by Contamination' is used here and is discussed in Appendix C.

7.5.5 Based on the above a Preliminarily Conceptual Model (PCM) has been created and is presented in hereunder.

Table 15: Preliminarily Conceptual Model

PPL ID	Source	Pollutant(s)	Receptor(s)	Pathways to Receptor	Probability	Consequence	Risk
1	Made Ground	Arsenic, asbestos, beryllium, cadmium, chromium (III and VI), copper, cyanide, lead, mercury, molybdenum, nickel, PAH's (USEPA 16) selenium, sulphur, thallium, hydrocarbons (TPHCWG), vanadium, zinc	Human beings (construction workers)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust	Likely	Minor – can be prevented by the use of PPE	Low
2			Human beings (future residents)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust Dermal contact with soil / soil dust outdoors Dermal contact with soil dust indoors Ingestion of home-grown produce Ingestion of soil attached to home-grown produce Inhalation of soil dust indoors Inhalation of soil dust outdoors		Medium – there is a potential for chronic effects to humans	Moderate
3			Human beings (trespassers / transient users)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust		Medium – there is a potential for chronic effects to humans	Moderate
4			Human beings (residents of adjacent properties)	Ingestion of soil / soil dust Dermal contact with soil / soil dust Inhalation of soil dust Dermal contact with soil / soil dust outdoors Dermal contact with soil dust indoors Ingestion of home-grown produce Ingestion of soil attached to home-grown produce Inhalation of soil dust indoors Inhalation of soil dust outdoors		Medium – there is a potential for chronic effects to humans	Moderate
5			Property in the form of buildings (on site)	Direct contact with aggressive ground conditions		Mild – significant damage to buildings	Moderate / low
6			Potable water mains (on site)	Direct contact with aggressive ground conditions Direct contact with organic contamination	Unlikely – no evidence of the storage of chemicals / fuel either on or within 15m of the site	Medium – ingress of contaminants through plastic potable water pipes	Low

7.5.6 The potential significant linkages listed above are based on the available data listed in the sections above and the features noted during the site walkover. Therefore the linkages identified are tentative and subject to the following uncertainties(s):

- Presence of made ground under the site;

7.5.7 The precautionary principle as discussed in PPS23 (withdrawn) has been applied in the assessment of potential sources, pathways and receptors.

7.5.8 It can be seen that contaminant linkages 2 to 5 require further investigation.

8 RECOMMENDATIONS FOR FURTHER WORKS AND SAMPLING STRATEGY

8.1 Assessment of the Viability of Remedial Measures as An Alternative to Intrusive Site Investigation

8.1.1 Whilst it is acknowledged that undertaking remediation in lieu of investigation on the assumption of impacted soils / ground gases are present. It may not be as cost effective or as sustainable as site investigation, however, it may be an appropriate alterative to site investigation on certain sites.

8.1.2 It should also be noted that chemical analysis / WAC testing may be required in order to dispose of any site soils.

8.1.3 As of the 1st April 2018 the landfill tax is £88.95/tonne of soil (£2.80/tonne for inert waste – WAC tests and soil analysis will be required to demonstrate waste is inert), there will also be costs associated with the excavation and transport of the soils to take into account when deciding if remediation in lieu of investigation is the best option.

8.1.4 The placement of cover can range between removal and replacement of site soils to raising site levels to place the cover system. Raising site levels with a cover system would remove/reduce the requirement of disposal of site soils**.**

8.1.5 **Remediation of Garden and Landscaped Areas**

8.1.6 Remediation of garden/landscaped area is only a viable option on sites where there is no evidence of the potential for mobile contamination to be present (e.g. hydrocarbons, oils, fuels, herbicides, pesticides etc.). Sites where the existing hard-standing and associated made ground will need to be removed in order to create landscaped/garden areas will be better suited for remediation.

8.1.7 As the site or any adjoining land does not have any commercial / industrial legacy the remediation of any potential pollution linkages associated with the made ground in lieu of site investigation is viable.

8.1.8 The pollution linkages can be broken by either source removal (removal of made ground from the garden and landscaped areas) or by breaking the pathways (placement of cover on garden/landscaped areas).

8.1.9 For this site it is noted that the proposed garden areas are in the current landscaped areas so it is unlikely that any made ground will be present.

8.2 Proposals for Further Works

8.2.1 The proposals to investigate / break the potential contaminant linkages identified above in the PCM are discussed hereunder (in order of risk).

Table 16: Proposed Aims and Scope of Further Works

PPL ID	AIM(S) / OBJECTIVES(S)	Proposed Further Investigation	Proposed Remediation In Lieu of Site Investigation
2 to 5	To determine if made ground is present on the site and if present, is it impacted by elevated levels of contamination:	Given the site investigation undertaken by others has demonstrated that made ground is not present across the majority of the site no further intrusive works are proposed.	Based on the discussion in Clause 8 remediation in lieu of site investigation is suitable for the site, the proposals are given hereunder: **Garden/ Landscaped Areas:** Removal of all made ground from garden/landscaped areas up to a maximum of 600mm, where the made ground is present at depths of greater than 0.60mbgl, a 600mm cover underlain by a geotextile will be placed.

8.2.2 The proposed sampling strategy and site investigation has been created in line with the guidance in BS5930:2015, BS10175:2011, CLR4 and the EA publication 'Secondary model for the development of appropriate soil sampling strategies for contaminated land'.

8.2.3 If any demolition is to be undertaken on site, consideration of BS 6187 should pre-empt any demolition carried out on site. Care should be taken not to spread any potential contamination to other areas during such an exercise with due consideration to CIRIA paper SP102 Remedial Treatment for Contaminated Land, Decommissioning, Decontamination and Demolition.

8.2.4 Prior to any demolition and redevelopment of the site it may be necessary to undertake a Type 3 Asbestos Survey.

8.2.5 If asbestos is encountered during any demolition works or during the intrusive investigation, it should be removed by a licensed contractor.

8.3 Recommendations For Watching Brief

8.3.1 A number of potential sources of contamination have been assessed as having a risk of 'low' or 'very low', hence further intrusive works / remediation is not warranted, however the following watching brief is proposed.

Table 17: Proposed Watching Brief

WATCHING BRIEF FOR LOW RISK POTENTIAL SOURCES OF CONTAMINATION / PRELIMINARILY POLLUTION LINKAGES
This report has identified a number of potential sources of contamination (Table 12) where the overall risk was low, and further works were not justified. This assessment is based on the information within this report; hence, it is proposed that a watching brief be undertaken during the development. **Site Building**: As the development commences if there is any visual or olfactory evidence of contamination further works should be undertaken.

8.4 Responsibility of Developer / Landowner

8.4.1 In line with the National Policy Planning Framework, where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

8.5 Management of Unexpected Contamination

8.5.1 It is possible that further contamination may be found at any time during the development. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly.

8.5.2 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.

8.6 Liaison With the Local Planning Authority

8.6.1 Prior to the commencement of any site works it is recommended that a copy of this report is forwarded to South Holland District Council, and their approval of the

conclusions/recommendations contained in this report is obtained prior to the commencement of any works on the site.

8.6.2 Where this report has recommended remedial measures, the methodology on the validation of the remedial measures should be agreed with South Holland District Council prior to commencement of site works (Phase IIIa Implementation Plan). On completion of the remediation a Phase IIIb completion report will need to be submitted to South Holland District Council in order to demonstrate the site has been suitably remediated.

APPENDIX A: REFERENCES

The following documents were available or have been obtained for reference or obtaining data:

Groundsure Report			
BGS Borehole Record Viewer			
The Environmental Protection Act	1990		
The Contaminated Land (Wales) Regulations	2006		
The Contaminated Land (Scotland) Regulations	2000		
The Environment Act	1995		
The Radioactive Contaminated Land (Modifications of Enactments) (England) Regulations	2006		
The Radioactive Contaminated Land (Modifications of Enactments) (Wales) Regulations	2006		
The Radioactive Contaminated Land (Scotland) Regulations	2007		
The Water Resources Act	1991		
The Water Act	2003		
The Water Environment and Water Services (Scotland) Act	2003		
The Water (Northern Ireland) Order	1999		
The Wildlife and Country Act	1981		
The Conservation (Natural Habitats, etc.) Regulations	1994		
The Town and Country Planning Act	1990		
The Town and Country Planning (Scotland) Act	1997		
The Building Control Act	1990		
The Construction Design and Maintenance (CDM) Regulations	2007		
The Control of Substances Hazardous to Health (COSHH) Regulations	2002		
The Factories Act	1961		
The Offices, Shops and Railway Premises Act	1963		
The Health and Safety at Work, etc. Act	1974		
The Pollution Prevention and Control Act	1999		
The Control of Pollution Act 1994 as amended	1994		
The Environmental Damage (Prevention and Remediation) Regulations	2009		
The Environmental Damage (Prevention and Remediation) (Wales) Regulations	2009		
The Environmental Liability (Scotland)	2009		
The Environmental Protection (Duty of Care) Regulations	1991		
The Environmental Permitting (England and Wales) Regulations	2007		
The Pollution Prevention and Control (Scotland) regulations	2000		
Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)	2013	BS 8576:2013	2013
Good practice on the testing and verification of protection systems for buildings against hazardous ground gases	CIRIA	C735	August 2014
Investigation of Potentially Contaminated Sites	BSI	BS10175:2011+A:2013	2013
Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)	BSI	BS 8576:2013	2013
Environmental Protection Act 1990: Part 2A - Contaminated Land Statutory Guidance	DEFRA	-	April 2012
Environmental Protection Act 1990: Part 2A – Contaminated Land	DEFRA	Circular 1/2006	September 2006 (withdrawn April 2012)
National Planning Policy Framework	Communities and Local Government	-	24 July 2018
Guiding Principles for Land Contamination	Environment Agency	GPLC1 / GPLC2 / GPLC3	March 2010
Planning and Pollution Control	ODPM	PPS23	November 2004 (withdrawn March 2012)
Circular 22/87: Development of Contaminated Land	Welsh Government	22/87	August 1987
Planning Advice Note PAN 33	Scottish Government	PAN 33	October 2000
Contaminated Land Statutory Guidance for Wales	Welsh Government	WG15450	2012
Explanatory Memorandum to the Contaminated Land	Welsh Government	-	February

(Wales) (Amendment) Regulations 2012 and the draft Contaminated Land Statutory Guidance 2012			2012
NHBC Standards	NHBC	-	2014
Code of Practice for Ground Investigations	BSI	BS5930:2015	July 2015
Technical aspects of site investigations in relation to land contamination	Environment Agency	EA P5-065/TR:2000	2000
Contaminated Land Risk Assessment: A Guide to Good Practice	CIRIA	C552	2001
Secondary model for the development of appropriate soil sampling strategies for contaminated land	Environment Agency	EA P5-066/TR:2000	2000
Remedial Targets Methodology - Hydrogeological Risk assessment for Land Contamination	Environment Agency		2006
The physical properties of the minor aquifers in England and Wales	BGS		2000
A framework for assessing the impact of contaminated land on groundwater and surface water	Department of the Environment	DOE CLR 1	1994
Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environmental Protection Act 1990.	Environment Agency		May 2002
Guidance on Preliminary site inspection of contaminated land	Department of the Environment	DOE CLR 2	1994
Documentary search on industrial sites	Department of the Environment	DOE CLR 3	1994
Sampling strategies for contaminated land	Department of the Environment	DOE CLR 4	1994
Information systems for land contamination	Department of the Environment	DOE CLR 5	1994
Prioritisation + categorisation procedure for sites which may be contaminated	Department of the Environment	DOE CLR 6	1995
Model Procedures for the Management of Land Contamination	Environment Agency	CLEA CLR 11	September 2004
A quality approach for contaminated land consultancy	Department of the Environment	DOE CLR 12	1997
Human health toxicological assessment of contaminants in soil	Environment Agency	Science Report SC050021/SR2	January 2009
Updated technical background to the CLEA model	Environment Agency	Science Report SC050021/SR3	January 2009
A review of body weight and height data used within the Contaminated Land Exposure Assessment model (CLEA)	Environment Agency	SC050021/ Technical Review 1	2009
Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values	Environment Agency	Science Report SC050021/SR7	2008
The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soil	Environment Agency	Report P5-080/TR3	2005
Review of the Fate and Transport of Selected Contaminants in the Soil Environment	Environment Agency	Draft Technical Report P5-079/TR1	2003
Guidance on Comparing Soil Contamination Data with a Critical Concentration	CL:AIRE/ CIEH		May 2008
Various toxicology reports	Environment Agency / DEFRA	CLR TOX1-24	Various dates
Industry Profiles	DEFRA		Various dates
Radon: guidance on protective measures for new developments	BRE	BRE 211	November 2007
Contaminated Land management manual	LQM	LQM2000	2000
Assessing risks posed by hazardous ground gases to buildings (revised)	CIRIA	CIRIA C665	December 2007
Code of practice for the design of protective measures for methane and carbon dioxide ground gas for new buildings	BSI	BS 8485:2015	2015
Using Soil Guideline Values		Science Report SC050021/SGV Introduction	March 2009
Soil guideline values for inorganic arsenic	Environment Agency	SC050021/ arsenic SGV	May 2009
Soil guideline values for mercury	Environment Agency	SC050021/ mercury SGV	April 2009
Soil guideline values for selenium	Environment Agency	SC050021/ selenium SGV	April 2009
Soil guideline values for benzene	Environment Agency	SC050021/ benzene	April 2009

		SGV	
Soil guideline values for toluene	Environment Agency	SC050021/ toluene SGV	April 2009
Soil guideline values for ethylbenzene	Environment Agency	SC050021/ ethylbenzene SGV	April 2009
Soil guideline values for xylenes	Environment Agency	SC050021	April 2009
Supplementary information for the derivation of for inorganic arsenic	Environment Agency	SC050021	May 2009
Supplementary information for the derivation of for mercury	Environment Agency	SC050021	April 2009
Supplementary information for the derivation of for selenium	Environment Agency	SC050021	April 2009
Supplementary information for the derivation of for benzene	Environment Agency	SC050021	April 2009
Supplementary information for the derivation of for toluene	Environment Agency	SC050021	April 2009
Supplementary information for the derivation of for ethylbenzene	Environment Agency	SC050021	April 2009
Supplementary information for the derivation of for xylenes	Environment Agency	SC050021	April 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Inorganic Arsenic	Environment Agency	SC050021/Tox 1	May 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Mercury	Environment Agency	SC050021	April 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Selenium	Environment Agency	SC050021	April 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Benzene	Environment Agency	SC050021	April 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Toluene	Environment Agency	SC050021	April 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Ethylbenzene	Environment Agency	SC050021	April 2009
Contaminants in soil: updated collation of toxicological data and intake values for humans : Xylenes	Environment Agency	SC050021	April 2009
Reclamation of Contaminated Land	Wiley		2004
Policy and Practice For The Protection of Groundwater	Environment Agency		1999
CIRIA Special Publication 102 - Remedial Treatment for Contaminated Land - Volume II: Decommissioning, Decontamination and Demolition	CIRIA	SP102	January 1995
Guidance on the Safe Development of Housing on Land affected by Contamination	Environment Agency	R&D Publication 66	2008
ProUCL User Guide and Technical Guide	USEPA	-	
Guidance on the assessment of and monitoring of natural attenuation of contaminants in groundwater	Environment Agency	R&D Publication 95	2000
The standard penetration test in insensitive clays and soft rocks	Proceedings of the European Symposium on Penetration Testing in the UK	-	1988
Protection of Workers and the General Public During Development of Contaminated Land	HSE	HSG66	September 1991
Trenching practice. 2nd edition	CIRIA	R97	2001
Desiccation in clay soils	BRE	412	February 1996
Methods of test for soils for civil engineering purposes	BSI	BS1377 (Parts 1 to 9)	1990
Eurocode 7: Geotechnical Design – Part 1: General Rules British	BSI	BS EN 1997-1	2004
Eurocode 7: Geotechnical Design – Part 2: Ground Investigation and Testing	BSI	BS EN 1997-2	2007
Geotechnical investigation and testing. Field testing. Electrical cone and piezocone penetration test	BSI	BS EN ISO 22476-1	2012
Geotechnical Investigation and Testing – Field Testing Part 2: Dynamic Probing	BSI	BS EN ISO 22476-2+A1	2011
Geotechnical Investigation and Testing – Field Testing Part 3: Standard Penetration Test	BSI	BS EN ISO 22476-3+A1	2011
Geotechnical investigation and testing. Field testing-Ménard pressuremeter test	BSI	BS EN ISO 22476-4	2012
Geotechnical investigation and testing. Field testing - Flexible dilatometer test	BSI	BS EN ISO 22476-5	2012
Geotechnical investigation and testing. Field testing - Borehole jack test	BSI	BS EN ISO 22476-7	2012
Geotechnical investigation and testing. Field testing – Flat dilatometer test	BSI	BS EN ISO 22476-11	2006

Geotechnical investigation and testing. Field testing - Mechanical cone penetration test (CPTM)	BSI	BS EN ISO 22476-12	2009
The standard penetration test (SPT): methods and use	CIRIA	R143	1995
Low-rise Buildings on Shrinkable Clay	BRE	BRE Digest 240 and 241	1993
Settlement of structures on clay soils	CIRIA	SP27	1983
Piled foundations in weak rock	CIRIA	R181	1999
Theoretical soil mechanics	Terazaghi	-	1943
Soils for civil engineering purposes	BSI	BS 1337	1990
Groundwater Control – Design and Practice	CIRIA	C515	2000
Trees in relation to design, demolition and construction. Recommendations	BSI	BS 5837	2012
Workmanship on Building Sites	BSI	BS 8000	Various
ICRCL 61/84 Notes on the fire hazards of contaminated land	ICRCL	61/84	1986
Soakaway Design	BRE	Digest 365	1991
Design guidance for road pavement foundations (draft HD 25) (Revision 1)	Highways Agency	Draft HD25	2006
Building Regulations Approved Documents	HM Government	Various	2013

APPENDIX B: LEGISLATIVE CONTEXT

LEGISLATION OVERVIEW

This report includes hazard identification and environmental risk assessment in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a "suitable for use approach". When considering the current use of land, Part IIA of the Environment Protection Act 1990 (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995, which came into force in England on 1 April 2000. The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land.

Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

"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:

Significant harm is being caused or there is a significant possibility of such harm being caused; or Pollution of controlled waters is being, or is likely to be, caused."

Harm is defined under section 78A of the Environmental Protection Act as meaning 'harm to the health of living organisms or other interference with the ecological systems of which they form part and, in the case of man, includes harm to his property'. Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as "the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter".

Types of harm are related to specific receptors in order to determine whether they can be regarded as "significant harm" or "significant possibility of significant harm', as defined in Clause 4 of the DEFRA publication 'Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance', which is presented hereunder:

Table 1: Categories Of Significant Harm and Significant Possibility of Significant Harm for Each Receptor

	Type of Receptor	Description of harm to that type of receptor that is to be regarded as:"	
		Significant Harm	Significant Possibility of Significant Harm
1	Human beings	Death; life threatening diseases (e.g. cancers); other diseases likely to have serious impacts on health; serious injury; birth defects; and impairment of reproductive functions Physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. 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.	-
2	Any ecological system, or living organism forming part of such a system, within a location which is: • a site of special scientific interest (under section 28 of the Wildlife and Countryside Act 1981) • a national nature reserve (under s.35 of the 1981 Act) • a marine nature reserve (under s.36 of the 1981 Act) • an area of special protection for birds (under s.3 of the 1981 Act) • a "European site" within the meaning of regulation 8 of the Conservation of Habitats and Species Regulations 2010 • any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS 9) on nature conservation (i.e. candidate Special Areas of Conservation, potential Special Protection Areas and listed Ramsar sites); or • any nature reserve established under section 21 of the National Parks and Access to the Countryside Act 1949. and Access to the Countryside Act 1949.	The following types of harm should be considered to be significant harm: • 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 significantly 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. In the case of European sites, harm should also be considered to be significant harm if it endangers the favourable conservation status of natural habitats at such locations or species typically found there. In deciding what constitutes such harm, the local authority should have regard to the advice of Natural England and to the requirements of the Conservation of Habitats and Species Regulations 2010.	Conditions would exist for considering that a significant possibility of significant harm exists to a relevant ecological receptor where the local authority considers that: • significant harm of that description is more likely than not to result from the contaminant linkage in question; 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.
3	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 their 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. The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a diminution in yield or loss in value is caused by a contaminant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss.	Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question, taking into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.
4	Property in the form of buildings. For this purpose, "building" means any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables.	Structural failure, substantial damage or substantial interference with any right of occupation. The local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the purpose for which it is or was intended. In the case of a scheduled Ancient Monument, substantial damage should also be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled.	Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question during the expected economic life of the building (or in the case of a scheduled Ancient Monument the foreseeable future), taking into account relevant information for that type of contaminant linkage.

For human beings and controlled waters there are four categories of harm, given hereunder:

Table 2: Categories Of Harm for Human Beings and Controlled Waters

Category	Description of harm to that type of receptor that is to be regarded as:"	
	Human Beings	**Controlled Waters**
1	The local authority should assume that a significant possibility of significant harm exists in any case where it considers there is an unacceptably high probability, supported by robust science based evidence, that significant harm would occur if no action is taken to stop it. For the purposes of this Guidance, these are referred to as "Category 1: Human Health" cases. Land should be deemed to be a Category 1: Human Health case where: (a) the authority is aware that similar land or situations are known, or are strongly suspected on the basis of robust evidence, to have caused such harm before in the United Kingdom or elsewhere; or (b) the authority is aware that similar degrees of exposure (via any medium) to the contaminant(s) in question are known, or strongly suspected on the basis of robust evidence, to have caused such harm before in the United Kingdom or elsewhere; (c) the authority considers that significant harm may already have been caused by contaminants in, on or under the land, and that there is an unacceptable risk that it might continue or occur again if no action is taken. Among other things, the authority may decide to determine the land on these grounds if it considers that it is likely that significant harm is being caused, but it considers either: (i) that there is insufficient evidence to be sure of meeting the "balance of probability" test for demonstrating that significant harm is being caused; or (ii) that the time needed to demonstrate such a level of probability would cause unreasonable delay, cost, or disruption and stress to affected people particularly in cases involving residential properties.	This covers land where the authority considers that there is a strong and compelling case for considering that a significant possibility of significant pollution of controlled waters exists. In particular this would include cases where there is robust science-based evidence for considering that it is likely that high impact pollution (such as the pollution described in paragraph 4.38) would occur if nothing were done to stop it.
2	For land that cannot be placed into Categories 1 or 4, the local authority should decide whether the land should be placed into either: (a) Category 2: Human Health, in which case the land would be capable of being determined as contaminated land on grounds of significant possibility of significant harm to human health; or (b) Category 3: Human Health, in which case the land would not be capable of being determined on such grounds. The local authority should consider this decision in the context of the broad objectives of the regime and of the Government's policy as set out in Section 1. It should also be mindful of the fact that the decision is a positive legal test, meaning that the starting assumption should be that land does not pose a significant possibility of significant harm unless there is reason to consider otherwise. The authority should then, in accordance with paragraphs 4.26 to 4.29 below, decide which of the following two categories the land falls into:	This covers land where: (i) the authority considers that the strength of evidence to put the land into Category 1 does not exist; but (ii) nonetheless, on the basis of the available scientific evidence and expert opinion, the authority considers that the risks posed by the land are of sufficient concern that the land should be considered to pose a significant possibility of significant pollution of controlled waters on a precautionary basis, with all that this might involve (e.g. likely remediation requirements, and the benefits, costs and other impacts of regulatory intervention). Among other things, this category might include land where there is a relatively low likelihood that the most serious types of significant pollution might occur.
3	(a) Category 2: Human Health. Land should be placed into Category 2 if the authority concludes, on the basis that there is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm, with all that this might involve and having regard to Section 1. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis. (b) Category 3: Human Health. Land should be placed into Category 3 if the authority concludes that the strong case described in 4.25(a) does not exist, and therefore the legal test for significant possibility of significant harm is not met. Category 3 may include land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted. This recognises that placing land in Category 3 would not stop others, such as the owner or occupier of the land, from taking action to reduce risks outside of the Part 2A regime if they choose. The authority should consider making available the results of its inspection and risk assessment to the owners/occupiers of Category 3 land.	This covers land where the authority concludes that the risks are such that (whilst the authority and others might prefer they did not exist) the tests set out in Categories 1 and 2 above are not met, and therefore regulatory intervention under Part 2A is not warranted. This category should include land where the authority considers that it is very unlikely that serious pollution would occur; or where there is a low likelihood that less serious types of significant pollution might occur.
4	The local authority should not assume that land poses a significant possibility of significant harm if it considers that there is no risk or that the level of risk posed is low. For the purposes of this Guidance, such land is referred to as a "Category 4: Human Health" case. The authority may decide that the land is a Category 4: Human Health case as soon as it considers it has evidence to this effect, and this may happen at any stage during risk assessment including the early stages. The local authority should consider that the following types of land should be placed into Category 4: Human Health: (a) Land where no relevant contaminant linkage has been established. (b) Land where there are only normal levels of contaminants in soil. (c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria. (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 in the normal course of their lives). The local authority may consider that land other than the types described above should be placed into Category 4: Human Health if following a detailed quantitative risk assessment it is satisfied that the level of risk posed is sufficiently low. Local authorities may decide that particular land apparently matching the descriptions above immediately above poses sufficient risk to human health to fall into Categories other than Category 4. However, such cases are likely to be very unusual and the authority should take particular care to explain why the decision has been taken, and to ensure that it is supported by robust evidence.	This covers land where the authority concludes that there is no risk, or that the level of risk posed is low. In particular, the authority should consider that this is the case where: (a) no contaminant linkage has been established in which controlled waters are the receptor in the linkage; or (b) the possibility only relates to types of pollution described in paragraph 4.40 above (i.e. types of pollution that should not be considered to be significant pollution); or (c) the possibility of water pollution similar to that which might be caused by "background" contamination.

Category 1 or 2 encompass land which is capable of being determined as contaminated land on grounds of significant possibility of significant harm to human health.

The guidance defines what 'normal' levels of contamination is and that a site should not be classified as 'contaminated land'.

'Normal' levels of contamination is defined as:

> (a) The natural presence of contaminants (e.g. caused by soil formation processes and underlying geology) at levels that might reasonably be considered typical in a given area and have not been shown to pose an unacceptable risk to health or the environment.
>
> (b) The presence of contaminants caused by low level diffuse pollution, and common human activity other than specific industrial processes. For example, this would include diffuse pollution caused by historic use of leaded petrol and the presence of benzo(a)pyrene from vehicle exhausts, and the spreading of domestic ash in gardens at levels that might reasonably be considered typical.

The UK regulatory authorities have adopted the widely recognised pollutant linkage concept for assessing risks from land contamination. However, the scenarios under which significant harm may occur are often largely defined by the site conditions and the receptor sensitivity. The concept of suitability for use is adopted to ensure that the risk management process addresses the site-specific conditions and that any remediation undertaken reduces risks to an acceptable level. To meet requirements under Part IIA the site should be suitable for its current use, including use for which a planning permission is already held.

Part IIA of The Environmental Protection Act 1990 is supported by the DEFRA publication of April 2012 'Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance' (this replaces DETR Circular 06/2006), which defines the duties of Local Authorities in dealing with it. Part IIA places contaminated land responsibility as a part of planning and redevelopment process rather than Local Authority direct action except in situations of very high pollution risk. In the planning process guidance is provided by the National Planning Policy Framework which requires that a site which has been developed shall not be capable of being determined "contaminated land" under Part IIA.

The criteria for assessing levels of pollutants and hence determining whether a site represents a hazard are based on a range of techniques, models and guidance. Within this context it is relevant to note that Government objectives are:

(a) To identify and remove unacceptable risks to human health and the environment;

(b) To seek to ensure that contaminated land is made suitable for its current use;

(c) To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

These three objectives underlie the "suitable for use" approach to remediation of contaminated land. The "suitable for use" approach focuses on the risks caused by land contamination. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Risks therefore should be assessed on a site-by-site basis.

The "suitable for use" approach comprises of three elements:

(a) ensuring that land is suitable for its current use

(b) ensuring that land is made suitable for any new use, as planning permission is given for that new use

(c) limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought

The mere presence of pollutants does not therefore necessarily warrant action, and consideration must be given to the scale of risk involved for the use that the site has, and will have in the future.

Legislation in Scotland, Northern Ireland and Wales

Northern Ireland

The Northern Ireland Assembly was established as part of the Belfast Agreement and it is the prime source of authority for all devolved/transferred matters (including environment and planning) and has full legislative and executive authority. Devolution powers became the responsibility of the Northern Ireland Assembly on the 2nd December 1999. The Executive was subsequently suspended and Direct Rule restored on the 11th February 2000. Restoration of devolution subsequently took place on 30th May 2000. Twenty-four hour suspensions also took place in August and September 2001.

On the 14th October 2002 the Assembly was again suspended and then formally dissolved on the 28th April 2003. Subsequently the Assembly was restored to a state of suspension following elections in November 2003 with the Assembly finally being restored on 8th May 2007.

The Environment and Heritage Service (EHS) is the largest Agency within the Department of the Environment (DOE NI), one of the eleven Northern Ireland Departments created in 1999. The EHS takes the lead in advising on, and in implementing, the Government's environmental policy and strategy in Northern Ireland.

The Planning Service, another Agency which comes under the umbrella of the DOE NI, is responsible for developing and implementing Government planning policies and development plans in Northern Ireland.

Part 3 of the Waste and Contaminated Land (Northern Ireland) Order 1997 contains the main legal provisions for the introduction of a contaminated land regime in Northern Ireland. The Order was enacted in 1997 but the regime is not yet in operation. The provisions within Part 3 are virtually identical to those provided by part 2A and would establish a regime whereby local authorities are under a duty to investigate and identify contaminated land and identify those responsible for its remediation.

In terms of provision of technical guidance for regulators to assist them in the determination of contaminated land the DOE NI references the DEFRA SGV Task Force and CLEA publications.

The primary legislation governing planning in Northern Ireland is the Planning (Northern Ireland) Order 1991 (as amended). This is backed up by secondary legislation and planning policy, including planning policy statements (PPSs) and area plans. However there is currently no specific PPS addressing development on potentially contaminated land.

Planning applications are determined by the Planning Service with local councils, along with other government departments, acting as consultees to the approval process. Despite the lack of guidance the Planning Service, in considering planning applications for brownfield sites, will impose conditions for site investigation and remediation that broadly mirror the requirements of part 3/Part 2A.

Wales

Both the Environment Protection Act 1990 and the Environment Act 1995 were issued on a UK wide basis, so the same principles of Part 2A legislation are applicable. In July 1997 the UK Government published a white paper outlining proposals for devolution. In Wales a referendum was held in September 1997 and the result led to the Government of Wales Act 1998 being issued thus establishing the National Assembly for Wales (NAW) with powers being transferred on 1st July 1999.

Since this time subordinate legislation has been introduced in Wales that details how the provisions of an Act of Parliament will apply, hence the reason for different effects in Wales to that of England.

The elected Assembly Members effectively delegated their powers for implementation of policies and legislation to the Welsh Assembly Government (WAG). One of the subject areas within WAG is Environment Planning & Countryside, which covers the policies and subordinate legislation relevant to land contamination. The preliminary legislation was The Contaminated Land (Wales) Regulations 2001 Welsh Statutory Instrument 2001 No. 2197 (W.157) which came into force on 1st July 2001. This has now been revoked and replaced by The Contaminated Land (Wales) Regulations 2006 Welsh Statutory Instrument 2006 No. 2989 (W.278) which came into force on 10th December 2006. These include the changes for appeals on Remediation Notices, which are required to be made to NAW. The Radioactive Contaminated Land (Modification of Enactments) (Wales) Regulations 2006 were implemented at the same time.

Current Statutory Guidance relevant to Wales is the 'Contaminated Land Statutory Guidance – 2012' (2012) issued by the Welsh Government. This comprises Guidance previously issued in November 2001 and further guidance to accompany other modifications such as the introduction of radioactivity. The principle regulators of the Part 2A process are Environment Agency Wales and as appropriate the local authority responsible for the site in question. As in England the use of the CLEA v1.06 model and the relevant SGV and TOX reports are applicable in Wales.

In respect of Planning the circular 022/87 (WO) prepared by DETR (Department of Environment, Transport and the Regions) on Development of Contaminated Land remains applicable for outlining the requirements associated with new developments, including change of use. The document states that contamination is a material planning consideration, but is ambiguous in a number of areas. It does however indicate that an investigation will normally be required where the previous history of the site suggests contamination.

Planning Policy Wales (2002) outlines that the physical constraints on the land are to be taken into account at all stages of the planning process and this is in the context of land instability and land contamination. It also explains that LPA's (Local Planning Authorities) should be aware of the requirements of Part 2A and ensure that their policies and decisions are consistent with it. This implies that the methods used in assessing land for Part 2A purposes should be applied within the planning regime. Accordingly the concept of risk assessment as a tool to help direct development on a suitable for use basis is appropriate as in England.

NPPF does not apply in Wales, however it may be referred to as good practice, though this may be open to challenge. In Wales Technical Advice Notes (TAN) are used as Planning Policy Statements and currently there is no TAN applicable to land contamination in Wales. WAG is considering the preparation of a TAN and it is understood that this will look at the suitability of PPS23 for Wales, though no timetable for delivering this has been made.

Land Contamination: A Guide for Developers prepared on behalf of the Welsh Local Government Association, Environment Agency Wales & WAG was issued in July 2006. Whilst this is not statutory guidance, it helps confirm good practice and broadly details the risk assessment process in line with CLR11 (Model Procedures).

Scotland

Since the passing of the Scotland Act and the official convening of the Scottish Parliament and the Scottish Executive on the 1st July 1999 devolved matters, including the environment and planning, have been the responsibility of Scottish Ministers.

There are two regulatory enforcement bodies in Scotland with duties and powers in terms of identification and remediation of contaminated land and development of brownfield sites; Local Authorities and the Scottish Environment Protection Agency (SEPA) which was established in 1996.

The current structure of local government in Scotland was established by the Local Government (Scotland) Act 1994. Since the passing of the Act Scotland has been divided into 29 unitary authorities and 3 island authorities. It is the responsibility of the Scottish Executive to implement Part 2A of the Environmental Protection Act, 1990. Scottish Ministers therefore implemented.

The Contaminated Land (Scotland) Regulations 2000 (SI2000/178) (the 2000 Regulations) with accompanying statutory guidance on the 14th July 2000. The 2000 Regulations were replaced on the 1st April 2006 by the Contaminated Land (Scotland) 2005 Regulations (the 2005 Regulations). The 2005 Regulations amended Part 2A of the Environmental Protection Act 1990 and the 2000 Regulations in the light of the Water Environment and Water Services (Scotland) Act 2003. Guidance on the 2005 Regulations was published in June 2006 in the form of Paper SE/2006/44 (Statutory Guidance; Edition 2) by the Scottish Executive. The document replaces in its entirety the guidance issued July 2000.

Contaminated land was defined in the 2000 Regulations where pollution of controlled waters is being, or is likely to be caused. This meant that any degree of pollution of controlled waters could have resulted in the land being designated as contaminated. The 2005 Regulations addressed the anomaly whereby trivial amounts of pollution resulted in land being designated as contaminated by introducing a requirement that pollution be "significant" or likely to be "significant" in relation to the water environment.

Unlike England and Wales the 2005 Regulations do not include radioactive contamination. The Radioactive Contaminated Land (Scotland) Regulations 2007 came into force in Scotland on the 30th October 2007. The Regulations make provision for Part 2A to have effect with modifications for the purpose of the identification and remediation of radioactive contaminated land.

When brownfield or contaminated sites are being developed, Local Authorities require that the need for remediation is determined using guidance provided by Planning Advice Note (PAN) 33. PAN 33 uses the Suitable for Use Approach. The approach focuses on the risks caused by land contamination and recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors such as the underlying geology.

The Suitable for Use Approach comprises three elements:

- Ensuring that land is suitable for its current use;
- Ensuring that land is made suitable for any new use as planning permission is given for that use; and
- Limiting the requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use for which planning permission is being sought.

APPENDIX C: RISK ASSESSMENT METHODOLOGIES

RISK ASSESSMENT METHODOLOGY

The methods applied by ***DEMETER ENVIRONMENTAL Ltd*** in the assessment of risks to receptors from soil, water and gas data, are presented hereunder:

LEGISLATION OVERVIEW:

The legislative background to risk assessment is discussed in the legislative Appendix B.

RISK ASSESSMENT METHODOLOGY

Current practice recommends that the determination of potential liabilities that could arise from land contamination be carried out using the process of risk assessment, whereby "risk" is defined as:

(a) The probability, or frequency, or occurrence of a defined hazard; and
(b) The magnitude (including the seriousness) of the consequences."

The UK's approach to the assessment of environmental risk is set out in by the Department of the Environment (2000) publication "A Guide to Risk Assessment and Risk Management for Environmental Protection." This established an iterative, systematic staged process which comprises:

(a) Hazard identification
(b) Hazard assessment
(c) Risk estimation
(d) Risk evaluation
(e) Risk Assessment

At each stage during the investigation process the above steps are repeated as more detailed information becomes available for the site.

CLR11- 'Model Procedures for the Management of Land Contamination', a document published by the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency (EA) outlines a tiered approach to the assessment of risks posed by contaminated land, as summarised hereunder:

Tier 1: Preliminary Risk Assessment

A Preliminary Risk Assessment is usually undertaken as part of a desk study, outlines potential risks posed by potential contamination to all receptors by defining plausible "pollution linkages" and developing a preliminary conceptual model (PCM). The purpose of this model is to define all possible complete pollution linkages, where the requisite source – pathway – target elements are present, and these elements being defined as:

- a contaminant (source) is a hazardous substance or agent, present at levels that have the potential to cause harm or damage a receptor
- a pathway is the means by or through which a contaminant comes into contact with, or otherwise affects, the receptor
- a receptor (target) is an entity (human being, aquatic environment, flora and fauna etc) that is vulnerable to the adverse effects of the contaminant

This relationship is termed a "pollution linkage". It should be recognised that for a health or environmental risk to exist, all three elements of the relationship or linkage must be present, i.e.

- if there is no contaminant, or contaminant present at levels below those considered to be harmful or damaging to a receptor, then there can be no adverse effect on a receptor
- if there is no receptor present that can be adversely affected by a contaminant, no harm or damage can arise
- even where both a contaminant and a receptor are present, no harm or damage will occur if there is no pathway by or through which a linkage between the two can be established

The absence of one or more of each component (source, pathway, receptor) would prevent a pollutant linkage being established and there would be no significant environmental risk.

Potential contaminants of concern are identified with the aide of the Environment Agency and NHBC publication 'Guidance for the Safe Development of Housing on Land Affected by Contamination', the Department of Environment Industry Profiles and the now withdrawn CLEA CLR 8, which consolidated the information Industry Profiles into a tabular format.

The PCM is subject to continual refinement as additional data becomes available. As part of a Phase I Investigation (Desk Study and site walk over) a PCM is formed. Based on the PCM, potential pollutant linkages can be assessed. If the PCM and hazard assessment indicate that a pollution linkage is not of significance then no further assessment or action is required due to this linkage. For each significant and possible linkage a risk assessment is carried out. The linkages which potentially pose significant risks may require a variety of responses ranging from immediate remedial action or risk management or, more commonly, further investigation and risk assessment. This next stage is usually termed a Phase II Main Site Investigation and should provide additional data to allow refinement of the PCM and assess the level of risk from each pollutant linkage. The risk assessment will usually include a Tier 2 Generic Quantitative Risk Assessment and / or, if necessary, a Tier 3 Detailed Quantitative Risk Assessment.

The criteria used for a Tier 1 risk assessment are broadly based on those presented in Section 6.3 of the CIRIA Report 'Contaminated Land Risk Assessment: A Guide to Good Practice' (CIRIA Report C552) and Section 1.7 of Guidance on the Safe Development of Housing on Land affected by Contamination. The consequence of the risk is classified according to the criteria in Table A below:

Assessment of Sensitivity of Water Resources

The criteria used to determine the sensitivity of a water resource is given hereunder:

Groundwater

Sensitivity Assessment	**Standard Response**	**Implications/need for further work (subject to nature of source and pathway)**
H1 (Very high)	Highly vulnerable aquifer, actively used in vicinity of site with short travel times to sources of supply or sensitive watercourses. Likely to be within an inner or outer groundwater protection zone (Zones I or II under EA protection policy). All contaminant releases to the ground environment of concern.	Extensive groundwater and soil clean-up or removal is likely to be needed if a source and pathway exist. Potential for major on-site and off-site liabilities. Further, detailed risk assessment essential and is likely to be required by the Regulators. Could be long-term residual liabilities with major cost implications and potential high risk of prosecution.
H2 (High)	Major or minor vulnerable aquifer with probable use nearby (either direct abstraction or baseflow to sensitive watercourses and springs). Likely to be within Outer or Source Catchment protection zones (Zones II or III). Most contaminant releases to the ground environment of concern.	Significant groundwater remediation measures may be required, after detailed risk assessment, which is likely to be required by the Regulators. Soil decontamination or isolation probably necessary. Potential for significant on-site and off-site liabilities, including treatment and/or replacement of local potable water supplies. Substantial cost implications and potential moderate/high risk of prosecution.
M1 (Moderately high)	Recognised major or minor aquifer, moderately vulnerable, with probable use (either direct or via baseflow to a sensitive watercourse). Within formal protection zone or catchment of authorised abstractions for potable or other high quality uses. Minor, short-term releases of contaminants may be tolerable.	Following risk assessment, soil decontamination or isolation may be required. Localised groundwater clean-up may be needed but large scale clean-up unlikely unless source is substantial and toxic. Possible off-site liabilities such as replacement/treatment of local potable water supplies. Moderate cost implications and potential moderate risk of prosecution.
M2 (Moderate)	Minor aquifer, low to moderately vulnerable, but with possible uses in general area, particularly for domestic supplies. May provide pathway to surface water.	Risk assessment may indicate need for localised clean up/isolation of soil and groundwater only, but may be some off-site liabilities e.g. local potable water supplies. Moderate to low cost implications. Potential prosecution less likely.
L1 (Low)	Permeable strata/minor aquifer near surface, but no apparent use and low vulnerability (may also be a significant aquifer but downgraded by long-term/ permanent degradation of water quality). May provide pathway to surface watercourse at distance.	Localised clean-up/isolation of soil and groundwater only. Unlikely to be significant off-site liabilities or action by statutory authorities with respect to groundwater. Low cost implications.
L2 (Very low)	Not a recognised aquifer, but strata beneath site may retain a small amount of contaminated liquid but there is likely to be limited vertical penetration. High potential for surface runoff or ponding.	Clean-up/isolation of soil and contained groundwater only, in immediate vicinity of release. Unlikely to be off-site liabilities or action by statutory authorities with respect to groundwater. Low cost implications.

Surface Water (exc coastal waters)

Sensitivity Assessment	Standard Response	Implications/need for further work (subject to nature of source and pathway and no short circuiting by artificial drainage systems)
H1 (Very high)	High quality watercourse (GQA A or B) within close proximity (less than 250m) of site or with potential for rapid transmission of pollutants to that watercourse via a fissured aquifer. Or interconnected unclassified drain or stream.	Potential for major pollution incident with fish kills, risk to river users etc. Major cost implications for remediation measures and with respect to penalties on prosecution. Potential for major adverse publicity.
H2 (High)	Site within catchment and reasonable proximity (less than 500m) of high quality watercourse (GQA A/B) or with potential transmission of pollutants via baseflow from an aquifer with little subsurface attenuation or via an interconnected unclassified drain or stream.	Potential for significant pollution incident that requires remedial measures and likely to involve a prosecution and adverse publicity. Substantial cost implications.
M1 (Moderately high)	Site within catchment and reasonable proximity (less than 500m) of a moderate quality watercourse (GQA C/D) or 500-1000m of a high quality watercourse (GQA A/B). Also where there is potential transmission of pollutants via baseflow with little subsurface attenuation or via an interconnected unclassified drain or stream.	Potential for significant pollution incident that requires remediation measures. Possible prosecution, particularly if contamination is likely to be visible or result in public complaints.
M2 (Moderate)	Site within catchment of and relatively close (less than 1000m) to moderate or poor quality (GQA C to F) watercourse that may be subject to planned improvement by attainment of surface water quality objectives. May be potential for transmission of pollutants via baseflow from a highly permeable formation.	Minor incidents are unlikely to attract third party liabilities, but action by statutory authorities likely if contamination is visible or repeated.
L1 (Low)	Within catchment of and over 250m from generally poor quality watercourse (GQA E or F) that is unlikely to improved by current or foreseeable surface water quality objectives or at distance (over 1000m) from a good quality watercourse with no interconnecting drains or baseflow from fissured strata.	Unlikely to be third party liabilities or action from statutory authorities from surface water viewpoint.
L2 (Very low)	No surface water within general area of the site (at least 250m) or closed drainage within site. Little or no potential for significant transmission via baseflow and no interconnecting drains.	Liabilities restricted to site itself (localised soil contamination or ponding) or associated with groundwater.

Coastal Waters

Sensitivity Assessment	Standard Response	Implications/need for further work (subject to nature of source and pathway and no short circuiting by artificial drainage systems)
H1 (Very high)	Within 100m of a sensitive coastal water, that is, a recognised bathing water, a "more sensitive area" (as defined under the Urban Wastewater Treatment Directive) or a marine SSSI or at a greater distance but with a direct connection via a stream or a highly fissured aquifer to such a coastal water with the potential for rapid flow to that water.	Potential for major environmental health risks and ecological damage. Probability of high remedial costs, prosecution and adverse publicity.
H2 (High)	As above, within 250m or with a relatively rapid route of transmission or within 100m of a "less sensitive area".	
M1 (Moderately high)	Within 500m of a bathing water or a defined sensitive area (see above); with possibility of diffuse flow via groundwater seepages at coastline or with connection via nearby watercourses.	LESS DATA AVAILABLE FOR COASTAL SITES TO GIVE GENERALISED ASSESSMENTS OF POTENTIAL LIABILITIES.
M2 (Moderate)	Within 500m of a coastal water (undefined), with possibility of diffuse flow via groundwater seepages at coastline or with connection via nearby watercourses.	
L1 (Low)	No coastline nearby (within 1km), but with possibility of diffuse groundwater seepages at coastline or connection via nearby watercourses.	Liabilities initially associated with watercourses or groundwaters.
L2 (Very low)	No coastline nearby (within 1km) and/or no direct connection via surface or ground water.	No liabilities likely.

Artificial Drainage System

Sensitivity Assessment	Standard Response	Implications/need for further work (subject to nature of source and pathway and no short circuiting by artificial drainage systems)
H1 (Very high)	Extensive land use/industrial history, successive building development. Steep surface slopes (rapid travel times with little opportunity for dilution/ interception facilities) or close proximity (within 250m) to surface watercourses or high sensitivity groundwater. Former mining areas where subsurface mine drains are present or suspected. Detailed drainage records absent.	Probability of interconnection of artificial and natural drainage systems, with consequent risks to sewers, surface and ground water. Potential unconsented connections and discharges on and off-site with third party pipes/structures, risk of third party action and additional effluent treatment costs. Potential damage to site fabric and structures due to leakages and collapse. Major cost implications for investigation and implementation of remedial measures. Drainage investigation and risk assessment essential.
H2 (High)	As above, but shallower slopes (longer retention times in drains) or more distant (over 250m) to surface watercourses or with detailed records of drainage systems.	As above, but potentially lower investigatory and remedial costs. Drainage investigation and risk assessment essential.
M1 (Moderately high)	More than one phase of site development with limited historic records of drainage systems (sewers, surface water, pipelines). Over 250m from surface watercourse.	As above, but less extensive drainage investigation and reduced investigation and remedial costs.
M2 (Moderate)	More than one phase of site development with detailed historic records of drainage systems (sewers, surface water, pipelines).	As above, costs likely to be dependent on-site processes and degree of maintenance of existing drainage systems.
L1 (Low)	Recent (greenfield) development, with recorded and low intensity drainage systems or older sites with thoroughly investigated and recorded drainage systems, drainage risk assessment and implementation of remedial measures. Within 250m of surface watercourses or on low permeability strata. No mine drains.	Leakages from drains may contaminate soil locally and eventually reach a watercourse. Low risk of third party action.
L2 (Very low)	Recent (greenfield) development, with recorded and low intensity drainage systems, or older sites with thoroughly investigated/recorded drainage systems, drainage risk assessment and implementation of remedial measures. Remote from surface watercourses, all drainage to adopted sewers and with no permeable strata within 10m of the site surface. No mine drains.	Leakages from drains may contaminate soil locally.

Table A – Consequence of Risk

CLASSIFICATION	DEFINITION	EXAMPLES
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Short term risk of pollution of sensitive (H1/H2) water resource. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. A short term risk to a particular ecosystem, or organism forming part of such ecosystem. Catastrophic damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" or "significant possibility of significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Pollution of a highly sensitive (H1/H2) water resource. Significant damage/change to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Pollution of moderately sensitive (M1/M2) water resources. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Significant damage to crops, buildings, structures and services ("significant harm" as defined in Circular 1/2006).	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services. Pollution of low sensitive (L1/L2) water resource. Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

The probability of the risk occurring is classified according to criteria given in Table B below:

Table B – Probability of Risk Occurring

CLASSIFICATION	DEFINITION	EXAMPLES
High likelihood	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	a) Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden. b) Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50 years.
Likely	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	a) Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space. b) Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.
Low likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.	a) Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space. b) Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	a) Elevated concentrations of toxic contaminants are present below hardstanding. b) Light industrial unit <10 yrs old containing a doubleskinned UST with annual integrity testing results available.

An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in Table C below:

Table C – Calculation of Risk

		CONSEQUENCE			
		Severe	**Medium**	**Mild**	**Minor**
PROBABILITY	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very low Risk	Very low Risk

The above evaluated risk terms are described hereunder in Table D:

Table D – Description of the Evaluated Risks from Table 3

EVALUATED RISK	DESCRIPTION
Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the long term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but there is a low likelihood of this hazard occurring and if realised, harm would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.
No Potential Risk	There is no potential risk if no pollution linkage has been established.

The likely action required for each of the above evaluated risks is as follows:

Action in the form of site investigation and risk assessment, mitigation of risk or remediation of contamination is required at sites evaluated as **Very High Risk** or **High Risk**.

Site investigation is required at sites evaluated as **Moderate Risk**.

No action is required at sites evaluated as **No Potential Risk**, **Low Risk** or **Very Low Risk.**

Tier 2: Generic Quantitative Risk Assessment (GQRA)

GQRA requires an intrusive investigation in order to characterise the site assisting in the re-assessment of the source-pathway receptor linkage. The conceptual model should be refined accordingly.

If GQRA reveals that unacceptable risks are not present then no further action is required. If GQRA identifies a possibility of risk, a decision must be made whether further work is required or necessary for the purposes of risk assessment. If further risk assessment is deemed not suitable / not required an Options Appraisal should be undertaken. If further risk assessment is required, the scope / nature of further risk assessment must be decided – it is possible that a Tier 3 DQRA will be undertaken in this scenario.

Tier 3: Detailed Quantitative Risk Assessment (DQRA)

DQRA is used when pollutant linkages require further assessment. DQRA is often undertaken for pollutant linkages where GAC are unavailable or inappropriate for or more conservative than the actual circumstances of the site. Site specific data is used to create Site Specific Assessment Criteria (SSAC) and enable a more accurate assessment of the risks. Further investigation may or may not be required to formulate SSAC depending on the site specific conditions and information already obtained.

If DQRA reveals that unacceptable risks are not present then no further action is required. If DQRA identifies a possibility of risk, a decision must be made whether further work is required or necessary for the purposes of risk assessment. If further risk assessment is deemed not suitable / not required an Options Appraisal should be undertaken. If further risk assessment is required, the scope nature of further risk assessment must be decided.

NOTE: A Tier 1 Preliminary Risk Assessment is undertaken as part of a Desk Study Report and a Preliminary Conceptual Model is developed for all pollutant linkages including risks ground gas and controlled waters. The methodologies for assessing the risks to human health, risks to controlled waters and risk posed by ground gas using quantitative techniques vary considerably, therefore GQRA and DQRA for human health, controlled waters and ground gas must be undertaken separately. The risk assessment methodologies where quantitative assessment is used for risks to human health, risks to controlled waters and risks posed by ground gas, if relevant, are described hereunder.

HUMAN HEALTH RISK ASSESSMENT METHODOLOGY – SOIL AND WATER

Background

In January 2009, the EA published the revised Contaminated Land Exposure Assessment (CLEA) Model and a series of related reports. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. These reports together with associated "TOX" and "SGV" documents are continually being published and will be used in any assessment.

Guidance on statistical assessment is given in CL:AIRE :2008 "Guidance on Comparing Data With a Critical Concentration"

A different approach to the statistical appraisal of data is required depending on whether the assessment of risk is to assess whether land is Contaminated Land in accordance with regulations, or whether the assessment is to determine whether the site is suitable for new development in according with planning guidance. This is discussed further in CL:AIRE :2008 "Guidance on Comparing Data With a Critical Concentration".

COLLATION OF SOIL TOXICOLOGICAL DATA

The toxicological data collated by ***Demeter Environmental Ltd*** is presented as a separate document, available to regulatory bodies on request. The data gathered is generally in accordance with the hierarchy given in the EA Science Report SC050021/SR21 "Human health toxicological assessment of contaminants in soil". The hierarchy may be circumvented where more up to date authoritative data from a toxicological study has been published from sources lower down the hierarchy.

DERIVATION OF SOIL ASSESSMENT CRITERIA

GAC's derived by ***Demeter Environmental Ltd*** are based on a Soil Organic Matter (SOM) content of 1%. Whilst this approach differed from the Environment Agency (who have published SGV's based on a 6% SOM) it provides a more conservative GQRA. Where SSAC's are required, site specific SOM will be used in the DQRA. Where available, other parameters such as building size, receptor and soil characteristics will be used in the DQRA.

Assessment criteria are available from a number of sources, namely (and in order of use):

1. Land Quality Management Suitable for Use Levels (S4UL's) (Copyright Land Quality Management Limited reproduced with permission; Publication number S4UL3093. All rights reserved);
2. C4SL for lead;
3. EIC/AGS/CL:AIRE Generic Assessment Criteria;
4. In-house derived GAC's / S4UL's.

STATISTICAL ASSESSMENT OF SOIL CONTAMINATION DATA

In any site investigation only a small fraction of the soil on the site is analysed. Therefore the mean derived from the contamination data for a contaminant may not be the same as the true mean for the contaminant distribution on the site. To improve the reliability of any assessment a statistical analyses is if the dataset is undertaken.

The statistical assessment is undertaken using ProUCL, which is published by the USEPA, which provides a statistical assessment that exceeds the guidance given in the CL:AIRE document "Guidance on Comparing Soil Contamination Data with a Critical Concentration".

Where the number of results in a dataset is less than four, a statistical assessment cannot be undertaken, and the assessment is performed by comparison of the maximum value(s) with the assessment criteria. Dependant on the distribution of the data, a statistical analysis may not be feasible and in those cases the results will be assessed directly to their respective assessment criteria.

If the screening levels are exceeded then more sophisticated quantitative risk assessment can be undertaken or remedial action may be taken to break the pollutant linkages. The benefits of undertaking a quantitative risk assessment must be weighed against the likelihood that it will bring about cost savings in the proposed remediation.

ASSESSMENT OF RISK TO HUMAN HEALTH

ASSESSMENT VALUES

Assessment criteria are available from a number of sources, namely:

1. Land Quality Management Suitable for Use Levels (S4UL's) (Copyright Land Quality Management Limited reproduced with permission; Publication number S4UL3093. All rights reserved);
2. C4SL for lead (the C4SL is used in lieu of the in house derived GAC as it provides a more conservative assessment);
3. EIC/AGS/CL:AIRE Generic Assessment Criteria;
4. In-house derived GAC's / S4UL's

TIER 2 GENERIC ASSESSMENT CRITERIA FOR SOILS

Generic Assessment Criteria (GAC's) have been derived by ***Demeter Environmental Ltd*** to aid in the assessment of the risk to human health. These are derived using CLEA v1.06. Details of the derivation of the GAC's are provided within the Report. GAC's are based on generic assumptions on the land use, building and soil parameters.

SITE SPECIFIC ASSESSMENT CRITERIA FOR SOILS

Where there are exceedances of the Tier 2 GAC, Site Specific Assessment Criteria (SSAC) are derived, using site specific data for the Soil Organic Matter (SOM), building parameters, land use etc. An SSAC, like SGV's, S4UL's and GAC's is a threshold below which the risk is minimal.

Whilst CLEA v1.06 is normally used to derive SSAC's, other risk assessment packages may be used if they are more suitable for the subject site.

ASSESSMENT OF RISK TO HUMAN HEALTH FROM SOIL WATER

Where exposure to contamination in soil water is significant this will be assessed using BP RISC (amended to be as close to UK compliant as possible).

CONTROLLED WATER RISK ASSESSMENT METHODOLOGY

Background

Definition of Controlled Waters

The term 'controlled waters' is defined in Section 104 of the Water Resources Act 1991 as:

"Territorial Waters…which extend seawards for three miles…, coastal waters…, inland freshwaters, waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata."

Note that the definition of groundwater under the Water Resources Act 1991 includes all water within underground strata (including soil / pore water in the unsaturated zone). The definition of groundwater under the Groundwater Directive however is limited to water in the saturated zone. From the 1st October 2004, the definition of groundwater in relation to Part IIA was amended, by the Second Water Act Commencement Order SI 2004 No 2528. For the purposes of Part IIA of the Environmental Protection Act 1990, the Environment Agency recommends that the groundwater within the saturated zone only is considered as the receptor (rather than soil / pore water).

INTRODUCTION

Demeter Environmental Ltd utilises the methodology for the assessment of groundwater as discussed in the Environment Agency publication 'Remedial Targets Methodology and Policy and Protection of Groundwater.

The procedure for determining site-specific remedial targets is summarised below:

1) Determine a target concentration at the receptor or compliance point in relation to its use.

2) Undertake the tier assessment to determine whether the contaminant source would result in the target concentration being exceeded at the receptor or compliance point. At each tier, a remedial target is determined.

3) If the contaminant concentrations on-site exceed the remedial target, then the decision whether it is appropriate to upgrade the tier analysis is based on:

- timescale – the decision to proceed to the next tier analysis should only be made if any risk involved in delaying the decision to implement the remedial action is acceptable;
- what additional information is required and can be obtained;
- cost-benefit analysis, i.e. the cost of tier upgrade in relation to the potential reduction in the cost of the remedial solution.

Four assessment tiers are proposed for the assessment of contaminated soil to protect water resources:

Level 1 considers whether contaminant concentrations in "pore water" in contaminated soil are sufficient to impact on the receptor, ignoring dilution, dispersion and attenuation along the pathway. The "pore water" concentration is determined from:

i) measured "pore water" concentrations or perched water quality;
ii) soil leaching tests;
iii) theoretical calculations based on soil/water partitioning equations.

Level 2 considers dilution by the receiving groundwater or surface water body and whether this is sufficient to reduce contaminant concentrations to acceptable levels. The remedial target is defined as the target concentration multiplied by a dilution factor (DF).

Levels 3 and 4 consider whether natural attenuation (including dispersion, retardation and degradation) of the contaminant as it moves through the unsaturated and saturated zones to the receptor are sufficient to reduce contaminant concentrations to acceptable levels. The remedial target is defined as target concentration multiplied by a dilution factor (DF) and attenuation factor (AF). In Level 3 simple analytical models are used to calculate the significance of attenuation, whereas in Level 4 more sophisticated numerical models are used.

For each level, the "pore water" concentration determined for the soil zone is compared to the remedial target to determine the need for remedial action.

The assessment in relation to contaminated groundwater commences at Level 2 as the contaminants have already moved through the soil zone, so that the only processes of significance are attenuation, dispersion and further dilution of this groundwater as it moves from the source towards the receptor. Thus the assessment levels for contaminated groundwater are:

Level 2 – the observed contaminant concentration in groundwater below the site is compared directly to the target concentration.

Levels 3 and 4 – the observed groundwater concentration below the site is compared directly to the target concentration multiplied by an attenuation factor (AF); as with the soil levelled assessment, Levels 3 and 4 are distinguished by the sophistication of the modelling and prediction processes.

BACKGROUND INFORMATION, CURRENT GUIDANCE AND RISK ASSESSMENT METHODOLOGY FOR RISKS POSED BY GROUND GAS

Background

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment, the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern; methane and carbon dioxide, and does not apply to other ground gases (e.g. radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of ground gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table E below. The generation potential of each source is given below.

Table E- Sources and Origins of Ground Gases

Source	Origin		Typical Range of Concentrations			Generation Potential
			Methane	Carbon Dioxide	Others	
Anthropogenic						
Landfill sites (include shallow and old landfill)	Microbial decay of organic materials derived from the disposal of putrescible materials	Landfill gas is a product of the biodegradation of organic materials contained in wastes deposited in landfill sites. Age and composition of landfill affect the gas regime. The gas regime will also be influenced by physical parameters such as volume/depth of waste and the groundwater regime, as well as environmental factors such as temperature, moisture content and pH value. These factors are considered in some detail in earlier CIRIA guidance (Barry et al, 2001). The Environment Agency Guidance on the management of landfill gas provides useful information on the mechanisms by which landfill gas is generated, its composition and physical and chemical characteristics and behaviour (Environment Agency, 2004a). Leachate from landfill sites may also contain dissolved gases or may degrade during migration to produce methane with carbon dioxide and associated gases.	20-65%	15-40%	Several hundred trace organic gases (maybe odorous or toxic) (generally makes up <1% of total volume, eg H_2S	Very high if the landfill has recently closed (post 1960) Moderate (pre 1960 landfills) Very low (inert landfills)
Made ground	Microbial decay of organic materials contained in reworked natural ground containing demolition and other wastes	Made ground will often contain degradable material such as wood, rags, paper and vegetation. However, the proportion of such carbon-rich materials is typically low, with major components often comprising re-worked clays, silts, sands and gravels together with anthropogenic inclusions such as ash, clinker, brick, concrete etc. Many brownfield sites contain made ground and on these sites the methane concentrations are usually not highly elevated, although there are exceptions, while concentrations of carbon dioxide can typically range to higher values. The rate of gas generation also tends to be low, resulting in small but sustained volumes of gas. There often tends to be a lack of driving force within made ground (see Section 2.6.1). The low rate of gas generation, the limited driving force and the fact that the gas is denser than air result in little upward migration of carbon dioxide.	0-20%	0-10%		Very low (inert made ground) Low (made ground with high levels of organic/ putrescible matter)
Foundry sands	Microbial decay of waste materials from the foundry process (phenolic binders, dextrin, coal dust, wood rags, paper)	In foundry sands, organic materials resulting from the foundry process such as phenolic binders, detrin and coal dust, and other foundry wastes such as wood, lignin and paper can provide a substrate for methanogenic bacteria (Hooker et al, 1993)	Up to 50%	15-40%	Trace organic gases (generally <1% of total volume) (maybe odorous and/or toxic)	Very low to low depending on presence of organic/ putrescible matter

Table E (continued)- Sources and Origins of Ground Gases

Source	Origin		Typical Range of Concentrations			Generation Potential
			Methane	Carbon Dioxide	Others	
Anthropogenic						
Sewage sludge, dung, cess pits/heaps	Microbial decay of organic materials	Methane and carbon dioxide are the main components associated with the anaerobic decomposition of organic components of sewage (Hooker et al, 1993). Hydrogen sulphide is also often present resulting from the degradation of organic matter and sulphur containing compounds (including mercaptans) in the sewage. Nitrogen oxide and ammonia gases are also associated with sewage. These gases can be a problem in sewer systems with confined spaces such as pipework, manholes and service chambers which can lead to potentially explosive, asphyxiating or chemically harmful atmospheres. Additionally the formation of sulphuric acid from the oxidation of hydrogen sulphide can corrode pipes, resulting in migration into the surrounding soils.	60-75%	18-40%	Trace organic gases (generally <1% of total volume) (maybe odorous and/or toxic)	Moderate
Burial Grounds (including cemeteries)	Microbial decay of organic materials contained within human/animal remains.	The generation of gases from the decomposition of corpses is well documented (Polson et al, 1975). The gases generated are predominantly carbon dioxide and methane with trace amounts of odorous sulphur-containing gases. Diphosphane may be generated by anaerobic decomposition of phosphorus in skeletal material (generally in waterlogged areas). Other gaseous emissions may include formaldehyde, associated with the preparation of cadavers and present in medium density fibreboard (MDF), widely used to make coffins.	20-65%	15-40%		Moderate
Industrial/chemical/petroleum sites/manufacturing	Organic vapours derived from leaks or spills from storage, processing and disposal areas		3-100%	2-8%	Trace organic gases (generally <1% of total volume) (maybe odorous and/or toxic), cyanide	Low
Natural gas (supply pipes)	Leakage from bulk pipeline transportation of natural gas	Mains gas is derived from the same geological source as methane in coal mines. Leaks into surrounding soils can occur from damaged or poorly maintained underground pipes. In the UK, a combination of mercaphens and sulphide are added as odourants which can often be detected. Ethane additives will also indicate the presence of distributed main gases.	90-95%	0-9.5%	1 – 27% C2-C4 alkanes, 4.7% CO	Low

Table E (continued)- Sources and Origins of Ground Gases

Natural						
Soils	Physical, chemical and biological transformations of rock during weathering		<2ppm	350ppm		Very low (none if no organic material is present)
Coal measures strata	Burial of vegetation under high temperatures and pressures, liberating gases as a by-product as a result of mining activities	Methane is associated with coal bearing carboniferous strata, produced by the anaerobic decomposition of ancient vegetation trapped within the rock. Associated gases include higher alkanes (for example ethane), hydrogen and helium. Former shafts and/or fractured rock can provide a migration pathway to the surface and rising groundwater or flooding of mine workings can release trapped methane and carbon dioxide.	<1-90%	0-6%	4–13% C_2-C_4 alkanes, 0 – 10% CO production of H_2S possible but rarely occurs in hazardous concentrations	High (active mine working) Moderate (abandoned mine working) Very low (flooded mine workings)
Peat/bog areas	Gas formed by the microbial decay of accumulated plant debris under anaerobic conditions	Methane from these sources is produced by the microbial decay of organic material under anaerobic conditions, usually waterlogged vegetation. Carbon dioxide is usually produced by acid reaction on carbonate fraction in any alluvial soil, and also generated by methane oxidation. Trace gases include hydrogen sulphide and light hydrocarbons. Methane can migrate large distances through soils. The source of the methane which caused the explosion at Abbeystead in 1985 was naturally occurring oil shales at more than 1 km depth.	10-90%	0-5%		Moderate
Alluvium (organic rich sediments)			0-5%	0-10%		Low (may be very low depending on levels of organic matter)
Radon emitting rocks	Decay of naturally occurring uranium within soils and rocks	Radon is a radioactive gas that occurs naturally and has no taste, smell or colour. It is formed from the decay of uranium, which is found in small quantities in all soil and rocks, in particular granite. Radionuclides (the decay products of radon) can damage lung tissues and ultimately lead to lung cancer. An action level of 200 Bq/m³ was set by the former National Radiological Protection Board	Variable	Variable	0-1000 Bq/m³ radon gas. Higher concentrations of gas up to 4,000,000 Bq/m³ have been recorded in the southwest	N/A
Carbonate rich strata	Dissolution of calcium carbonate by acidic water	Acidic waters such as rainwater can react with calcium carbonate (e.g. chalk and limestones etc) to form carbon dioxide. Elevated concentrations of carbon dioxide (>five per cent) have been detected in confined spaces particularly those associated with groundwater abstraction infrastructure such as pump houses, located in chalk areas.	Variable	1-9%		Very low to low depending on water content

This does not provide guidance for the assessment of risk when other gases are present due to 'Other Sources' from the above table (particularly volatile organic compounds or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc)
3. Properties of gases present including:
   - Chemical composition
   - Physical properties
   - Ratios of components e.g. methane: carbon dioxide
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are most likely.

Hazards Associated with Presence of Methane

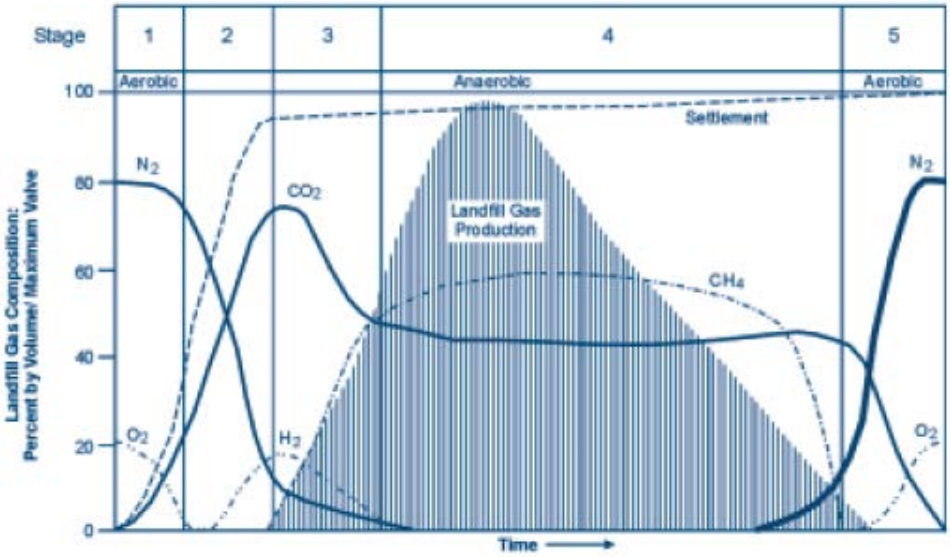
Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Hazards Associated with Presence of Carbon Dioxide

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long Term Occupational Exposure Limit (LTOEL, 8 hour period) and the Short Term Occupational Exposure Limit (STOEL, 15 minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

The figure below is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:



The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event as marked above, as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;
- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing 'face' for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g. rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Ground Gas Risk Assessment Methodology

Assessment of risk posed by ground gas is undertaken using the methodology as outlined previously, and summarised hereunder:

- Tier 1 Preliminary Risk Assessment
- Tier 2 Generic Quantitative Risk Assessment
- Tier 3 Detailed Quantitative Risk Assessment

The methodology used in each of the above assessments with concern to ground gas is discussed hereunder.

<u>Tier 1 Preliminary Risk Assessment</u>

All potential sources of methane and carbon dioxide are identified in the Preliminary Conceptual Model and the generation potential determined. The background information discussed earlier is referred to in order to determine the potential for a source to generate ground gas.

CIRIA C665 provides idealised monitoring frequency / period dependent upon generation potential of gas source and sensitivity of the proposed land use as below:

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)

		Generation Potential of Source				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Sensitivity of Development	**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 the number of readings and the second is the minimum period in months (e.g. 6/2 – six sets of readings over two months).

2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

The monitoring programme is decided using the above table prior to the intrusive site investigation. However, if the intrusive investigation reveals that a potential source is better or worse than anticipated the monitoring programme should be modified accordingly. For example, if the made ground contains no evidence of organic material and comprises entirely granular brick fill, the potential for that made ground to generate ground gas is reduced considerably.

Tier 2 Generic Quantitative Risk Assessment

Generic Quantitative Risk Assessment is undertaken upon completion of the required gas monitoring period.

All three current guidance documents propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$$

GSV's are compared to typical max concentrations and limiting gas screening values derived for either Situation A - All development except low rise housing with gardens, or Situation B low rise housing with gardens (NHBC Traffic Light System). Table 8.5 from CIRIA C665 is used for comparison of gas screening values for "Situation A Developments" and is presented hereunder:

Characteristic Situation (CIRIA R149)	Comparable Partners in Technology gas Regime (see Box 8.2)	Risk Classification	Gas Screening Value (CH_4 or CO_2) (l/hr)[1]	Additional Factors	Typical Source of Generation
1	A	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	B	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	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification

Table 8.7 is used for comparison of gas screening values for "Situation B Developments" and is presented hereunder:

Traffic light	Methane [1]		Carbon dioxide [2]	
	Typical max concentration[3] (% by volume)	Gas screening value [2,4] (litres /hour)	Typical max concentration[3] (% by volume)	Gas screening value [2,4] (litres /hour)
Green				
	1	0.13	5	0.78
Amber 1				
	5	0.63	10	1.60
Amber 2				
	20	1.60	30	3.10
Red				

Notes:
1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

CIRIA C665 Table 8.7 NHBC Traffic light system for 150 mm void

Dependant on the outcome of the assessment of risk posed by ground gas it is determined whether gas protection measures are required for the proposed development, and or whether a detailed quantitative risk assessment is required for the site.

Selection & Design of Protective Measures

Table 8.6 and Box 8.4 of CIRIA C665 contain information on the detailed design of protection measures and were initially intended for the purposes of determining then level of protection measures a development requires. These tables and related text include some useful information on the design of gas protection measures, however BS8485:2015 which supersedes the guidance included within CIRIA C665, is used for selection of gas protection measures. BS8485:2015 uses a scoring system dependant on the Characteristic Situation / NHBC Traffic Light and proposed end use of the site. The scoring system is summarised in BS8485:2015 Table 4 as presented hereunder:

Characteristic gas situation, CS	**NHBC traffic light**	**Required gas protection**			
		Type A Building (private ownership with no building management controls on alterations to the internal structure, the use of rooms, the ventilation of rooms or the structural fabric of the building. Some small rooms present. Probably conventional building construction (rather than civil engineering). Examples include private housing and some retail premises)	**Type B Building** (private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building, including the gas protection measures. Multiple occupancy. Small to medium size rooms with passive ventilation of rooms and other internal spaces throughout ground floor and basement areas. May be conventional building or civil engineering construction. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings (such as schools, hospitals, leisure centres) and parts of hotels)	**Type C Building** (commercial building with central building management control of any alterations to the building or its uses and central building management control of the maintenance of the building, including the gas protection measures. Single occupancy of ground floor and basement areas. Small to large size rooms with active ventilation or good passive ventilation of all rooms and other internal spaces throughout ground floor and basement areas. Probably civil engineering construction. Examples include offices, some retail premises, and parts of some public buildings (such as schools, hospitals, leisure centres and parts of hotels).	**Type D Building** (industrial style building having large volume internal space(s) that are well ventilated. Corporate ownership with building management controls on alterations to the ground floor and basement areas of the building and on maintenance of ground gas protective measures. Probably civil engineering construction. Examples are retail park sales buildings, factory shop floor areas, warehouses.
1	*Green*	0	0	0	0
2	*Amber 1*	3.5	3.5	2.5	1.5
3	*Amber 2*	4.5	4.0	3.0	2.5
4	*Red*	6.5 (a)	5.5 (a)	4.5	3.5
5		(b)	6.5 (a)	5.5	4.5
6		(b)	(b)	7.5	6.5
NOTE *Traffic light indications are taken from NHBC Report no.:10627-RO1 (04) and are mainly applicable to low-rise residential housing[1]. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.*					
a) Residential buildings should not be built on CS4 or higher sites 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. b) The gas hazard is too high for this empirical method to be used to define the gas protection measures					

The NHBC guidance and CIRIA C665 guidance refers to low rise housing (which is up to three storeys without lifts) that is constructed with a 150mm ventilated sub-floor void.

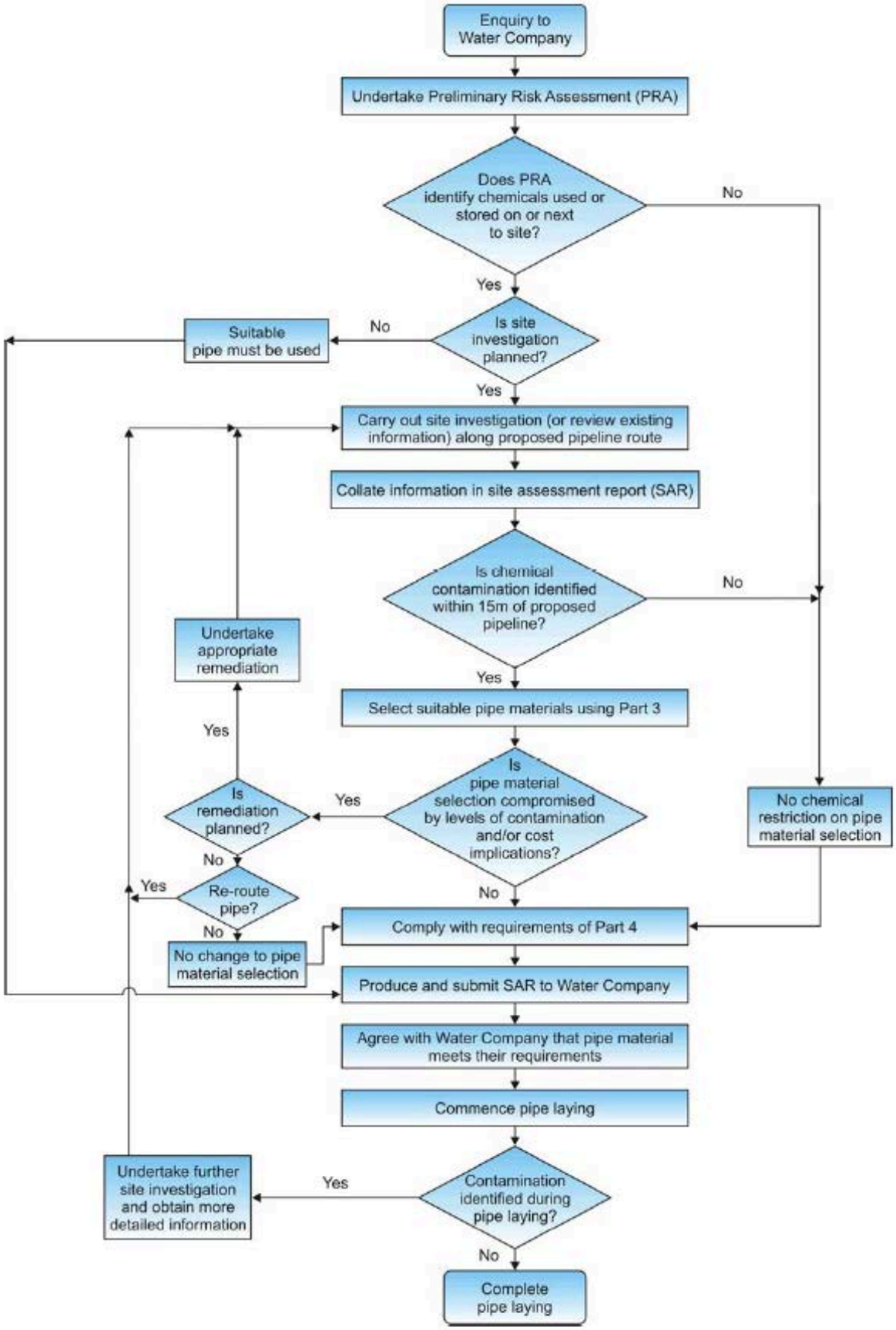
BS8485:2015 Table 2 Required gas protection by characteristic gas situation and type of building

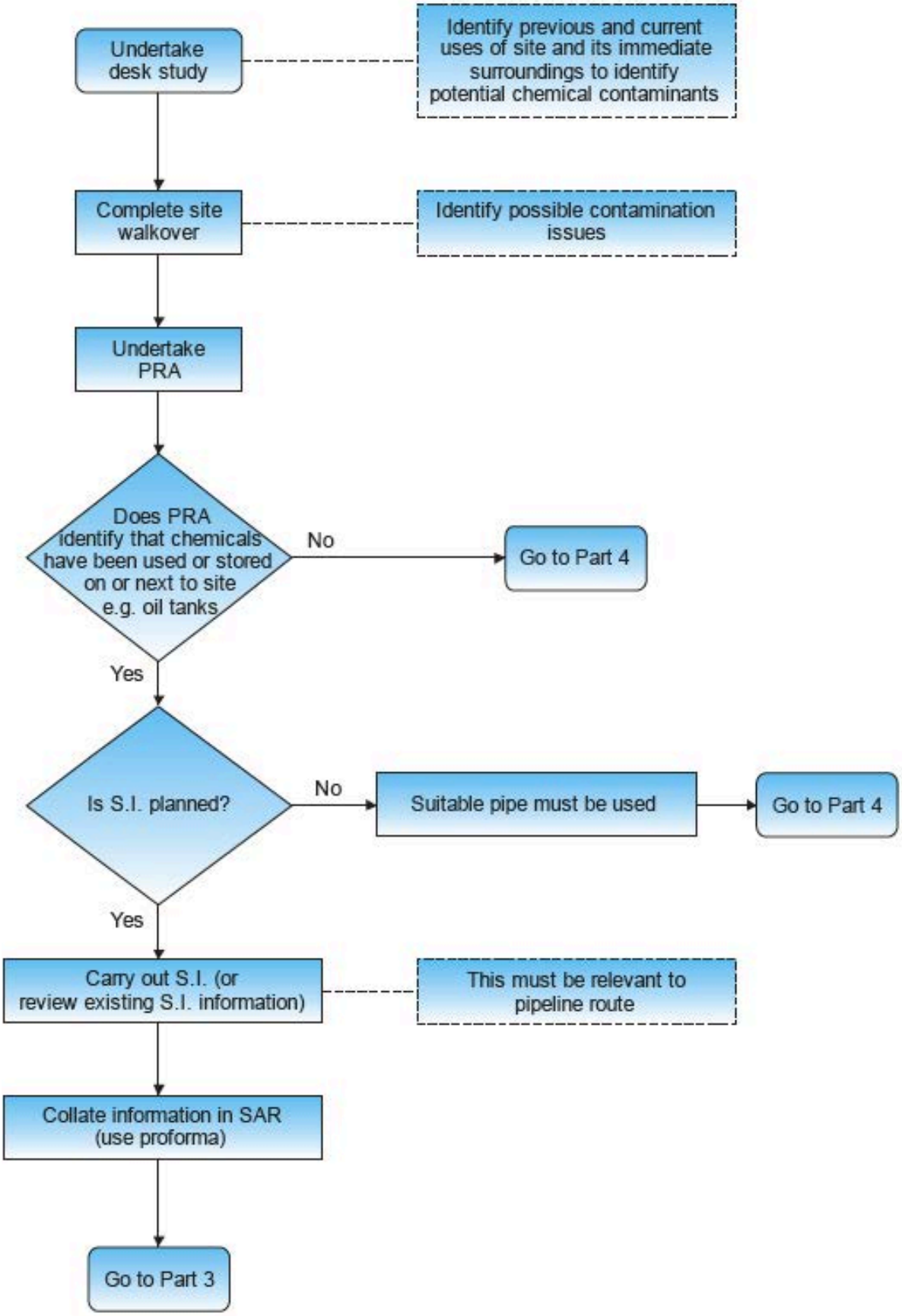
Once a score is assigned, a combination of protection systems / elements is chosen from BS8485:2015 Table 3 shown below:

PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
Gas Protection Scores for Ventilation Protection Measures		
Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building)	0.5	*Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems.* *If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is zero.*
Passive sub floor dispersal layer: Very good performance Media used to provide the dispersal layer are: • Clear void, Polystyrene void former blanket, Geocomposite void former blanket, No-fines gravel layer with gas drains, No-fines gravel layer Good performance	2.5 1.5	*The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in BS8485:2015. Passive ventilation should be designed to meet at least "good performance".*
Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	*This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place.* *There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least "good performance", as described in BS8485:2015.*
Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	*This system relies on continued operation of the pumps, therefore alarm and response systems should be in place.* *The score assigned should be based on the efficient "coverage" of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least "good performance".*
Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)	4.0	*Assumes that the car park is vented to deal with car exhaust fumes, designed to Buildings Regulations 2000, Approved Document F*
Gas Protection Scores for the Structural Barrier		
Floor and Substructure Design Precast suspended segmental subfloor (i.e. Block and beam floor slab) Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement) Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations Basement floor and walls conforming to BS 8102:2009, Grade 2 waterproofing (c) Basement floor and walls conforming to BS 8102:2009, Grade 3 waterproofing (c)	 0 (a) 0.5 (a) 1.0 or 1.5 (a), (b) 2.0 2.5	*a) The scores are conditional on breaches of floor slabs, etc. being effectively sealed;* *b) to achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in;* *c) the score is conditional on the waterproofing not being based on the se of a geosynthetic clay liner waterproofing product*
Membranes		
Gas resistant membrane meeting all of the following criteria: • sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m2/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	2	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. For example, a minimum 0.4 mm thickness (equivalent to 370 g/m2 for polyethelene) reinforced membrane (virgin polymer) meets the performance criteria in BS8485:2015 If a membrane is installed that does not meet all the criteria in column 1 then the score is zero.*

WATER MAINS RISK ASSESSMENT

Risks to water supply pipes are assessed using the document 'Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites' published by the UK Water Industry Research (UKWIR). The methodology for the selection of water pipes in brownfield sites is below:




Undertake desk study
Identify previous and current uses of site and its immediate surroundings to identify potential chemical contaminants
Complete site walkover
Identify possible contamination issues
Undertake PRA
Does PRA identify that chemicals have been used or stored on or next to site e.g. oil tanks
No
Go to Part 4
Yes
Is S.I. planned?
No
Suitable pipe must be used
Go to Part 4
Yes
Carry out S.I. (or review existing S.I. information)
This must be relevant to pipeline route
Collate information in SAR (use proforma)
Go to Part 3

For sites where the preliminarily conceptual site model (PCSM) does not identify the potential for chemical storage either on or next to the site, there are no chemical restrictions on the selection of pipe selection material.

The guidance recommends that if known, samples should be taken along the route of the water mains. At the time of any intrusive investigation the route of the water mains is generally unknown, hence the guidance recommends that samples are taken across the site.

Table 1: Pipe Selection Table

	Pipe Material					
	All thresholds are in mg/kg					
Contaminant	**PE**	**PVC**	**Barrier Pipe (PE-AL-PE)**	**Wrapped Steel**	**Wrapped Ductile Iron**	**Copper**
Extended VOC suite by purge and trap or head space and GC-MS with TIC	0.5	0.125	Pass	Pass	Pass	Pass
Total BTEX and MTBE	0.1	0.03	Pass	Pass	Pass	Pass
SVOC's TIC by purge and trap or head space and GC-MS with TIC (aliphatic and aromatic EC5-EC10)	2.0	1.4	Pass	Pass	Pass	Pass
Phenols	2	0.4	Pass	Pass	Pass	Pass
Cresols and chlorinated phenols	2	0.04	Pass	Pass	Pass	Pass
Mineral oil C11-C20 (aromatic/aliphatic EC10-EC16, aromatic EC16-EC21 and aliphatic EC16-35)	10	Pass	Pass	Pass	Pass	Pass
Mineral oil C21-C40 (aliphatic EC16-EC35 and aromatic EC21-EC35)	500	Pass	Pass	Pass	Pass	Pass
pH	Pass	Pass	Pass	Corrosive if pH<7 and conductivity >400uS/cm	Corrosive if pH<5, Eh not neutral and conductivity >400uS/cm	Corrosive if 5<pH>8 and Eh positive
Conductivity						
Redox						
SPECIFIC SUITE IDENTIFIED AS RELEVANT FOLLOWING SITE INVESTIGATION						
Ethers	0.5	1.0	Pass	Pass	Pass	Pass
Nitrobenzene	0.5	0.4	Pass	Pass	Pass	Pass
Ketones	0.5	0.02	Pass	Pass	Pass	Pass
Aldehydes	0.5	0.02	Pass	Pass	Pass	Pass
Amines	Fail	Pass	Pass	Pass	Pass	Pass

It can be seen that barrier pipe is suitable on all sites. Where metallic (steel, ductile iron or copper) pipes are to be used, information on the pH, conductivity and redox of the soils will be required to determine suitability. Where PE or PVC pipes are to be laid, information on the presence of organic contaminants identified in the PSCM will be required.

Stage 1 - Assessment Methodology Before Water Mains Alignment is Known

At the time of a Phase II site investigation the alignment of the water mains is generally unknown, and as part of the investigation the entirety of the site will be investigated. The contaminants subject to analysis will be guided by the preliminarily conceptual model, and only contaminants identified in the preliminary conceptual model will be subject to assessment, which will provide a preliminarily specification of water mains.

The site investigation data will be assessed against Table 1 above and a preliminarily assessment of the suitability of water pipe material will be made.

Stage 2 – Assessment Methodology Once Alignment of the Water Mains is Known

Once the alignment of the water mains is known, if cost effective, additional analysis can be undertaken along the alignment to determine if metallic, PE or PVC pipes would be suitable.

RISK TO CONCRETE IN THE GROUND

The risk to buried concrete is assessed in accordance with the BRE Special Digest 1:2005 – 'Concrete in Aggressive Ground'. Recommendations for the composition of concrete and supplementary protective measures (if required) are given on the basis of the assessment.

CURRENT GUIDANCE ON REMEDIATION

When risk assessment of the site has been completed and it indicates that remedial works are required, the main guidance in managing this process is set out in the DEFRA/EA publication CLR11 (2004) "Model Procedures for the Management of Land Contamination." The stages of managing remediation are as follows:

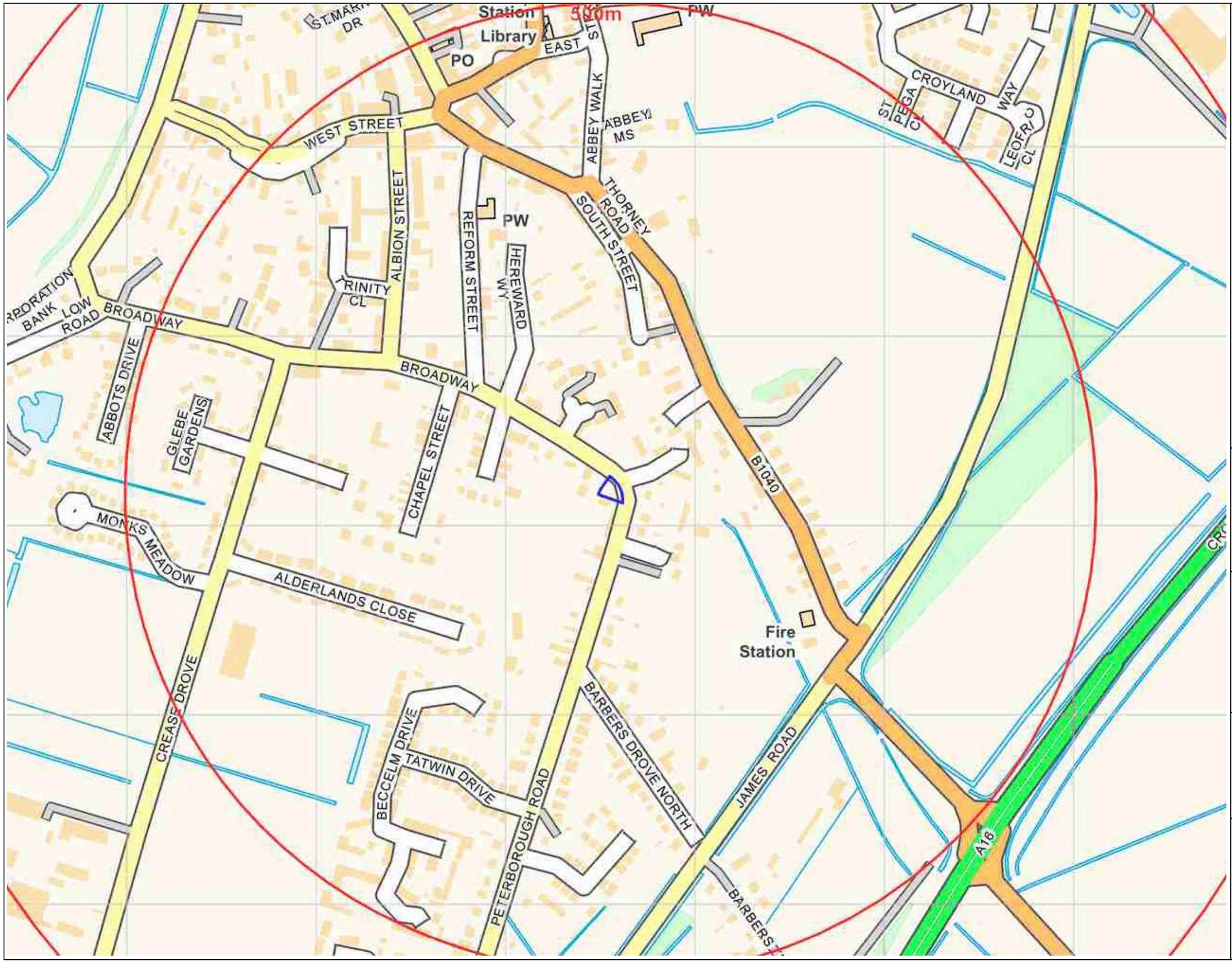
(a) Options Appraisal and develop Remediation Strategy;
(b) Develop Implementation Plan and Verification Plan;
(c) Remediation, Verification and Monitoring.

The Remediation Strategy sets out the remediation targets, identifies technically feasible remedial solutions and presents an evaluation of the options so that these can be assessed enabling that the most suitable solution is adopted. An outline of the proposed remedial method should be presented. Agreement should be sought of the appropriate statutory bodies for the Remediation Strategy before proceeding to the next stage.

The Implementation Plan is a detailed method statement setting out how the remediation is to be carried out including stating how the site will be managed, welfare procedures, health and safety considerations together with practical measures such as details of temporary works, programme of works, waste management licences and regulatory consents required. Agreement should again be sought of the appropriate statutory bodies for this Plan.

The Verification Plan sets out the requirements for gathering data to demonstrate that the remediation has met the required remediation objectives and criteria. The Verification Plan presents the requirements for a wide range of issues including the level of supervision, sampling and testing regimes for treated materials, waste and imported materials, required monitoring works during and post remediation, how compliance with all licenses and consents will be checked etc. Agreement should again be sought of the appropriate statutory bodies for the Verification Plan. On completion of the remediation a Verification Report should be produced to provide a complete record of all remediation activities on site and the data collected as required in the Verification Plan. The Verification Report should demonstrate that the remediation has met the remedial targets to show that the site is suitable for the proposed use.

APPENDIX D: DRAWINGS



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Brighton Office:
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Brighton, East Sussex
BN3 7BD
Tel: 01273 741 727

Email: enquiries@demeter-environmental.co.uk

Drawing 1

Land at Junction of Broadway / Peterborough Road

Scale: NTS

Site Location Plan

Demeter Environmental Ltd
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Email: enquiries@demeter-environmental.co.uk

Drawing 2

Land at Junction of Broadway/Peterborough Road

Aerial Plate

Date Taken: 6th April 2015

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Brighton, East Sussex
BN3 7BD
Tel: 01273 741 727

Email: enquiries@demeter-environmental.co.uk

Drawing 3

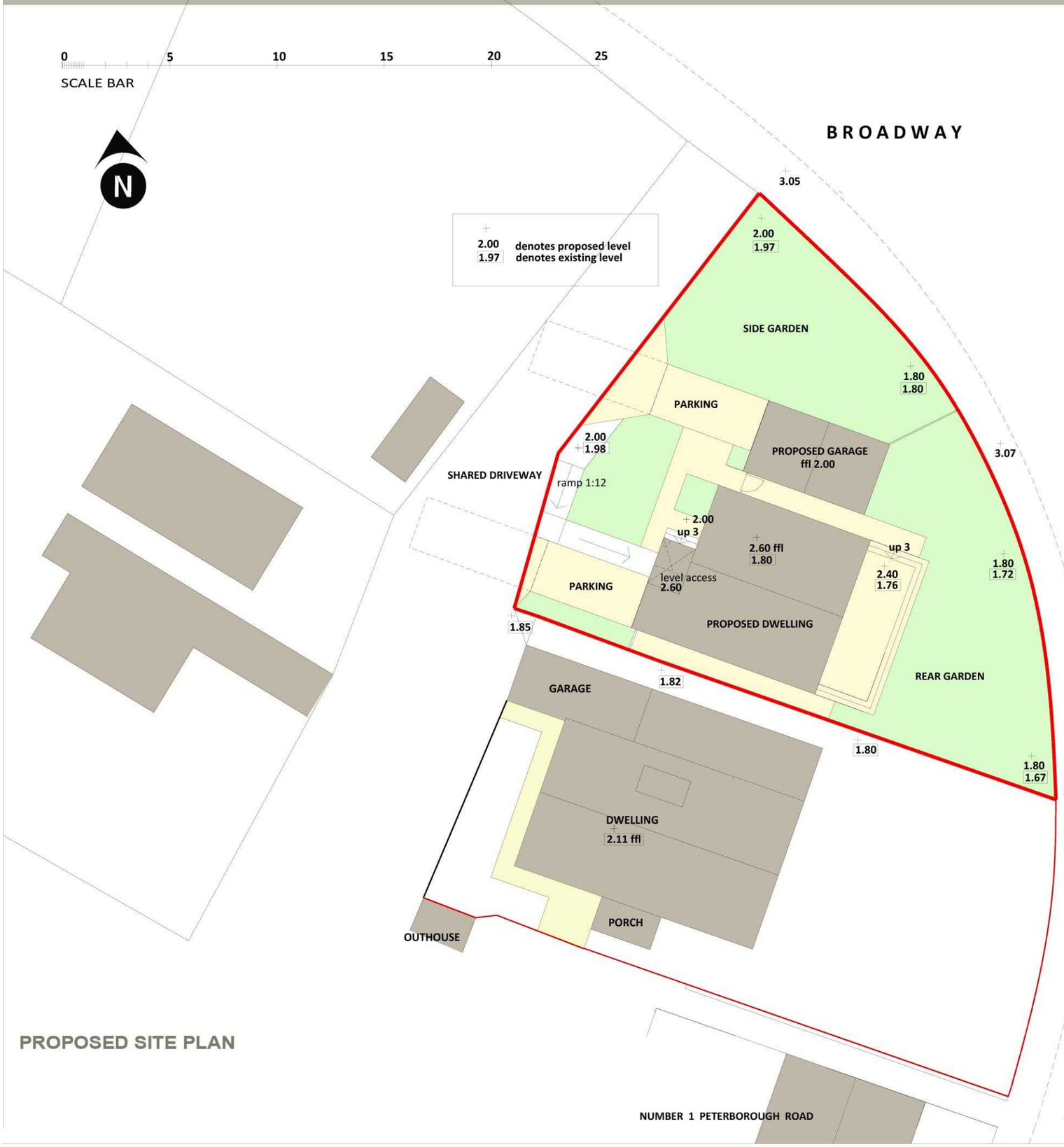
Land at Junction of Broadway / Peterborough Road

Scale: 1:250 at A3

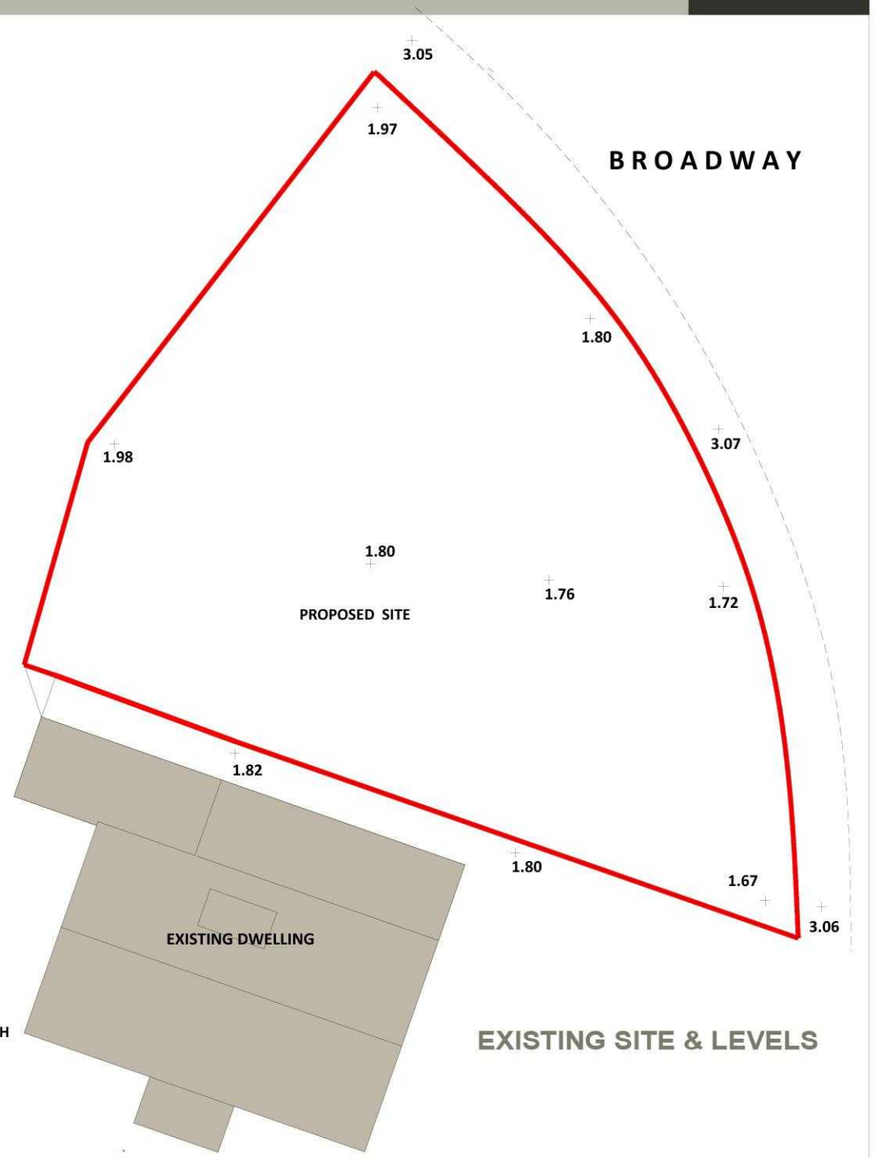
Site Location Plan

Land at BROADWAY. CROWLAND. PETERBROUGH.

drawing number
MS/04B



PROPOSED SITE PLAN



EXISTING SITE & LEVELS

scale	date	revision
1:200 Print at A3	February 2018	A 08/02/2018 Drawing issued B 19/04/2017 Revised re: levels

title
PROPOSED SITE PLAN

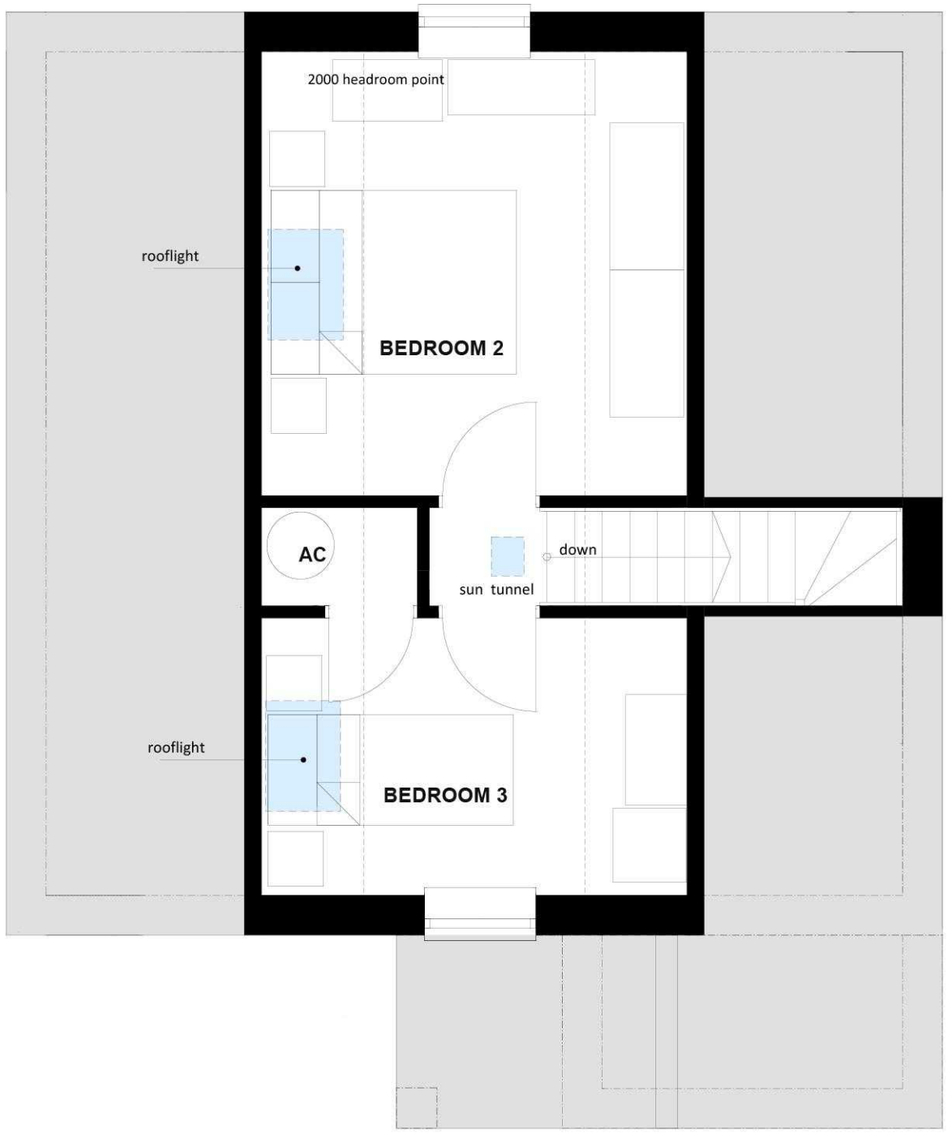
contract
MAURICE STRICKLAND.

sharman architecture
WILLOW BARNS. WILLOW DROVE. BOROUGH FEN. PETERBOROUGH. PE6 7QB
tel: 07724 529 094
email: paulsharman1@btinternet.com

Land at BROADWAY. CROWLAND. PETERBOROUGH.

drawing number
MS/10/A

NOTES
1 Do not scale from the drawings. Dimensions to be checked on site
2 All work to comply with the current building regulations.
3 All drawings are the copyright of sharman architecture.
4 This drawing is intended to identify the main features and principal components.Construction work should be carried out and supervised by experienced and competent personnel and hence exhaustive detail is not required.



0 5 10
Metres
SCALE BAR

title	scale	date
PROPOSED FLOOR PLANS	1:50 @ A3	FEBRUARY 18
contract: MAURICE STRICKLAND	revision: A 08/02/2018 Drawing issued	

sharman architecture
OAK BARN. WILLOW DROVE. BOROUGH FEN. PETERBOROUGH. PE6 7QB
tel: 07724 529 094
email: paulsharman1@btinternet.com

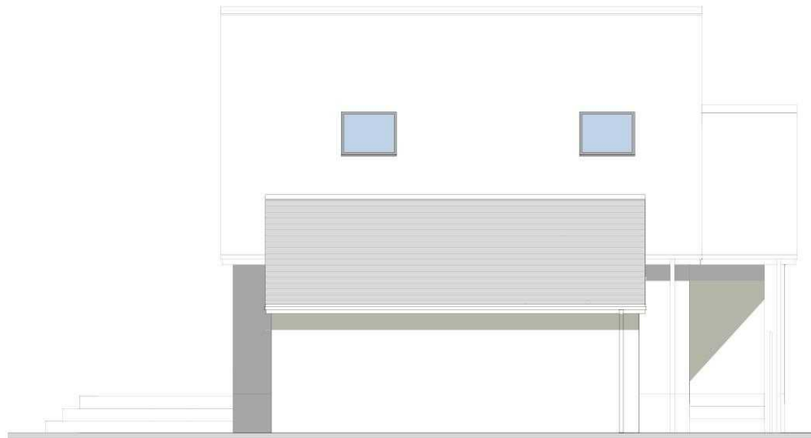
BROADWAY. CROWLAND. PETERBOROUGH

drawing number
MS/08/B

PROPOSED ELEVATIONS 1

FRONT ELEVATION

SIDE ELEVATION 1



GARAGE SIDE ELEVATION

title	scale	date
ELEVATIONS PROPOSED (SHEET 1)	1:100 at A3	JANUARY 2018
contract BROADWAY. CROWLAND. PETERBOROUGH.	revision A 08/01/2018 Drawing issued B 17/04/2018 Levels revised	

sharman architecture
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email: paulsharman1@btinternet.com

APPENDIX E: SITE PHOTOGRAPHS AND PHOTOGRAPH KEY PLAN

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Tel: 01273 741 727

Email: enquiries@demeter-environmental.co.uk

Drawing 3

Land at Junction of Broadway / Peterborough Road

Scale: 1:250 at A3

Photograph Key Plan

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Plate 1

Land at Junction of Broadway/Peterborough Road

Description: Looking north-west across site

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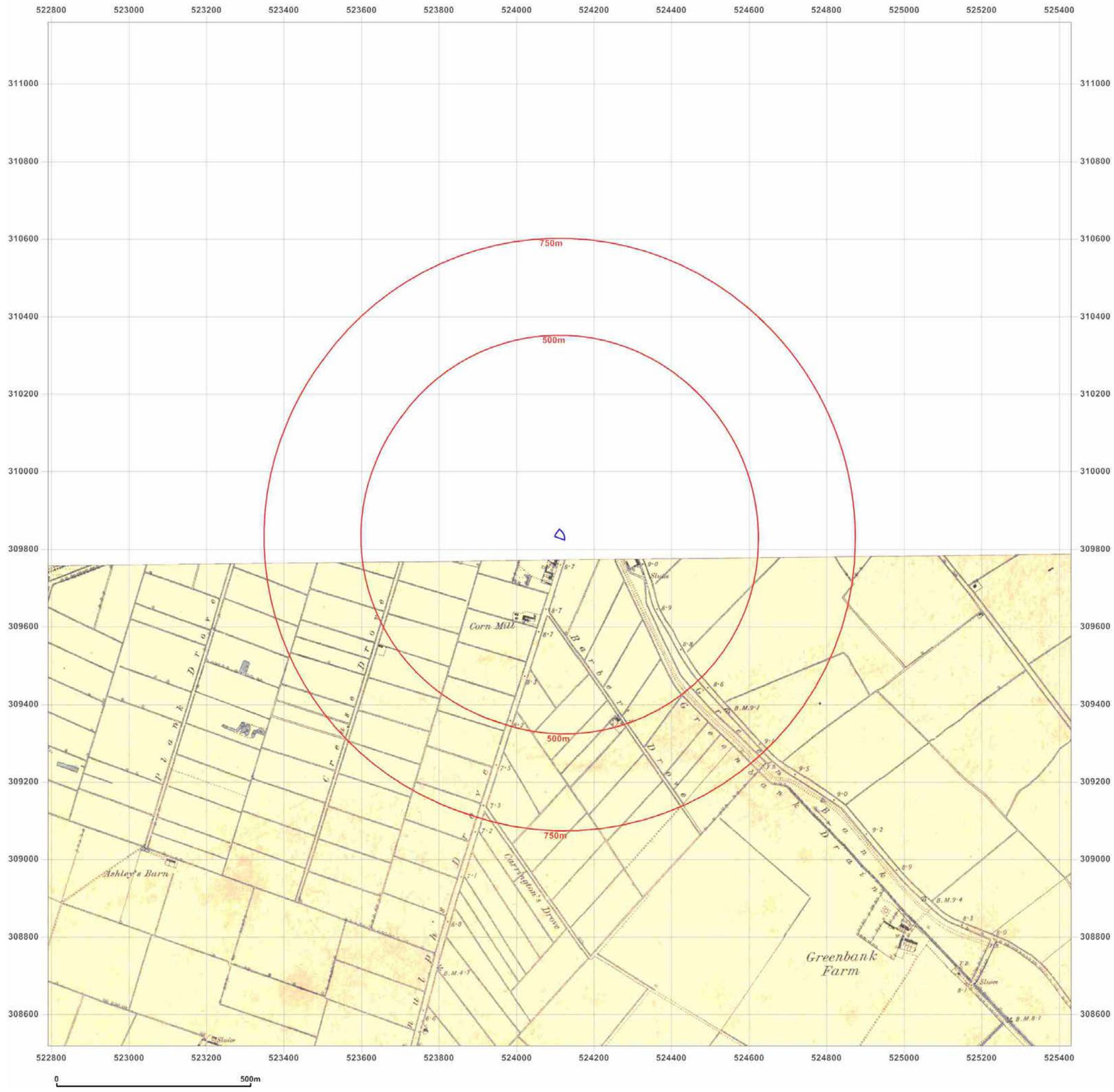
Email: enquiries@demeter-environmental.co.uk

Plate 2

Land at Junction of Broadway/Peterborough Road

Description: Looking east across site

APPENDIX F: HISTORICAL O.S. MAPS



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Site Details:

Land at Junction of Broadway/Peterborough Road,,Crowland

Client Ref: EMS_530185_713114
Report Ref: EMS-DE-530185_713114
Grid Ref: 524110, 309838

Map Name: County Series

Map date: **1886**

Scale: 1:10,560

Printed at: 1:10,560

N
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S

Surveyed 1886
Revised 1886
Edition N/A
Copyright N/A
Levelled N/A

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Map legend available at:
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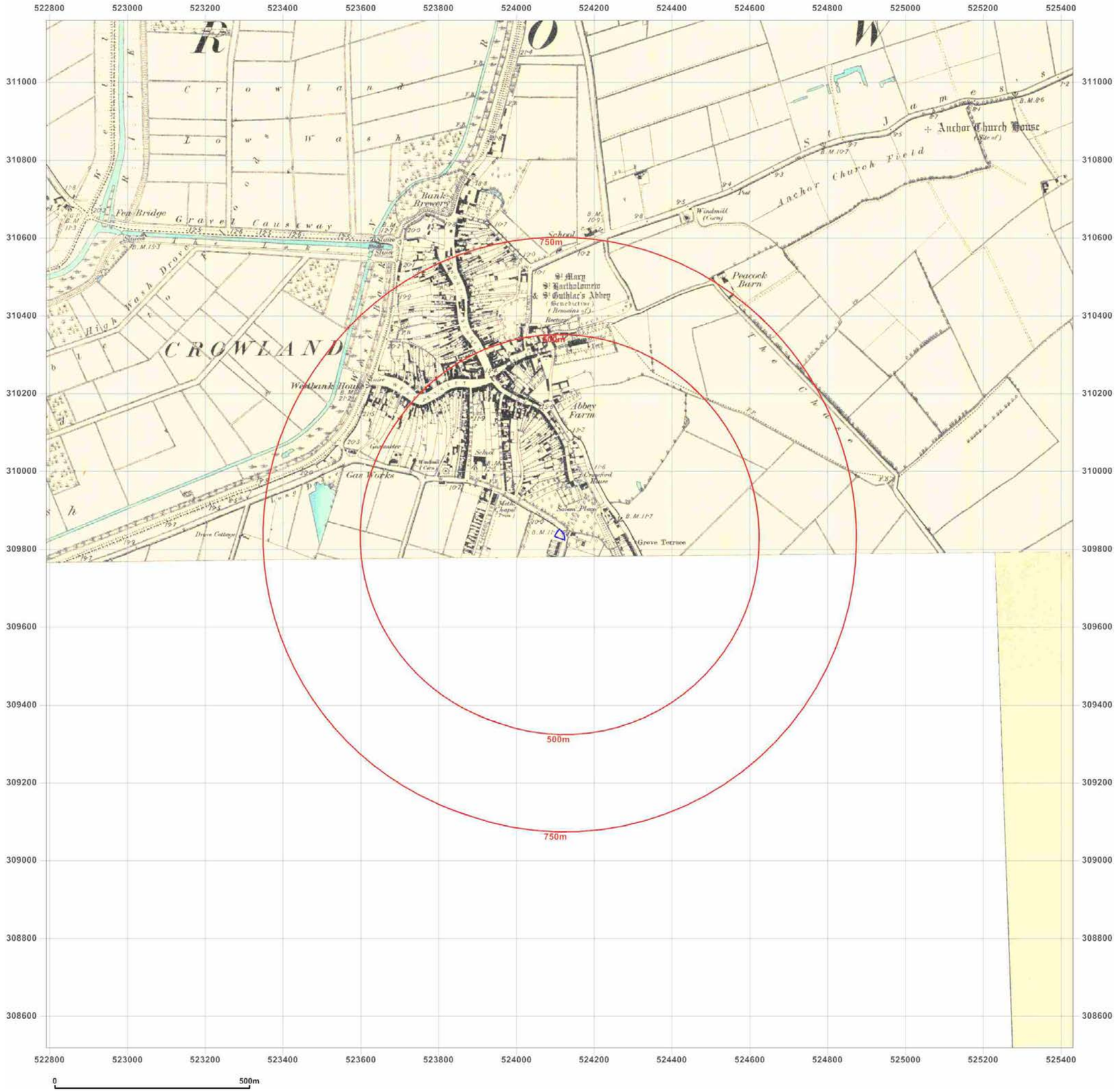

emapsite™

Site Details:

Land at Junction of Broadway/Peterborough Road,,Crowland

Client Ref: EMS_530185_713114
Report Ref: EMS-DE-530185_713114
Grid Ref: 524110, 309838

Map Name: County Series

Map date: **1886-1887**

Scale: 1:10,560

Printed at: 1:10,560

N
W E
S

Surveyed 1887
Revised 1887
Edition N/A
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Surveyed 1886
Revised 1886
Edition N/A
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Report Ref: EMS-DE-530185_713114
Grid Ref: 524110, 309838

Map Name: County Series

Map date: **1887-1888**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
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Surveyed 1888
Revised 1888
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1888
Revised 1888
Edition N/A
Copyright N/A
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Surveyed 1887
Revised 1887
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