
Appendix F Approach to Risk Evaluation

CSM Risk Evaluation Rationale

F.1 Introduction

F.1.1 The mechanism(s) through which a site is regulated will depend on its setting, context and the nature of any contamination present. Notwithstanding this, development and refinement of a CSM underpins the process through which risks associated with contaminated sites are evaluated in the UK irrespective of the context (e.g., whether the site is being developed under planning, assessed under Part 2A of the Environmental Protection Act 1990). The CSM identifies the possible relationships between contaminants, pathways and receptors and is used to identify relevant contaminant linkages that may warrant further assessment and/or remedial actions.

F.1.2 Consistent with DEFRA guidance⁷:

- “A “contaminant” is a substance which is in, on or under the land and which has the potential to cause significant harm to a relevant receptor, or to cause significant pollution of controlled waters;
- A “receptor” is something that could be adversely affected by a contaminant, for example a person, an organism, an ecosystem, property, or controlled waters; and
- A “pathway” is a route by which a receptor is or might be affected by a contaminant.”

F.1.3 Horizon’s approach to risk evaluation follows Environment Agency guidance⁸, with a tiered approach adopted to the assessment of risks associated with contaminated sites:

- Preliminary Risk Assessment (see Section G2 for more details) – a qualitative assessment, typically forming part of a Phase 1 report, the output from which is the preliminary CSM;
- Generic Quantitative Risk Assessment (see Section G3 for more details) – a quantitative assessment whereby the preliminary CSM is refined, typically on the basis of site-specific data obtained as part of a Phase 2 site investigation. Generic assessment criteria (GAC) are utilised to screen measured concentrations of contaminants and identify contaminant linkages which might warrant further assessment (i.e., detailed quantitative risk assessment) and/or remedial actions; and
- Detailed Quantitative Risk Assessment – a site specific evaluation of individual contaminant linkages to further evaluate potential risks. The scope of a DQRA will be tailored to the requirements of a particular site and might include additional characterisation activities to reduce uncertainty in the CSM, more detailed modelling or development of site-specific assessment criteria.

F.2 Preliminary Risk Assessment

F.2.1 The starting point in any contaminant linkage assessment is the identification of plausible sources of contamination (i.e., hazard identification). The review of desk-based information supplemented with observations from the site walkover where conducted form the focus for information collection at this stage in the process.

F.2.2 A potential source area is described on the basis of the potential impact that the material within the source could have on either environmental (e.g., surface water) and/or human health receptors in its vicinity. Sources include a wide range of materials which could differ in their potential impacts depending on a number of factors which include:

⁷ DEFRA (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance

⁸ Environment Agency (2004) Model Procedures for the Management of Land Contamination. CLR11.

- Chronic or acute affects;
- Long-term or short-term release;
- Phase of contamination (e.g., dissolved, free phase, vapour, etc);
- Point or diffuse discharge; and
- Toxicity, mobility and degradation potential of the contaminant.

F.2.3 Pathways represent the route via which contamination may eventually reach a sensitive receptor. Pathways may include direct and indirect exposure to contamination.

F.2.4 Horizon considers the potential for receptors identified in DEFRA guidance⁷ (e.g., humans, controlled waters, property, ecological systems) to be associated with a site, both in its current setting plus receptors that may be introduced if the site is being considered for redevelopment. A screening process is used to identify those receptors (both on-site and off-site) which may be at potential risk from contamination at the Site and therefore warrant inclusion in the CSM.

F.2.5 Where a potential contaminant linkage has been identified, the next step is assessing the potential risks associated with each individual contaminant linkage (i.e. risk evaluation). The potential magnitude and/or severity of individual contaminant linkages being present at the site along with an assessment of probability are combined. The first stage, utilising the table below, estimates potential magnitude / severity of a contaminant linkage, taking into account the potential severity of the hazard and the sensitivity of the receptor. This table has been developed with reference to R&D66⁹.

Consequence	Example
Severe	Highly elevated concentrations of contaminants likely to represent "significant possibility of significant harm to human health" or greater if exposure occurs (i.e., Category 1 or 2 as defined by DEFRA ⁷). Equivalent to EA Category 1 pollution incident. Major damage to aquatic or other ecosystems. Catastrophic damage to crops, buildings or property.
Medium	Elevated concentrations of contaminants, although unlikely to pass the legal test for "significant possibility of significant harm to human health" if exposure occurs (i.e., Category 3 as defined by DEFRA ⁷). Equivalent to EA Category 2 pollution incident. Significant damage to aquatic or other ecosystems (i.e., may result in substantial adverse change in functionality or harm to a species of interest). Significant damage to crops, buildings or property (e.g., ingress of contaminants through water supply pipes).
Mild	Slightly elevated concentrations of contaminants, potentially above a GAC, although unlikely to exceed the Category 3/4 boundary as defined by DEFRA ⁷). Exposure could lead to slight short-term effects such as mild skin rash. Equivalent to EA Category 3 pollution incident. Significant damage to aquatic or other ecosystems (i.e., may result in substantial adverse change in functionality or harm to a species of interest). Minor damage to crops, buildings or property (e.g., surface spalling of concrete).
Minor	Maximum contaminant concentrations unlikely to result in a measurable effect on humans. Equivalent to an insubstantial pollution incident with no observed effect on water / ecosystem quality. Repairable effects of damage to buildings, structures and services (e.g., discolouration of concrete).

Table F2-1: Approach to Magnitude / Severity Evaluation

⁹ NHBC (2008) Guidance for the Safe Development of Housing on Land Affected by Contamination. R&D66.
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F.2.6 Horizon utilises the following table, developed with reference to R&D66, to assess the potential likelihood of an individual contaminant linkage being present at the site. Where a contaminant linkage has not been established, a risk is not considered to exist.

Likelihood	Example
High	A contaminant linkage exists 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	A contaminant 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	There is a contaminant 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 a contaminant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.

Table F2-2: Classification of Probability (In the Event a Contaminant Linkage Has Been Established)

F.2.7 The likelihood that an individual contaminant linkage will be present is then combined with the potential severity using the qualitative approach presented in the table below to assess the potential risk associated with each contaminant linkage.

Probability (Likelihood)	Consequence			
	Severe	Medium	Mild	Minor
Very High	High Risk	High Risk	Medium Risk	Medium Risk
High	High Risk	Medium Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk	Negligible
Low	Medium Risk	Low Risk	Negligible	Negligible

Table F2-3: Approach to Consequence Evaluation

F.2.8 A description of the risks as classified in the table above is presented in the table below. These risk definitions have been developed by Horizon with reference to R&D66 and are utilised as part of the CSM in order to identify contaminant linkages warranting further assessment and/or remedial actions.

Magnitude of Potential Impact	Description
High	Harm is likely to arise or already is arising to a designated receptor from an identified hazard at the site. 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 are likely required.
Medium	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	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.
Negligible	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.

Table F2-4: Receptor Sensitivity Classification

F.3 Generic Quantitative Risk Assessment

F.3.1 If required, the second tier of assessment utilised to refine the CSM typically involves comparison of site-specific information obtained as part of a ground investigation with GAC. Typically, GAC are conservative and based on largely generic assumptions regarding characteristics and behaviours of sources, pathways and receptors, within defined ranges of conditions.

F.3.2 A variety of different GAC are available to assess risks posed to individual receptors and it is noted the nature of the GAC can vary considerably. For example, some GAC (such as the SGV by the EA to support the evaluation of risks to human health from soil contamination) make an attempt to estimate the probability that harm will occur under the specific circumstances being considered. Other GAC (e.g. Environmental Quality Standards utilised to assess potential risks to controlled waters) do not take into account the probability that harm will actually occur. Horizon takes into account the form and level of conservatism inherent in an individual GAC as part of the risk evaluation process. The GAC typically utilised by Horizon are summarised in the table below:

Media	GAC Adopted
Chronic Risks to Human Health	
Soil Contaminants [Inorganic & Organic Chemicals]	LQM S4ULs ¹⁰ along with DEFRA C4SLs ¹¹ where applicable are directly compared with measured soil concentrations. Where a S4UL or C4SL has not been derived for a specific contaminant, reference is made to alternative publicly-available sources. If appropriate on the basis of dataset size and distribution, statistical analysis may be conducted, including assessing the 95 th percentile of the sample mean against the adopted GAC. If appropriate the assessment may make reference to published background levels for a number of contaminants given the risk may still be considered to be low and the site suitable for use if concentrations of contaminants, although elevated, are below local background levels.
Soil contaminants [Asbestos]	In the absence of a published GAC for asbestos in soil, the presence of asbestos fibres reported in a soil sample by a laboratory is the level upon which Horizon would undertake additional, more detailed site-specific risk assessment.
Radon	Reference is made to BRE 211 ¹² to evaluate potential risks from soil-derived radon.
Ground Gas	Gas Screening Values (GSVs), calculated on the basis of gas concentrations and flow rates, are evaluated with reference to guidance published by CIRIA ¹³ , BSI ¹⁴ and NHBC ¹⁵ .
Dissolved Contaminants	Reference is made to Water Screening Values (WSVs) published by Atkins where organic contaminants are detected above the laboratory reporting limit in groundwater to assess chronic risks to human health via the indoor air inhalation pathway.
Risks to Controlled Waters	
Eluted Soil Contaminants / Dissolved Contaminants	Published Environmental Quality Standards (EQS) and Drinking Water Values (DWV) are used as an initial screen of eluted water quality and concentrations of dissolved phase contaminants in groundwater. These criteria make no reference to potential degradation, attenuation and dilution of contaminant concentrations between the source and the receptor.
Risks to Property	
Water supply pipes	Reference is made to the guidance published by the UK Water Industry ¹⁶ .
Sulphate & pH conditions	Reference is made to the guidance published by BRE ¹⁷ .
Risks to Vegetation & Plants	
Soil contaminants	Reference is made to guidance published by BSI ¹⁸ .

Table F3-1: GAC Typically Adopted by Horizon

¹⁰ LQM/CIEH (2015) The LQM / CIEH S4ULs for Human Health Risk Assessment

¹¹ DEFRA (2014) SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document

¹² BRE (2015) Radon Guidance on Protective Measures for New Buildings.

¹³ CIRIA (2007) Assessing Risks Posed by Hazardous Ground Gases to Buildings. C665.

¹⁴ BSI (2015) Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings. BS8485.

¹⁵ NHBC (2007) Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present.

¹⁶ UKWIR (2010) Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites.

¹⁷ BRE (2005) Concrete in Aggressive Ground. SD1

¹⁸ BSI (2015) Specification for Topsoil. BS3882

Horizon Consulting Engineers Ltd.

Suite 2 The Dairy Barn,
Westpoint Court
Sidmouth Road
Exeter
EX5 1DJ

www.horizon-ce.co.uk