

APPENDIX 1

LEGISLATIVE CONTEXT AND METHODOLOGY

LEGISLATIVE CONTEXT

The regime for contaminated land was set out in Part 2A (ss.78A-78YC) of the Environmental Protection Act 1990 (EPA), as inserted by S.57 of The Environment Act 1995 and came into effect in England on 1st April 2000 as The Contaminated Land (England) Regulations 2000 (SI 2000/227). These regulations were subsequently revoked with the provision of The Contaminated Land (England) Regulations 2006 (SI 2006/1380) (as amended), which came into force in August 2006, and consolidated the previous regulations and amendments. Revised statutory guidance ("the Guidance") for local authorities on how to implement the regime, including the decision-making process on whether land is contaminated land in the legal sense, has been published by Defra and entered into force in April 2012.

Under Part 2A of the EPA Section 78A(2), "contaminated land" is defined as "land which appears... to be in such a condition, by reason of substances in, on or under the land, that:

- a) significant harm is being caused or there is a significant possibility of such harm being caused¹; or
- b) significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused".

"Significant harm" is defined in the Guidance on risk-based criteria and must be the result of one or more relevant 'contaminant linkages' relating to the land. The presence of a contaminant linkage relies on the Source-Pathway-Receptor concept, where all three factors must be present and potentially or actually linked for a potential risk to exist. Under the Guidance, a 'significant contaminant linkage' is one which gives rise to a level of risk sufficient to justify a piece of land being determined as contaminated land. Should the authority consider that 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, the land should be deemed a Category 1: 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. Both Category 1 and Category 2 cases would be capable of being determined as contaminated land under Part 2A on the grounds of significant possibility of significant harm to human health. If the legal test for significant possibility of significant harm is not met, the authority should place the land into Category 3. If the local authority considers that there is no risk or that the level of risk posed is low, the land should be placed into Category 4.

The pollution of controlled waters is defined in Section 78A(9) of the Act as "the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter". The new Guidance stresses that the Part 2A regime is designed to identify and deal with 'significant pollution' and not lesser levels of pollution. As with human health risk, Categories 1 and 2 comprise land where the local authority considers that a significant possibility of significant pollution of controlled waters exists and Categories 3 and 4 comprises cases where the authority considers that a significant possibility of such pollution does not exist. The local authority should be satisfied that a substance is continuing to enter controlled waters or is likely to enter controlled waters.

Risk Assessment Framework

"Significant harm" or "significant pollution of controlled waters" is defined in the Guidance on risk-based criteria and must be the result of one or more relevant 'contaminant linkages' relating to the land.

The presence of a contaminant linkage relies on the Source-Pathway-Receptor concept, where all three factors must be present and potentially or actually linked for a potential risk to exist. For a risk

¹ Water Act 2003 (Commencement No. 11) Order 2012

of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A source - a substance that is capable of causing pollution or harm;
- A receptor - something which could be adversely affected by the contaminant; and
- A pathway - a route by which the contaminant can reach the receptor.

If one of these elements is absent there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

The Land Contamination: Risk Management² (LCRM) provides the technical framework for structured decision making about land contamination. LCRM advocates a phased approach, commencing with Stage 1 Risk Assessment comprising:

- Preliminary Risk Assessment (PRA) – desk study and qualitative assessment to develop of an outline Conceptual Site Model (CSM);
- Generic Quantitative Risk Assessment (GQRA) – an estimation of risk through assessment of contaminant concentrations against generic assessment criteria; and
- Detailed Quantitative Risk Assessment (DQRA) – an estimation of risk through detailed site-specific risk assessment and development of site-specific assessment criteria (SSAC) and site-specific risk assessment.

Each stage of assessment is focussed upon the development and refinement of a conceptual site model, which identifies Source-Pathway-Receptor linkages. The conceptual site model has been developed with consideration to guidance including BS EN ISO 21365:2020 Soil quality – Conceptual site models for potentially contaminated sites.

RISK ESTIMATION

An assessment of environmental risks is made for each potential pollutant linkage identified.

Risk estimation has been completed in accordance with the guidance provided in:

- NHBC and Environment Agency 2008. Guidance for the Safe Development of Housing on Land Affected by Contamination. R&D Publication 66: 2008.

The following is taken directly from NHBC/EA 2008. The key to the classification is that the designation of risk is based upon the consideration of both:

- the magnitude of the potential consequence (i.e. severity) [takes into account both the potential severity of the hazard and the sensitivity of the receptor]; and
- the magnitude of probability (i.e. likelihood) [takes into account both the presence of the hazard and receptor and the integrity of the pathway].

Table 1: Classification of Consequence (after NHBC/EA 2008)

Category	Definition
Severe	Highly elevated concentrations likely to result in “significant harm” to human health as defined by the EPA 1990, Part 2A, if exposure occurs.

² Land Contamination: Risk Management (LCRM), published by the Environment Agency on 8 October 2020

Category	Definition
	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. 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. Catastrophic damage to crops, buildings or property.
Medium	Elevated concentrations which could result in "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. Significant damage 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.
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. 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. Minor damage to crops, buildings or property.
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.

* 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.

The likelihood of an event (probability) takes into account both the presence of the hazard and target and the integrity of the pathway and has been assessed based on the categories given below.

Table 2: Classification of Probability (after NHBC/EA 2008)

Category	Definition
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.
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.
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.
Unlikely	There is pollutant linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term.

The potential severity of the risk and the probability of the risk occurring have been combined in accordance with the following matrix in order to give a level of risk for each potential hazard.

Table 3: The Classification of Risk (after NHBC/EA 2008)

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very high	High	Moderate	Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/ Low	Low	Very low
	Unlikely	Moderate/ Low	Low	Very low	Very low

Very high risk

There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.

High risk

Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.

Moderate risk

It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk

It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk

It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

No potential risk

There is no potential risk if no pollution linkage has been established.

GQRA METHODOLOGIES

In order to assess the significance of contaminant concentrations, Ramboll has derived Generic Assessment Criteria (GAC) for screening purposes. GAC are derived for each critical receptor identified. Receptors are considered in relation to:

- Human health receptors (e.g. site users); and
- The water environment (e.g. groundwater and surface water).

Potential risks to human health are considered primarily using measured concentrations of contaminants in soil. Potential risks to the water environment are considered primarily using groundwater and soil leachate (most commonly in the absence of groundwater) concentrations as indicative of the potentially mobile fraction of any soil impact.

Additional receptors may be relevant, dependent on the site e.g. flora/fauna, agricultural use, water supply pipes, buried concrete etc. These are considered separately on a site specific basis if relevant.

Soil Human Health Risk Assessment

The Ramboll GAC for human health risk assessment of soils are based on the generic scenarios outlined in the Defra³ SP1010 guidance, Contaminated Land Exposure Assessment (CLEA) methodology and associated guidance documents. The Ramboll GAC have been calculated by use of two proprietary risk assessment models (CLEA Version 1.071 and the ASTM RBCA⁴ Tool Kit Version 2.6 for Chemical Releases) which have been altered, where necessary, to reflect the current UK approach to human health risk assessment as set out in LCRM, DEFRA SP1010 guidance, and the CLEA guidance documents (incorporating Science Reports SC050021/SR2 (January 2009), SR3 (January 2009), SR4 (September 2009) and the SGV reports (2009)). The Ramboll GAC include the conservative assumptions of a sandy soil type and 1% soil organic matter.

A methodology for derivation of screening values, the Category 4 Screening Levels, or C4SLs, has been developed and endorsed for use by Defra that describe a low level of risk just below the Category 3/4 boundary set in the Statutory Guidance, i.e. where concentrations are below the C4SL, there is no risk or the level of risk is acceptably low. Initially, C4SLs were developed for six common contaminants (benzo(a)pyrene, cadmium, arsenic, benzene, hexavalent chromium and lead). The Environment Agency states under their LCRM approach that they expect C4SL values to be used in risk assessments for land contamination. C4SLs for additional compounds are being developed by Contaminated Land: Applications in Real Environments (CL:AIRE) and are published on their website when approved for publication⁵. Currently additional C4SLs have been published for vinyl chloride, trichloroethene, tetrachloroethene and 1,2-dichloroethane.

Defra's SP1010 Policy Companion document states that it is anticipated that risk assessors will use the C4SL values, where derived, in line with Part 2A Statutory Guidance. In the absence of a suitable C4SL, risk assessors should identify and select appropriate generic assessment criteria in accordance with established good practice. On this basis, Ramboll has adopted the use of C4SLs where available, however minimal risk (instead of the 'low' level of risk) toxicological assumptions have been applied for in-house Ramboll GAC for other contaminants of concern within our screening assessments.

For contaminants which do not have published C4SLs, the physiochemical and toxicological data has been taken from or derived using the methodology detailed in SR7 (November 2008) and SGV reports (2009), where feasible. Ramboll also attended the Land Quality Management and Chartered Institute of Environmental Health workshop for the collaborative development of 'Suitable 4 Use Levels' (S4ULs) and reference has been made to their publication 'The LQM/CIEH S4ULs for Human Health Risk Assessment, 2015'. Review of additional UK organisation guidance including CL:AIRE and partners GAC, including addendums up until 10 April 2012 has also been made. Finally, where necessary, other published sources of (non-UK) information, such as the RBCA V2.6 database have also been reviewed.

³ SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document, Defra, revised December 2014.

⁴ American Society for Testing Materials – Risk Based Corrective Action Model, Version 2.6

⁵ C4SL (claire.co.uk)

Assessment of Impact to Waters

Assessment of risks to water resources (referred to as "controlled waters" in England & Wales) is completed in general accordance with guidance provided in the Environment Agency's Approach to groundwater protection (2018⁶).

Generic assessment criteria for waters have been selected by Ramboll to assess potential risks to the identified environmental receptors. A hierarchical approach has been taken to the use of assessment criteria based on adoption of published water quality standards at European level and UK specific standards, with those standards being chosen based on the conceptual site model and identified critical receptors. For those determinants included in the analytical suite which do not have a corresponding UK drinking water or environmental screening criteria, reference is made to international guidance in accordance with Environment Agency recommendations.

Where such standards are unavailable, standards taken from other organisations, for example the World Health Organisation or OSPAR, have been used.

The list of critical legislation used in this approach is described below.

European Assessment Criteria:

- 2000/60/EC: Water Framework Directive;
- 2006/118/EC: On the Protection of Groundwater Against Pollution and Deterioration; and
- 2013/39/EU: Priority Substances in the Field of Water Policy Directive.

UK Assessment Criteria:

- UKTAG Groundwater Hazardous Substances Standards 2016, annex 2018.

English and Welsh Criteria:

- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017;
- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015;
- The Groundwater (Water Framework Directive) (England) Direction 2016; and
- The Water Supply (Miscellaneous Amendments) Regulations (England and Wales) 2010.

Other Criteria:

- World Health Organisation (WHO) Drinking Water Regulations 4th edition 2011;
- World Health Organisation (WHO): Petroleum Products in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality 2008;
- USEPA National Primary Drinking Water Regulations; and
- OSPAR: Establishment of a List of Predicted No Effect Concentrations (PNECs) for Naturally Occurring Substances in Produced Water. OSPAR Agreement 2014-2015.

Minimum reporting values are also considered for hazardous substances for assessment of risks to groundwater resources in order to comply with the requirements of the guidance to 'prevent' input of hazardous substances to groundwater.

Assessment of Water Impact to Human Health

A methodology for the generation of the GAC for groundwater vapours (GACgwvap) was published by the Society of Brownfield Risk Assessment (SoBRA) in February 2017⁷, which is based on the CLEA model. Ramboll has adopted SoBRA's approach and modified the model input parameters to reflect site conditions and generate site SSAC for groundwater contaminant sources designed to be protective of site users for a residential and/or commercial/industrial scenario as appropriate.

⁶ The Environment Agency's approach to groundwater protection; February 2018; Version 1.2.

⁷ SoBRA (2017) Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater. Version 1.0

The SoBRA (GACgwvap) methodology uses the Environment Agency's CLEA software model. The CLEA software was originally provided for deriving assessment criteria for soils, not groundwater; however, groundwater assessment criteria can be extracted from the calculations within CLEA. CLEA assumes a steady state equilibrium between the sorbed, water and vapour phase concentrations in soil. Consequently, as part of the process of calculating soil phase concentrations, the software also calculates the vapour phase concentration and the pore water dissolved concentration (soil solution concentration) at the soil GAC. Therefore, for given soil assessment criteria derived to be protective of health, a soil solution concentration is also available within the CLEA calculations which would give rise to this vapour concentration at the tolerable risk level. This soil solution concentration is used as an inferred groundwater SSAC.

The proprietary risk assessment model, the ASTM RBCA⁸ Tool Kit Version 2.6 for Chemical Releases, has been used for compounds which could not be run in CLEA. The RBCA model has been altered where necessary to reflect the current UK approach to human health risk assessment, as appropriate.

Contaminant Distribution Assessment

Concentrations above the GAC are considered further in relation to vertical and lateral distribution across the site. Where relevant, statistical analysis has been used with consideration to guidance provided in CL:AIRE statistical assessment guidance⁹.

GROUND GAS RISK ASSESSMENT

The assessment of risks from ground gas is based on current best practice guidance provided in the following documents:

- BS8485:2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings; and
- NHBC, 2007. Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present (applicable for low rise residential housing with beam and block flooring and a clear ventilated void).

Derivation of Characteristic Situation

The risk posed by ground gases using the approaches outlined in the documents above are assessed by calculating a Gas Screening Value (GSV). Derivation of the GSV is calculated by multiplying the steady state borehole flow rate (l/hr) with the peak carbon dioxide and methane concentrations for each well. Where required, a 'worst case' condition is also calculated by multiplying the maximum recorded steady state borehole flow rate with the peak carbon dioxide and methane concentrations for different strata across the entire site or zone (as applicable).

The calculated GSV is used to derive a 'Characteristic Situation' which ranges between CS1 (very low hazard potential) to CS6 (very high hazard potential) as defined within BS8485; or to categorise the site as Red / Amber / Green (referred to as traffic lights) as defined within the NHBC guidance for low rise residential buildings.

Requirement for Gas Protection Measures

Depending on the type of proposed development, the British Standards Characteristic Situation or NHBC traffic light system is used to determine the gas protection measures needed for a building.

⁸ American Society for Testing Materials – Risk Based Corrective Action Model, Version 2.6

⁹ CL:AIRE (2020) Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration

Gas protection measures are generally not required for CS1 or NHBC Green sites unless the Conceptual Site Model indicates a need for further consideration. Although BS8485 and NHBC guidance relates to assessment for new buildings the same assessment methodology can be applied for appraisal of existing site buildings.

BS8485 requires a gas protection score to be identified for a proposed development. This is categorised based on the 'building type' from Type A to D, based on factors including construction and use of the building, together with the control of future structural changes to the building and its maintenance, since potential risks posed by ground gases are strongly influenced by these factors. Gas protection measures are selected to meet the required gas protection score in BS8485, although for some developments in higher Characteristic Situations the gas hazard is considered too high to use the method outlined in BS8485 to define the gas protection measures and further detailed quantitative gas risk assessment is required.

For low rise residential developments, the NHBC traffic light system also uses the GSV to derive the minimum level of protection required and expectations for verification for sites classified as either Amber 1 or Amber 2. NHBC considers that standard residential housing sites with a Red classification would not normally be acceptable without a detailed gas assessment and /or possible remediation to reduce or remove the ground gas source.