

# Development of Remediation Targets for Contaminated Land

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Remediation on Nuclear Sites – The Decision Making Process  
Birmingham, 7 October 2009



# Overview

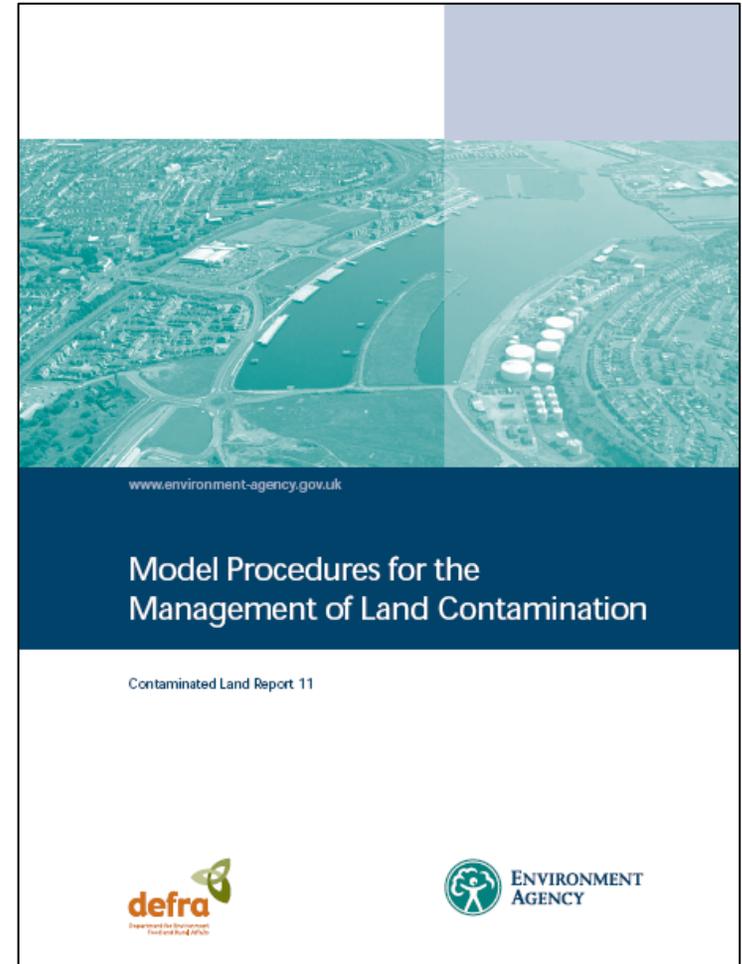
- Framework for managing the decision-making process
- Risk assessment guidance
- Risk assessment models
- Assessing significance of risks

# Contaminated Land Decision-Making Framework



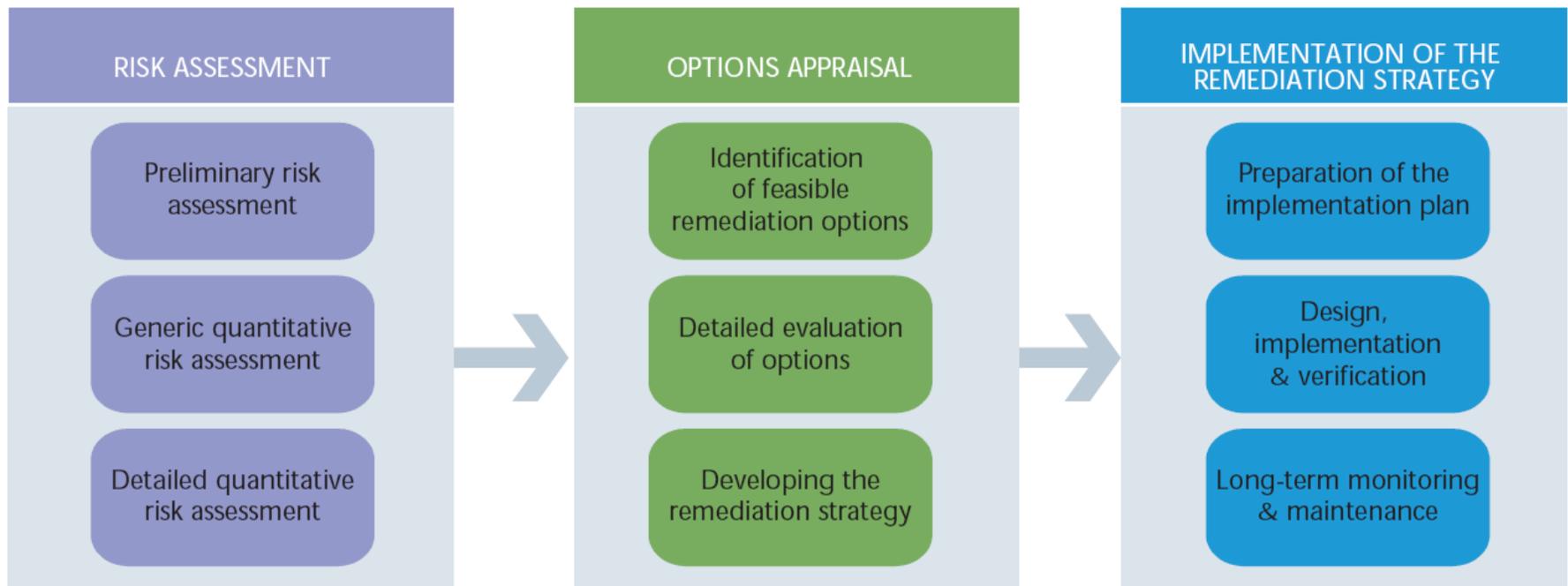
# CLR11 Model Procedures

- Structured framework for applying risk management process when dealing with land affected by contamination
- Consistent with UK government policies and legislation
- Recognised by all UK environmental regulators
- Applicable across range of non-regulatory and regulatory contexts, including
  - Planning Regime
  - Part 2A
  - Voluntary investigation and remediation



# Components

- Comprises 3 components applied iteratively:
  - Tiered risk assessment to evaluate source-pathway-receptor linkages
  - Options appraisal
  - Implementation

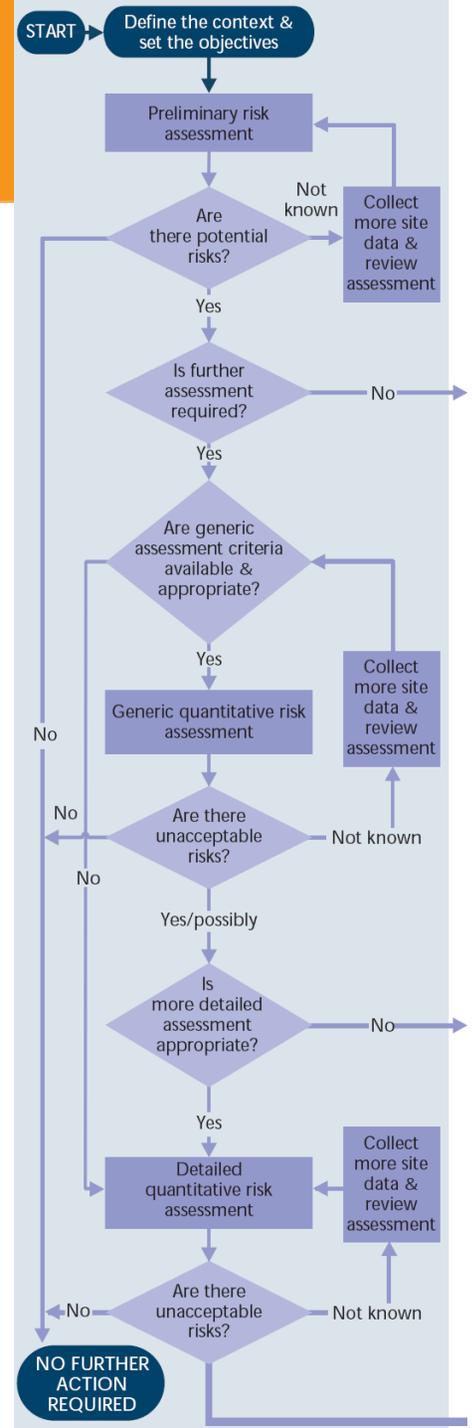


# Risk Assessment (1)

- Structured assessment using site-specific data, enabling cost effective decisions based on specified end-use of the land
- Framework allows for evaluation of uncertainties and factors such as costs and benefits
- Tiered approach:

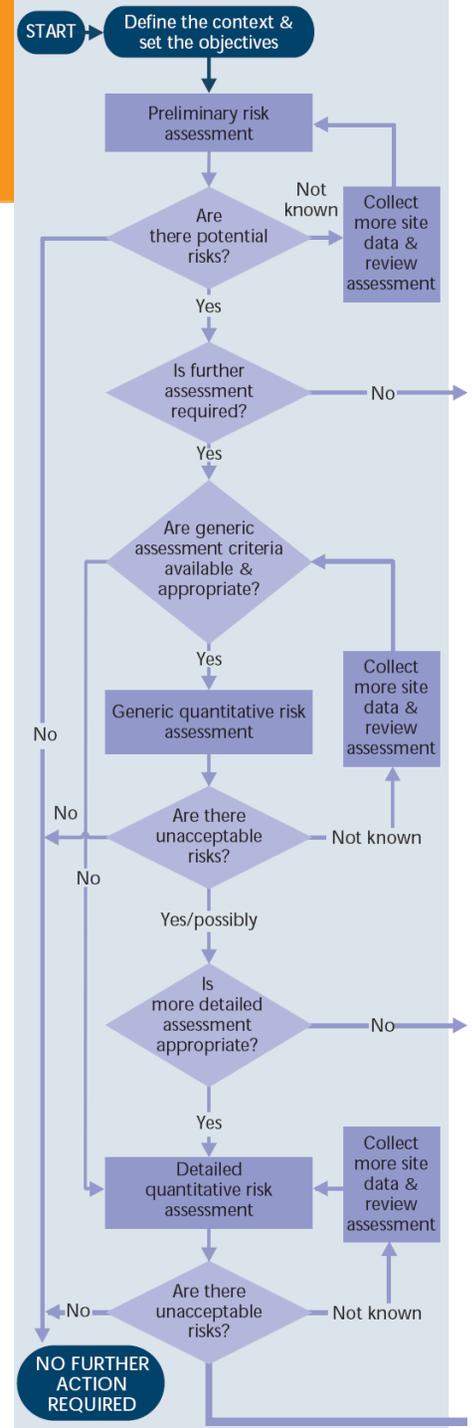
Increasing detail

|   |   |
|---|---|
| Tier 1 – Preliminary risk assessment          | Determination of context and objectives for risk assessment, development of outline conceptual site model and identification of potential risks                                   |
| Tier 2 – Generic quantitative risk assessment | Uses generic assessment criteria derived using conservative assumptions regarding characteristics and behaviour of sources, pathways and receptors                                |
| Tier 3 – Detailed qualitative risk assessment | Uses site-specific information on the characteristics and behaviour of contaminants, pathways and receptors that correspond to relevant criteria in relation to harm or pollution |

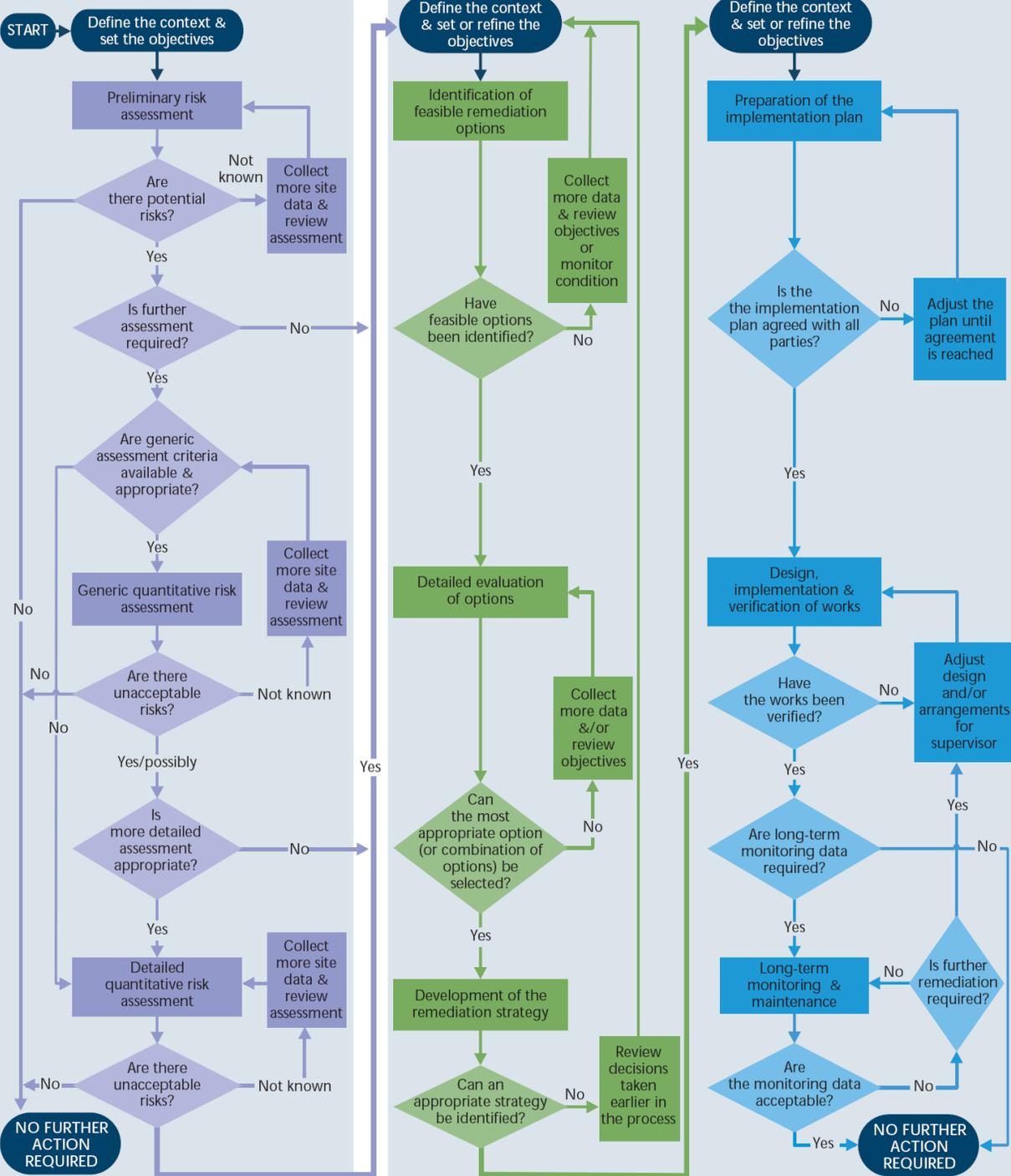


# Risk Assessment (2)

- Within each tier:
  - Assessment may be applied separately for some or all pollutant linkages
  - Assessment may be iterative or process revisited in the light of new findings
  - Process may be terminated, e.g. if no unacceptable risk identified, or to proceed straight to remediation
- Following each tier:
  - Conceptual site model updated
  - Options appraisal conducted if action is required to reduce or control risks, followed by implementation of appropriate actions (which could be to undertake more detailed assessment or undertake remediation)



# Options Appraisal and Implementation of Remediation Strategy



# Risk Assessment Guidance

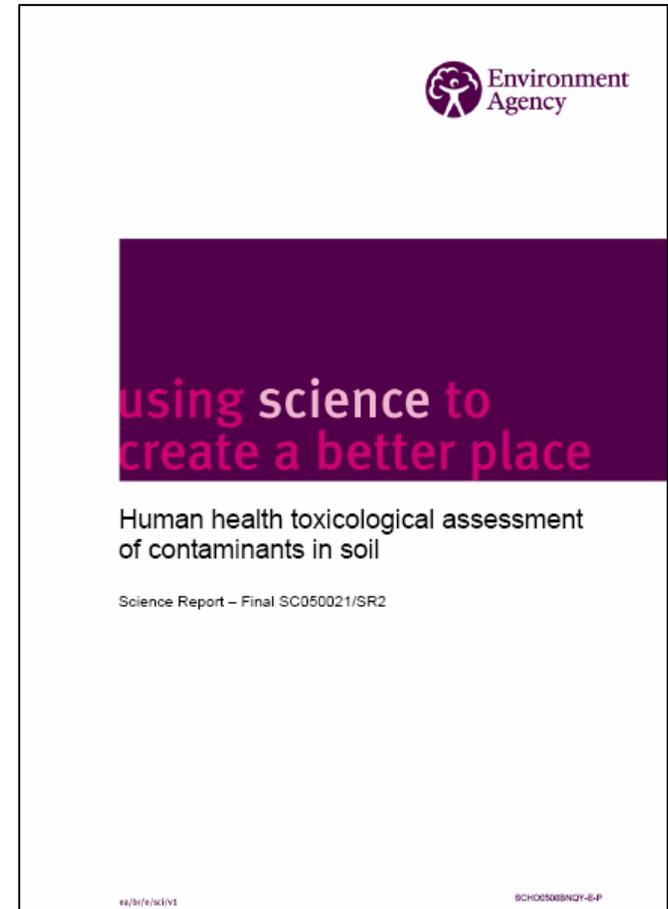


# Risk Assessment Guidance

- CLR11 references a number of documents giving guidance for conducting different types of risk assessment
- Many have been revised or superseded since CLR11 was published in 2004, and some new guidance documents have been published
- The following slides give a brief overview of some of the main guidance documents currently available

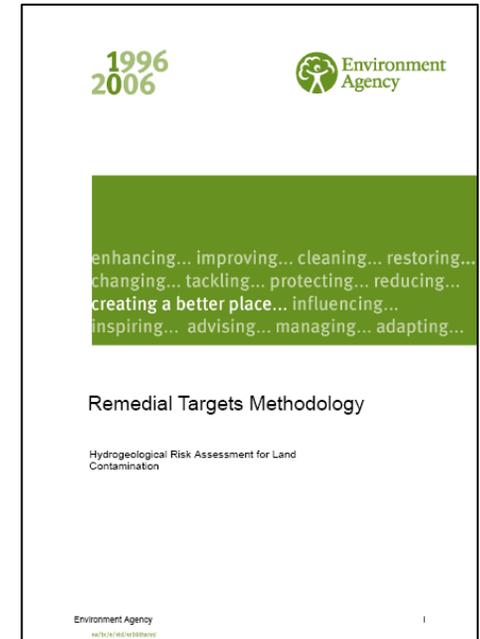
# Human Health Toxicological Assessment

- EA Science Report Final SC050021/SR2 published in 2009 – replaces CLR9
- Technical guidance for Part 2A and planning regimes
- Framework for collation and review of toxicological data and its use in derivation of soil contaminant intakes (Health Criteria Values, HCVs) that are protective of human health
  - Non-radiological contaminants only
  - Methodology for deriving Tolerable Daily Intake (TDI) levels for threshold contaminants
  - Methodology for deriving Index Dose (ID) for non-threshold contaminants (e.g. carcinogens)
- HCVs should be derived for each potential exposure route (e.g. oral, inhalation)
- Framework for derivation of Soil Guideline Values (SGVs) for threshold and non-threshold contaminants
  - Can be used to assess contaminants for which no UK HCVs have been published
  - Significant harm unlikely if exposure is less than HCV or SGV; *however*
  - Exceedence of HCV or SGV does not necessarily indicate SPOSH – more detailed assessment required



# Hydrogeological Risk Assessment

- Remedial Targets Methodology published by EA, SEPA & NIEHS in 2006 – replaced P20 & SEPA 2001 guidance
- Methodology for deriving site-specific remedial objectives for contaminated soils and/or groundwater to protect water environment
- Applicable for assessments under Part 2A, water pollution legislation, planning regime and voluntary remediation
- Procedure (applied iteratively):
  - Develop conceptual site model
  - Identify compliance point
  - Determine target concentration at compliance point, depending on current and potential use of water resources
  - Assessment to determine whether contaminant source likely to result in exceedance of target concentration at compliance point
- Tiered assessment:
  - Level 1 (soils only) – pore water/leachate concentration compared directly with target concentration
  - Level 2 – takes account of attenuation in soil and unsaturated zone and dilution by groundwater beneath site
  - Level 3 – takes account of attenuation between site and downgradient receptor or compliance point
  - Level 4 (where appropriate) – takes account of dilution in receiving watercourse
- Remedial target calculated by multiplying target concentration by Dilution Factor and Attenuation Factor. Measured soil or pore water concentration compared with remedial target to determine need for remediation
- Following each level, decision whether to remediate or undertake more detailed assessment, which reduces conservatism but increases sophistication of model and data requirements



# RCLEA Methodology

- Defra's recommended approach for assessment of radioactively contaminated land under Part 2A
- Largely complements CLEA
- Considers 47 radionuclides (including short-lived daughters) and/or combinations
- Considers generic exposure scenarios:
  - Residential ( $\pm$  consumption of home-grown produce)
  - Allotments
  - Commercial/industrial
- Can be used as screening tool using generic exposure parameters
  - Calculation of doses from given concentrations of radionuclides in soil
  - Derivation of RSGVs (radionuclide concentrations corresponding to regulatory dose criteria)
- Key limitations:
  - Contamination assumed to be uniformly distributed in soil to depth of 1m. Cannot consider buried contamination or discrete artefacts
  - Excludes volatile contaminants and skin absorption pathways
  - Excludes exposure from radon
  - Excludes groundwater migration pathway
  - Cannot assess mixed radioactive and non-radioactive contamination



Using RCLEA - the Radioactively Contaminated Land Exposure Assessment Methodology



The Radioactively Contaminated Land Exposure Assessment Methodology - Technical Report

CLR-13  
Draft

CLR-14  
Draft 1.1

December 2006



# Human Radiation Dose Assessment

- HPA methodology for estimating doses to members of the public, published 2003
- Describes general methodology for assessing doses and risks from radioactively contaminated land
  - 36 most common radionuclides (including short-lived daughters) considered
  - Scenarios considered include exposed, buried, uniform and patchy contamination distributions
  - Pathways considered are external irradiation, internal exposure from radionuclides associated with soil (via inhalation and ingestion) and from ingestion of contaminated foods, water and fish
- Methodology applicable to assess risks from current use (intervention situation) and redevelopment (practice situation)
- Used methodology to calculate annual effective dose per unit activity concentration in soil for generic exposure scenarios (Agriculture, Recreation, Construction, School, Industrial, Housing and Hard Cover)
  - Results tabulated for dominant age group and exposure pathway
  - Tables may be used for generic assessment by scaling-up tabulated values to actual inventory present
- General methodology may also be applied to undertake site-specific assessments
- Results can be used to derive remedial targets for concentration of radionuclides which will give a predetermined dose criterion



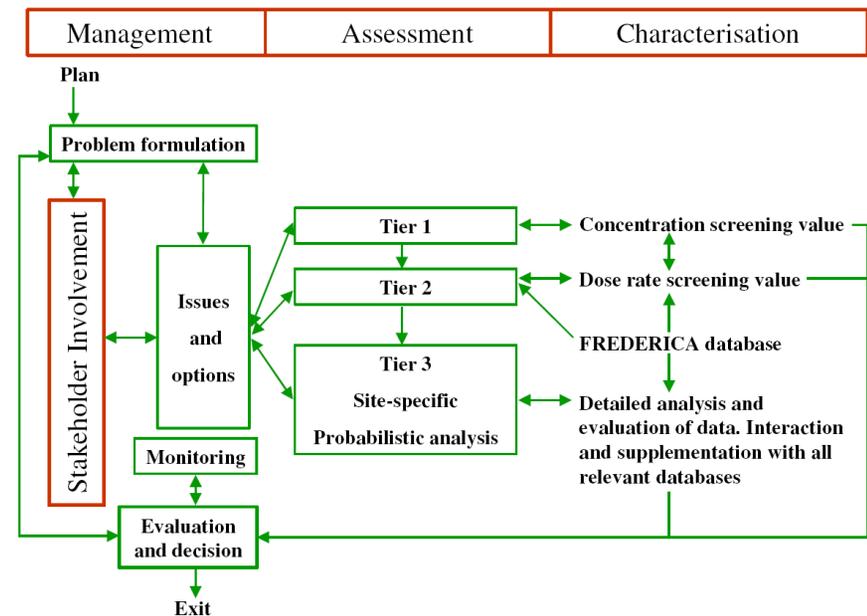
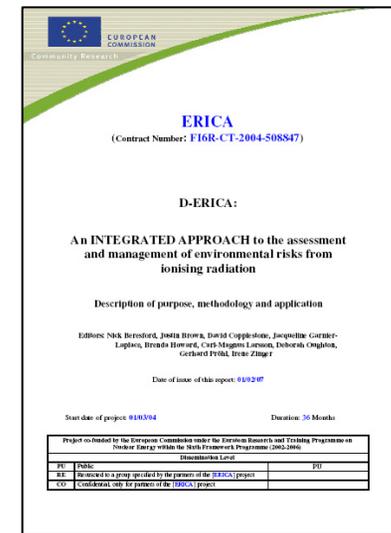
# Ecological Risk Assessment

- EA Science Report SC070009/SR1, published 2008
- Structured framework for assessment of risks to ecology from chemical contamination in soil
  - Does not consider radionuclides nor water contamination
- Primary purpose is for assessment under Part 2A, but also applicable under other regimes e.g. conservation, planning & pollution control
- Tiered approach based on identification and assessment of source-pathway-receptor linkages:
  - Tier 1 – screening assessment based on comparison of site soil contaminant concentrations with Soil Screening Values (SSVs)
  - Tier 2 – uses choice of tools (ecological survey & biological testing) to provide evidence for harm to receptors
  - Tier 3 – seeks to attribute harm to the chemical contamination
- Separate document (Science Report SC070009/SR2b) provides guidance on derivation and use of SSVs – concentrations of chemical contaminants in soils below which there are not expected to be any adverse effects on wildlife or microbial function of soil
  - UK SSVs published for 12 substances, based on EC technical guidance
  - US EPA, Canadian, Oak Ridge Laboratory and RIVM guidance suggested as sources of alternative screening criteria for other contaminants



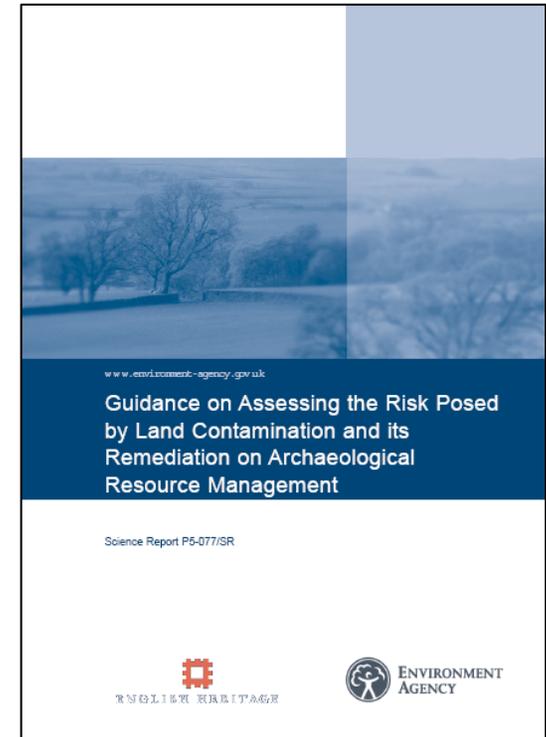
# Assessment of Environmental Risks from Radioactivity

- Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) methodology (2007)
- Integrated framework for decision-making - recognised as “good practice” for radioactive substance habitat assessments by EA
  - Problem formulation – consideration of ecological, political & societal issues
  - Tier 1 assessment – simple screening assessment requiring minimal data
    - Default screening criterion is incremental dose rate of  $10 \mu\text{Gy h}^{-1}$  for all ecosystems and organisms
    - Screening dose rate back-calculated to yield Environmental Media Concentration Limits (EMCLs) for all reference organism/radionuclide combinations
    - Exit assessment after Tier 1 if most restrictive EMCL for each radionuclide not exceeded
  - Tier 2 – site and organism specific assessment. Evaluation performed directly against screening dose rate
  - Tier 3 – probabilistic risk assessment using detailed site information and most recent biological effects data



# Archaeological Risk Assessment

- EA and English Heritage guidance on assessing risk posed by land contamination and its remediation on archaeological resources
- Addresses requirements for assessment under Part 2A and planning regimes
- Follows risk-based approach underpinned by source-pathway-receptor framework, represented by conceptual site model which is refined as the assessment proceeds
  - In addition to being a receptor, archaeological resource may itself be a contamination source or a pathway
  - Impact of remedial works on archaeological resources also considered
- Part 2A:
  - Only applies to ancient monuments with Statutory designation
  - “Significant harm” defined as substantial damage to features by reason of which monument was scheduled
  - SPOSH defined as “likelihood of significant harm resulting from the pollutant linkage for the foreseeable future”
- Planning regime:
  - Applies to land contamination and archaeological resources in their widest sense
  - Guidance gives considerable discretion to Planning Authority in assessing potential impacts and specifying precautions



# Assessment of Risks to the Built Environment

- EA published generic guidance in 2001 on assessment and management of risks to buildings, building materials and services from:
  - Aggressive substances
  - Combustible materials
  - Expansive slags
  - Unstable fills
- Does not cover risks from explosive gases or vapours, for which other guidance exists
- Intended for use where new construction planned; materials must be selected for remedial works; or buildings, materials and services already exist
- Phased risk assessment based on source-pathway-receptor analysis to build and refine conceptual site model:
  - Phase 1a Initial hazard identification based on desk study, site reconnaissance and/or limited sampling
  - Phase 1b More detailed hazard identification, usually through additional desk study and site investigation
  - Phase 2 *Risk estimation*, usually following detailed site investigation, using appropriate assessment criteria (mostly qualitative). Published criteria are listed (NB some now superseded)  
*Risk evaluation* to determine whether remedial measures required
- Guidance is given on risk management strategies

**Assessment and Management of Risks  
to Buildings, Building Materials and  
Services from Land Contamination**

R&D Technical Report P5-035/TR/01

# Risk Assessment Models



# Risk Assessment Models

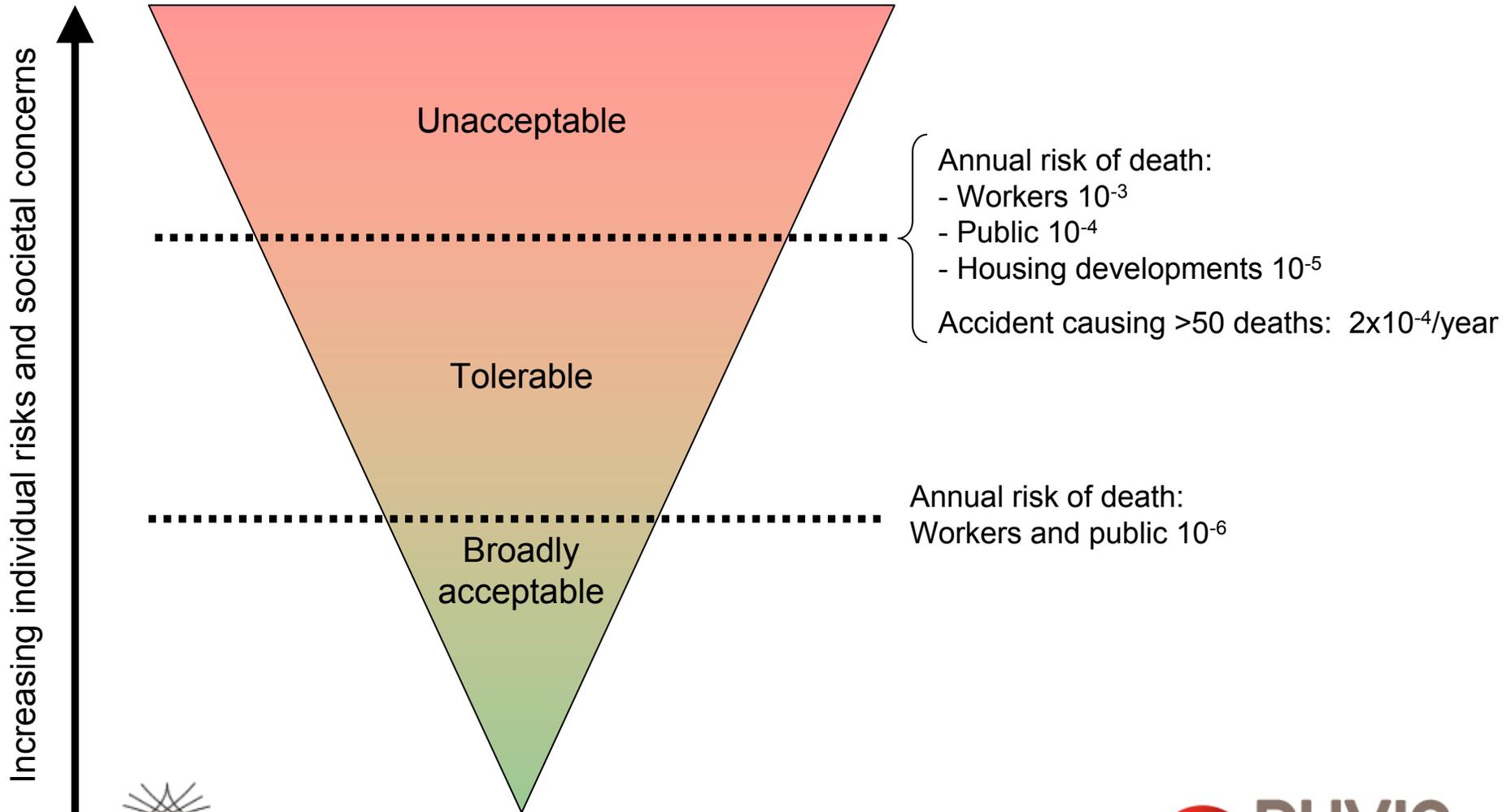
- CLEA model v1.04 (Excel)
  - Deterministic model for generic or site-specific assessment of human health risks from non-radioactive contaminants
  - Can be used to derive SGVs for use in *screening* assessments
- RCLEA model v2 (Excel) (CLR15)
  - Deterministic model for generic or site-specific assessment of human health risks from radioactive contaminants (complements CLEA)
  - Can be used to derive RSGVs for use in *screening* assessments in England & Wales (use with caution in Scotland since model does not account for risks to non-human species or water environment)
- Hydrogeological risk assessment using EA Remedial Targets Methodology
  - EA Remedial Targets Worksheet v3.1 (Excel)
    - Deterministic. Calculates soil remedial targets at Level 1, 2 or 3, and Level 3 groundwater remedial targets
  - ConSim
    - Probabilistic. Level 1, 2 and 3 assessments for soils, Level 2 and 3 assessments for groundwater, and combined soil and groundwater analyses
- ERICA assessment tool v1.0 May 2009
  - Deterministic (Tier 1 and 2) and probabilistic (Tier 3) model for assessment of environmental risks from ionising contaminants
- Numerous other models are available !

# Assessing Significance of Risks



# Assessing Significance of Risks

## HSE Tolerability of Risk Framework



# Questions?

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