Environment Agency

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Guidance on desk studies and conceptual site models in ecological risk assessment

Science Report – SC070009/SR2a

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- **Delivering information, advice, tools and techniques**, by making appropriate products available to our policy and operations staff.

Steve Killeen

Head of Science

Executive summary

This document provides a 10 step methodology for performing a desk based study and constructing a Conceptual Site Model for land that may require to be risk assessed under Part 2A of the Environmental Protection Act (1990) as being potentially contaminated. It accompanies the first stage of the Ecological Risk Assessment (ERA) Framework for soil contamination.

The user is led through the process of deciding whether a risk assessment is required, from establishing whether a site has the appropriate regulatory context (i.e. has a relevant form of conservation designation), through to identifying contaminants of potential concern, receptors (species of special interest or ecosystem functions) of potential concern and the pathways between them. The objective of constructing a Conceptual Site Model is to record all the potential pollutant linkages between the source of contamination and the receptors, i.e the reasonably possible ways in which the receptors may experience exposure and consequent adverse effects.

Although created for a Part 2A (Contaminated Land) context, this document may also be of use to those contemplating risk assessments under other regulatory drivers, such as the Conservation Regulations (Habitats Directive) and during planning applications for land change of use.

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1.1 The purpose of this document

This document provides guidance on undertaking a desk study and producing a Conceptual Site Model (CSM) as part of a tiered framework for an Ecological Risk Assessment (ERA) for soils.

General guidance on producing desk studies and CSM as part of an investigation of land contamination is available elsewhere (e.g. DoE 1994, BSI 2001 and Environment Agency 2004a).

This guidance document is intended to supplement the existing guidance and deals exclusively with risk assessment for eco-receptors as defined by Part 2A of the Environmental Protection Act 1990 (Contaminated Land). It is envisaged that risk assessors will read and use this document in conjunction with other best practice guidance when investigating any potentially contaminated site.

This document has been produced for the risk assessor acting under Part 2A of the Environmental Protection Act 1990, but should also be useful to all parties responsible for, or interested in, the management of ecological risks from land contamination, e.g. the planning regime.

1.2 How this document fits into the ERA framework

This document is one of six guidance documents that support the ERA framework.

The purpose of this guidance is to support the first step in an ERA – known as 'desk study and CSM'.

The position of this document (shown in red) within the overall ERA framework is summarised in the flow chart shown in Figure 1.1.

This report and the guidance documents in the series refer to each other in the following manner (full details can also be found in the reference list):

- This report is referred to as ERA 2a (Guidance on desk studies and CSM).
- The overarching Ecological risk assessment framework for contaminants in soil is referred to as ERA 1 (Framework document).
- The Guidance on the use of Soil Screening Values in Ecological Risk Assessment is referred to as ERA 2b (Guidance on the use of SSV).
- The Guidance on the use of Bioassays in Ecological Risk Assessment is referred to as ERA 2c (Guidance on the use of bioassays).
- The Guidance on the use of Ecological Surveys in Ecological Risk Assessment is referred to as ERA 2d (Guidance on the use of ecological surveys).
- The Guidance on the Attribution of Cause and Effect in Ecological Risk Assessment is referred to as ERA 2e (Guidance on the attribution of cause and effect).

- The Standard Operating Procedures for Bioassays is referred to as ERA 3 (SOPs for bioassays).

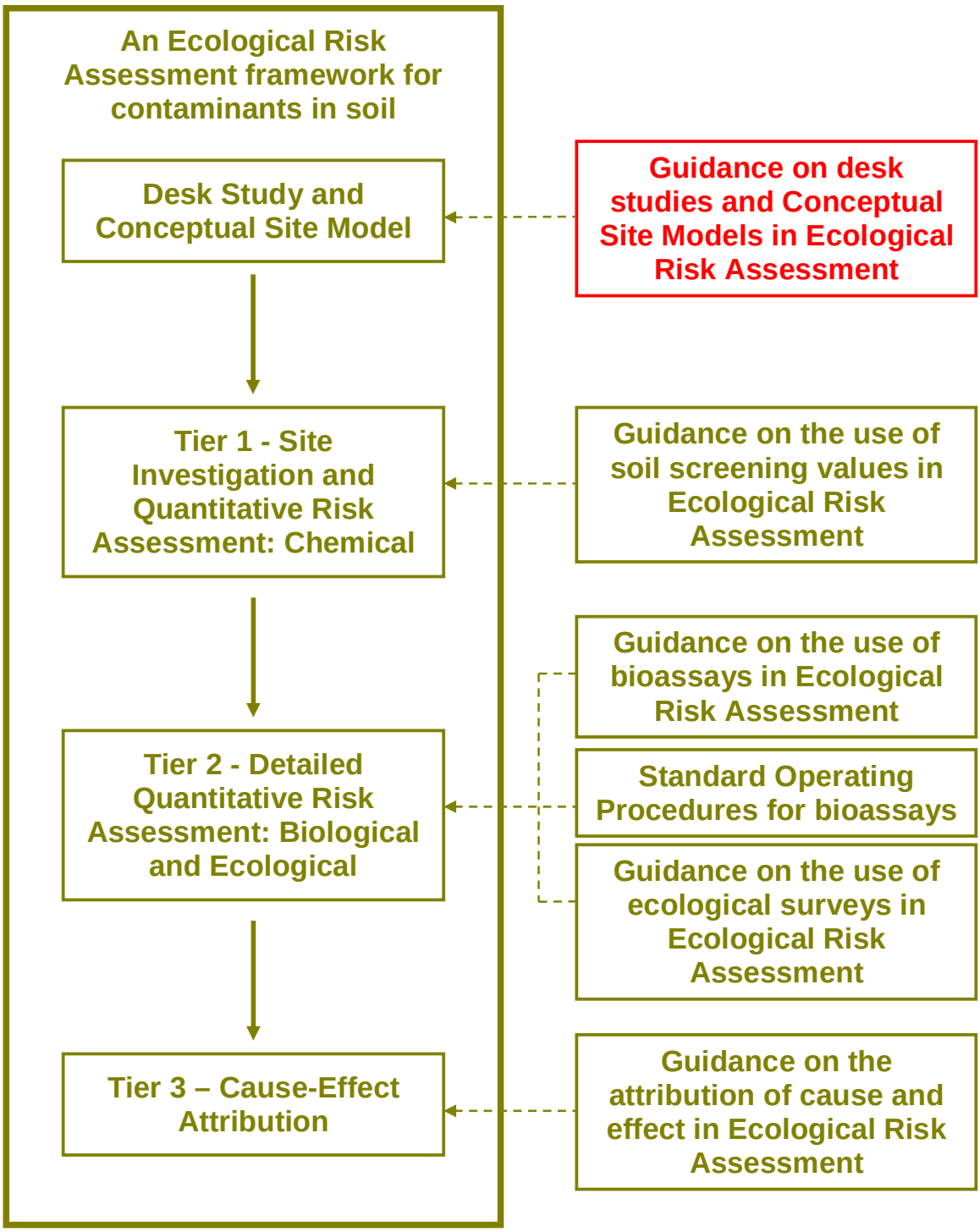


Figure 1.1 Position of this guidance document within the overall ERA framework

1.3 Potential regulatory drivers for ERA

The primary driver is Part 2A of the Environmental Protection Act 1990. Other potential regulatory drivers include the Habitats Directive and the planning regime.

1.3.1 Part 2A of the Environmental Protection Act

Section 57 of Part 2A of the Environmental Protection Act 1990 (EPA 1990) introduced a new statutory regime for the identification and control of contaminated land in England and Wales (DEFRA 2006, WAG 2006 and Scottish Executive 2006). The Act states that:

> *'Contaminated land' is 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…*

where 'harm' is defined as:

> *harm to the health of living organisms or other interference with the ecological systems of which they form a part, and in the case of man includes harm to his property.*

'Ecological harm' within Part 2A is confined to specified receptors as set out in Table A of the Statutory Guidance (DEFRA 2006, WAG 2006 and SE 2006). In summary, these are:

- any ecological system, or living organism forming part of such a system, within a location which is:
  - a site of special scientific interest (SSSI) notified under section 28 of the Wildlife and Countryside Act 1981;
  - a national nature reserve (declared under section 35 of the above act);
  - a marine nature reserve (designated under section 36 of the above act);
  - an area of special protection for birds (under section 3 of the above act);
  - any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS 9) on nature conservation;
  - any nature reserve established under section 21 of the National Parks and Access to the Countryside Act 1949;
  - any European site within the meaning of regulation 10 of the Conservation (Natural habitats etc) Regulations 1994;
  - any candidate Special Areas of Conservation or potential Special Areas of Conservation given equivalent protection.

1.3.2 Habitats Directive

Regulation 3 of the Conservation Regulations 1994 (commonly known as the Habitats Regulations) implements the requirements of the European Habitats Directive 92/43/EEC in Great Britain. It also secures the protection of areas classified under the Wild Birds Directive 79/409/EEC.

The Environment Agency is the competent authority (in England and Wales) for these regulations. As such, it applies the regulations when considering all applications for authorisations, permissions, permits, consents and environmental licences and for all relevant Environment Agency policy and operational activities.

A risk assessment process is initiated in situations where an application under the UK system of land use planning or a review of permits, licences, etc. is likely to impact on sites protected under the regulations. There are four stages to the risk assessment:

- identifying relevance;
- likely significant effect;
- identifying adverse impacts;
- implementing any changes.

The ERA framework will be a useful aid in this process.

1.3.3 Planning

Planning Policy Statement (PPS) 23: *Planning and Pollution Control* states that:

> *Land contamination, or the possibility of it, is a material planning consideration in the preparation of development plan documents and in taking decisions on individual planning applications* (ODPM 2004).

The remediation of contaminated land through the planning process should secure the removal of unacceptable risk and make the site suitable for its new use. Following redevelopment, the land should not be capable, as a minimum, of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990.

Development plans and decisions on individual planning applications should take into account the potential sensitivity of the area to adverse effects from pollution, including nature conservation interests such as:

- SSSIs;
- National Parks;
- Areas of Outstanding Natural Beauty (AONBs);
- Special Areas of Conservation (SACs);
- Special Protection Areas (SPAs);
- wetlands of international importance (RAMSAR sites).

Where appropriate, soil screening values and the wider ERA framework can be used to assess the possible risks to nature conservation interests when potentially polluting activities are proposed. Where necessary, they can also be applied to the assessment and remediation of historic contamination.

1.4 Report structure

Section 2 provides short overviews of desk studies and Conceptual Site Models. Section 3 contains technical guidance on how to undertake desk studies and how to develop Conceptual Site Models as part of an ERA. A glossary of terms is included along with a list of abbreviations.

Appendix 1 gives further information about protected areas while Appendix 2 contains contact details for Natural England, Countryside Council for Wales and Scottish Natural Heritage.

2 Introduction to desk studies and Conceptual Site Models

2.1 Purpose of the Desk Study and CSM

Undertaking a desk study and producing a CSM should be the starting point for any assessment of risks to ecological receptors from land contamination.

The extent of the desk study and CSM, and the level of detail required, will be specific to the circumstances at the site in question.

The purpose is to establish whether there is a reasonable possibility of pollutant linkages existing between a potential source of contamination and ecological receptors. In some instances, a simple desk study and CSM will be sufficient to achieve this.

In other cases, especially where it has already been established that there is a reasonable possibility of such linkages, the desk study and CSM may contain a great deal more information – possibly incorporating existing chemical or ecological data, which will be of use as the ERA progresses.

2.2 Desk study overview

A desk study is:

> *'Interpretation of historical, archival and current information to establish where previous activities were located, and where areas or zones that contain distinct and different types of contamination may be expected to occur, and to understand the environmental setting of the site in terms of pathways and receptors'* (Environment Agency 2004a).

It is vital that the desk study is undertaken at the early stages of the ERA because it provides:

- the underlying information from which an initial CSM is developed;
- the risk assessor with an initial indication of the likelihood of pollutant linkages being present.

A typical desk study includes the following general components:

- details of the regulatory context;
- documentary research including:
  - historical data collection and evaluation;
  - existing information on potential sources, pathways and receptors;
- consultation with relevant stakeholders including:
  - regulators;
  - statutory and non-statutory conservation organisations;

- land owners;

- identification of assessment and measurement endpoints;
- site reconnaissance (where necessary);
- gap analysis.

2.3 Conceptual Site Model overview

A Conceptual Site Model is:

> *'a representation of the characteristics of the site in diagrammatic or written form that shows the possible relationships between contaminants, pathways and receptors'* (Environment Agency 2004a)

A CSM is developed based on the information on potential sources, pathways and receptors gathered by the desk study. It is refined during any subsequent stages of risk assessment as more information on potential pollutant linkages becomes available. The CSM helps to:

- determine the way in which subsequent stages of risk assessment are completed;
- ensure each relevant potential pollutant linkage is followed up.

A CSM used as part of an ecological risk assessment needs to:

- incorporate the ecological information gathered during the documentary review (i.e. during the desk study);
- represent this information in a way that best illustrates the possible relationship(s) between the potential source(s), pathway(s) and ecological receptor(s).

To achieve this, the CSM may take a number of forms such as a table, matrix, diagram or picture – usually accompanied by a narrative description.

Within an ERA, the CSM may also need to incorporate some form of food web diagram to illustrate the relationships between different potential ecological receptors.

3 Technical guidance for desk studies and the development of Conceptual Site Models

3.1 Introduction

The process of undertaking a desk study and producing a CSM can be divided into 10 main steps as illustrated in Figure 3.1. These steps are described in detail in Sections 3.2 to 3.11.

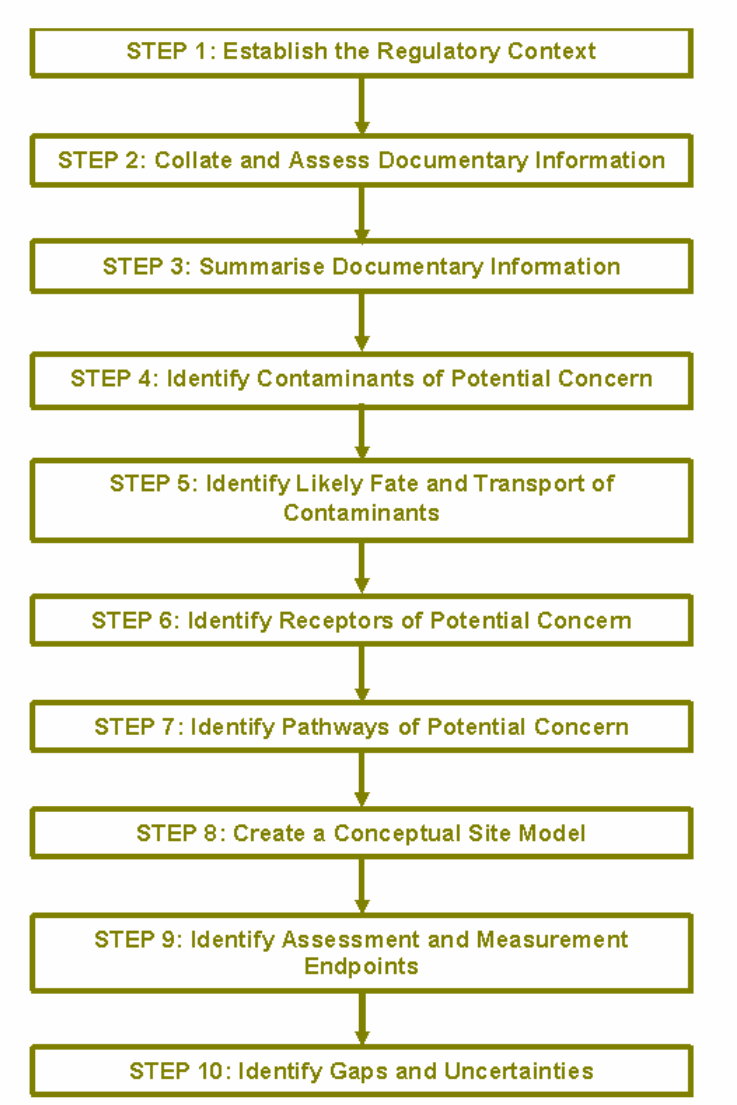


Figure 3.1 Flow chart showing the main steps in undertaking a desk study and developing a CSM as part of an ERA

3.2 Step 1: establish the regulatory context

At the earliest opportunity, risk assessors should consider the regulatory context within which any ERA is to be undertaken and therefore the overall objective of the risk assessment. This may involve consultation with regulators, conservation agencies and other stakeholders, for example to clarify:

- the requirements of any risk assessment;
- the timescale over which it should be performed;
- the management circumstances at a particular site.

When a risk assessment is to be undertaken under Part 2A of the EPA 1990, the risk assessor should be aware of the requirements of the Statutory Guidance and the list of applicable ecological receptors listed in its Table A (DEFRA 2006, WAG 2006 and SE 2006).

Eight types of protected location are described and any ecological system, or living organism forming part of such a system, within those locations can be a 'receptor' under Part 2A. The protected locations are listed below:

- *an area notified as an area of special scientific interest under section 28 of the Wildlife and Countryside Act 1981;*
- *any land declared a national nature reserve under section 35 of that Act;*
- *any area designated as a marine nature reserve under section 36 of that Act;*
- *an area of special protection for birds, established under section 3 of that Act;*
- *any European Site within the meaning of regulation 10 of the Conservation (Natural Habitats etc) Regulations 1994 (i.e. Special Areas of Conservation and Special Protection Areas);*
- *any candidate Special Areas of Conservation or potential Special Protection Areas given equivalent protection;*
- *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.*

Appendix 1 gives further information on the types of protected location including the legislation under which they are designated and a brief description.

Risk assessors should be aware that the ERA Framework is intended to assess risks to ecological receptors from contaminants in soil. In circumstances where contaminants in water represent a potential risk to aquatic ecosystems then risk assessors will need to consider this separately. This might involve the use of Environmental Quality Standards as screening values at Tier 1, and different forms of ecological surveys or biological tests at Tier 2.

In addition to any risks to aquatic ecosystems, the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter may constitute

'pollution of controlled waters' under Part 2A of the EPA 1990. Therefore unacceptable risks to aquatic ecosystems might also be addressed via this route.

3.3 Step 2: collate and assess documentary information

This step constitutes the documentary review referred to in subsequent steps.

3.3.1 Identify protected locations

The first stage in the review of documentary information is to establish where any 'protected locations' (as listed in Table A of the Statutory Guidance) are located in relation to the potential sources of contamination.

Deciding the search radius

When considering the radius of the area to be covered by a desk study and CSM, risk assessors should take into account the potential contaminant–pathway–receptor linkages (pollutant linkages) rather than a search radius based on legal and human-inserted boundaries.

In most cases, 1-2km will be sufficient to cover relevant potential pathways, but this may be extended up to 5km where contaminants are likely to travel along pathways of little resistance.

Risk assessors should keep their decisions about the search radius under review and, where necessary, revise them in light of any further information that becomes available.

Important points for consideration include:

- the location, characteristics and behaviour of contaminants of potential concern, for example:
  - To what extent are the contaminants soluble?
  - Do they give off vapours?
- the potential for pathways to be present between contaminants and receptors including those that may transport contamination from the source, for example:
  - Is the geology likely to allow migration of gaseous contaminants?
  - Is the direction of groundwater movement likely to take dissolved contaminants towards ecological receptors?
- the position of protected locations and the characteristics of potential ecological receptors. Risk assessors may need to consider where the potential receptors are in relation to the potential contaminants and how they might be exposed to the contamination. For example, are there any receptors that use the locality of the source for hunting / foraging?

The area ultimately covered by the desk study will be site-specific but must be technically defensible. Where there is any uncertainty regarding the potential for

pollutant linkages to ecological systems, the advice of the relevant nature conservation organisation should be sought.

Further guidance on potential receptors and their inclusion in the Conceptual Site Model is provided in Guidance on the use of ecological surveys in Ecological Risk Assessment (ERA 2d).

In some instances, the area of potentially contaminated land may be coincident with a protected location such as an old industrial facility within a large SSSI. In such cases, it may be evident to the risk assessor at an early point in the desk study and CSM process that there is a reasonable possibility of pollutant linkages to ecological receptors. The area to be covered by the risk assessment can therefore be established with some degree of confidence.

In other cases, the nearest protected location may be further away and the risk assessor may need to gather the other components of the documentary review (e.g. information on geology, hydrogeology, hydrology, possible contaminants, etc.) before being able to establish whether there is a reasonable possibility of pollutant linkages to ecological receptors.

As an example, the potential source of contamination may be a former industrial site with an SSSI situated 100 metres away. It may not be clear initially whether pollutant linkages to ecological receptors are reasonably possible. But as the review of documentary information proceeds, the risk assessor may establish that:

- the likely contaminants include substances that are highly mobile;
- the direction of groundwater movement is from the former industrial site towards the SSSI.

Consequently, the reasonable possibility of pollutant linkages to ecological receptors is established and the risk assessment can proceed accordingly.

Information on protected locations

To identify the protected locations, the following sources of information should be considered:

- For sites in England, a quick check should be performed on the Multi-Agency Geographic Information for the Countryside (MAGIC) website (http://www.magic.gov.uk) or the website of Natural England (http://www.naturalengland.org.uk).
- For sites in Wales, the website of the Countryside Council for Wales (CCW) (http://www.ccw.gov.uk) should be consulted in the first instance.
- For sites in Scotland, the website of Scottish Natural Heritage (SNH) (http://www.snh.org.uk/) should be consulted in the first instance.
- More detailed information may need to be obtained directly from the relevant nature conservation agency[1] or, in the case of locally designated sites, the relevant local authority or site managers etc.
- Further information on protected locations under Part 2A is provided in Appendix 1.

[1] Contact details for Natural England, CCW and SNH are given in Appendix 2.

- Further information on the identification of ecological receptors is provided in Guidance on the use of ecological surveys in Ecological Risk Assessment (ERA 2d).
- Other useful reference sources include:
  - UK Biodiversity Action Plan website (http://www.ukbap.org.uk);
  - Natural England publications[2] on habitats;
  - websites of CCW and SNH (see above);
  - Joint Nature Conservancy Council (JNCC) website (http://www.jncc.gov.uk/).

3.3.2 Assembling documentary information

Having identified the presence of one or more protected locations, the risk assessor should gather other relevant documentary information.

General information for desk studies

General information on how to assemble documentary information as part of a desk study is available from a variety of sources (e.g. DoE 1994, BSI 2001 and Environment Agency 2004a).

In a broad sense, the following sources of information should be considered:

- maps and aerial images;
- available environmental data, reports, records and studies such as:
  - information on geology, hydrogeology, hydrology and topography;
  - existing site investigation, assessment and remediation records (if available);
  - existing operational records, findings of environmental audits, etc.;
  - building control reports;
  - effluent discharge consents;
  - emergency response records (e.g. explosion, fire, spillages, etc.);
  - planning register details;
  - local authority environmental health department records (e.g. regarding statutory nuisance);
  - Environmental Permits or licences etc;
  - generic information on potential contaminants that may be associated with the use of the site. Such information includes Contaminated Land Report No. 8 (CLR8) (DEFRA and Environment Agency 2002) and the

[2] http://naturalengland.communisis.com/NaturalEnglandShop/browse.aspx?CID=5019f99a-b005-4b90-a04a-ea98ea8dd22d

Department of Environment (DoE) Industry Profiles published during the 1990s.[3]

Information on ecological receptors at protected locations

To gain a better understanding of the ecological receptors (i.e. ecological systems or living organisms forming part of such a system) at the identified protected location(s), the risk assessor should consider the following sources of information:

- The websites of the various conservation agencies provide a useful starting point and, in many cases, contain information on the reasons for the designation of protected sites, their conservation objectives and current condition (e.g. favourable/unfavourable):
  - Natural England: http://www.naturalengland.org.uk and http://www.natureonthemap.org.uk
  - Countryside Council for Wales: http://www.ccw.gov.uk
  - Scottish Natural Heritage: http://www.snh.org.uk
- The MAGIC website (http://www.magic.gov.uk) contains links to further information on protected sites in England
- The JNCC website (http://www.jncc.gov.uk) contains information on protected sites in England, Scotland and Wales and provides other useful links.
- Existing ecological survey data or records may be held by land owners, local interest groups, local wildlife trusts or local biological/environmental records centres. The website of the Biological Records Centre (BRC) may be a useful starting point (http://www.brc.ac.uk); from here there is a link to a contact list of Local Records Centres (http://www.nbn-nfbr.org.uk/nfbr.php).
- Where more detailed information on a particular ecological receptor is required, the risk assessor should contact the conservation agency[4] or other body with responsibility for, or which holds information on, the site. Any correspondence should highlight the purpose of the assessment (e.g. Part 2A).
- Interviews with site wardens, land owners or local interest groups may sometimes provide useful information for the risk assessor.
- A general site walk-over may also provide useful information, especially where the source and receptor locations are co-incident. Some general points to consider are included in Box 3.1.
- In some circumstances, it may be appropriate to undertake some level of ecological survey at the desk study and CSM stage of the ERA – possibly in combination with a site walk-over. Guidance on undertaking ecological surveys is provided in Guidance on the use of ecological surveys in Ecological Risk Assessment (ERA 2d).

[3] See http://www.environment-agency.gov.uk/subjects/landquality/113813/1166435/
[4] Contact details for Natural England, CCW and SNE are given in Appendix 2.

Box 3.1 Possible site walk-over information

1. Vegetation type, distribution and signs of distress (relative to season)
2. Observations of birds and wildlife (relative to season) including important ecological receptors/systems relative to Part 2A (identify through discussions with conservation organisations)
3. Proximity of potential receptors and potential sources
4. Evidence of disturbed ground, discoloured soil or water, subsidence, above ground deposits etc.
5. Significant odours
6. Liquid discharges from the site
7. Direction and flow of surface water run-off and presence of ponding
8. Presence, condition and nature of controlled waters
9. Land/water uses in the vicinity of the site
10. Photographs of ecological features

A site visit should ideally be conducted at a time of year when ecological features are most apparent (i.e. spring, summer, early autumn).

3.4 Step 3: summarise documentary information

Following the collation and review of documentary information, it can be helpful to bring the various strands of information together in a summary. This will assist the risk assessor and any other interested parties in understanding the particular characteristics of the area under investigation. The summary can be narrative, tabular or both and should include:

- details of the history and setting of the area under investigation;
- information on the chemistry and ecology of the area under investigation;
- an overview map

3.4.1 General history and setting

The history of the development of the area under investigation should be summarised to include details of:

- current and previous ownership;
- size and location;
- current use, historical use and, where appropriate, future use;
- historical layout including sub-division or amalgamation of land parcels;
- approximate locations of buildings (historical and current) and historical/present day operations in relation to soil, sediment, water and biota;
- historical and current activities and operations that may have resulted in contamination;
- historical activities on adjacent or nearby properties that may have resulted in additional contamination sources;

- the area's topographical, geological, hydrogeological and hydrological characteristics.

3.4.2 Chemistry

Where site-specific chemistry data are available (e.g. from previous site investigations), it should be compiled for each exposure medium (e.g. soil, sediment, water and air) and evaluated. This will help to:

- identify the type and magnitude of contamination;
- identify the Contaminants of Potential Concern (CoPCs) (see Section 3.5).

The following elements should be included in the summary of site chemistry data:

- a description of any previous site investigations (where they were undertaken, how they were undertaken, their objectives and conclusions);
- a narrative or tabular summary of the datasets available for different environmental media including:
  - a description of minimum and maximum concentrations;
  - summary statistics (e.g. number of samples, mean, median, 90th percentile etc) and percentage of analyses below the limit of detection;
  - sample size;
- a general description of chemical distributions over the study area;
- a review of the data to determine whether existing site chemistry data are appropriate for incorporation into further tiers of risk assessment. This should include an evaluation of:
  - sample collection and storage methods;
  - selection of analytical methods;
  - performance of analytical measures such as laboratory duplicates, matrix spikes and use of certified reference materials
  - use of appropriate analytical detection limits.

In many cases there will not be a great deal, if any, site-specific chemistry data available at the desk study stage of an ERA. In such circumstances the general background soil chemistry of the area could be considered through reference to generic literature values and the potential contaminants associated with the site activities could be summarised based on those identified within the documentary review, e.g. through consideration of guidance documents such as the DoE Industry Profiles and CLR8 (DEFRA and Environment Agency 2002).

3.4.3 Ecology

The amount of information on ecology available at the desk study stage is likely to vary greatly. In some circumstances, the risk assessor will simply have identified the presence of a protected location and obtained some limited information on the types of important habitat and species that it contains. In other cases, there may be detailed

survey information collected over a period of years available from either a land owner or a nature conservation organisation that can be incorporated into the desk study and CSM.

The summary of the ecology should include a brief narrative of the important ecological features of the protected location such as:

- type of terrestrial habitat (grassland, forest, moor, etc.);
- type of any aquatic habitat (marine subtidal, marine intertidal, shallow estuarine environment, wetlands, marshes, rocky shorelines, and flowing water such as rivers and streams);
- key communities, populations and species and the reason why they are important (e.g. internationally rare, breeding population, etc.);
- condition (favourable/unfavourable, etc.) of the location and the basis on which it was designated;

Other useful information to include might be:

- interaction of the site with surrounding land uses or other protect locations;
- meteorological data (temperature, precipitation, etc.).

Where a greater level of ecological information is available (e.g. from historic surveys or a recent site-specific survey), the guidance on presenting the results of an ecosurvey provided in Guidance on the use of ecological surveys in Ecological Risk Assessment (ERA 2d) should be considered.

3.4.4 Overview map

As part of the summary, the risk assessor should consider creating a site overview map. The aim of such a map is to illustrate all the important information obtained as part of the documentary review and which has been summarised under the headings of general site history and setting, site chemistry and site ecology.

Nature conservation organisations may have digital maps of protected locations available for download from their websites (e.g. Natural England[5]). These may assist with the production of the overview map.

3.5 Step 4: identify Contaminants of Potential Concern

Following the collation, assessment and summary of documentary information it should be possible to identify the Contaminants of Potential Concern (CoPCs). The confidence with which this can be undertaken at this point will vary depending on the level of information available.

Where detailed information is available on the potentially polluting activities undertaken, along with the results of previous site investigations and soil analysis, it may be possible to predict the CoPCs with more confidence than when information is lacking and it is necessary to rely on generic guidance such as the DoE Industry Profiles and CLR8 (DEFRA and Environment Agency 2002)

[5] http://www.naturalengland.org.uk/publications/default.htm

Initially it may be necessary to draw up a wider list of CoPCs corresponding to the substances that might reasonably be expect to be present at the site as identified in the documentary review. The risk assessor will need to provide strong justification for the exclusion of any contaminants at this early stage of the Ecological Risk Assessment.

3.5.1 Potential to bioaccumulate and biomagnify

Regardless of whether the site chemistry data are based on site-specific measurements or generic guidance, it is essential that the risk assessor attempts at this point to identify those contaminants with the potential to bioaccumulate and biomagnify.

According to Part II of the European Commission's Technical Guidance Document (TGD) (EC 2003), there is an indication of bioaccumulation potential if a substance:

- has a log Kow ≥3; or;
- is highly adsorptive; or;
- belongs to a class of substances known to have a potential to accumulate in living organisms; or;
- there are indications from structural features;
- and there is no mitigating property such as hydrolysis (half-life <12 hours).

To determine the potential for the CoPCs to bioaccumulate and biomagnify, the risk assessor may need to undertake a review of relevant literature.

3.6 Step 5: identify likely fate and transport of contaminants

Contaminants are subject to a range of physical, geochemical and microbiological processes within the environment that influence their transport, distribution and fate. The processes that are active will depend upon the properties of the contaminant and the subsurface but may include:

- sorption;
- leaching
- degradation;
- biodegradation;
- dissolution;
- advection;
- transformation;
- dispersion;
- transport by diffusion;
- volatilisation.

Identification of the likely fate and transport of each contaminant will help the risk assessor:

- understand potential source–pathway–receptor linkages;
- construct the CSM;
- plan any intrusive site investigations.

Where site-specific information on the properties of the CoPCs and the subsurface environment is lacking, identification of the likely contaminant fate and transport process should be based on how the particular types of contaminants are generally known to behave. This might be established through consulting the relevant literature.

3.7 Step 6: identify Receptors of Potential Concern

During Steps 1 and 2 the risk assessor identified any protected location(s) and gained some level of appreciation of their key ecological attributes. The aim of Step 6 is to identify, through consultation with the appropriate nature conservation organisation, which of the ecological systems, or living organisms forming part of those systems, within the protected location should constitute Receptors of Potential Concern (RoPCs).

Part 2A requires an assessment of whether there is 'significant harm' or the 'significant possibility of significant harm' (SPOSH) to ecological receptors.

Significant harm is defined in Table A of the Statutory Guidance as:

> *For <u>any</u> protected location:*
>
> - *harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or*
> - *harm which affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location.*
>
> *In addition, in the case of a protected location which is a European Site (or a candidate Special Area of Conservation or a potential Special Protection Area), harm which is incompatible with the favourable conservation status of natural habitats at that location or species typically found there.*

The condition for there being a Significant Possibility of Significant Harm is defined in Table B of the Statutory Guidance as:

> *If either:*
>
> - *significant harm of that description is more likely than not to result from the pollutant 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.*

Therefore, in order to assess whether there are any significant pollutant linkages, the ecological receptors identified should be related, as far as possible, to these definitions. In other words, they should be related to:

- the functioning of the ecological system(s) within the protected location(s);
- species of special interest within the protected location(s);
- those factors that affect the favourable conservation status of natural habitats at the protected location or species typically found there. This last criterion applies only to protected locations that are European Sites, a candidate SAC (cSAC) or a potential SPA (pSPA).

To do this, the risk assessor needs to work closely with the relevant nature conservation organisation(s). They are likely to have the greatest knowledge of the protected location and may have published 'conservation objectives' or standards for favourable condition that set out the habitats, ecological systems and species of special interest at the protected location.

If any Receptors of Potential Concern (RoPCs) are to be excluded at this early stage of the ERA, this must be agreed with the appropriate nature conservation organisation.

Following consultation with the relevant nature conservation organisations and the identification of RoPCs, it may be helpful to produce a simplified food web diagram. This will help the risk assessor to understand:

- the ecological systems;
- the trophic positions of the species of special interest;
- the likely interaction of these species with other organisms (e.g. predator–prey relationships).

This food wed diagram can be incorporated into the CSM in Step 8.

Other factors to take into account when considering RoPCs include:

- known species sensitivities to the CoPCs (e.g. birds are known to be sensitive to certain pesticides due to effects on egg shell thinning);
- the way in which the RoPCs may use the protected location such as:
  - where it forms part of a larger range or territory;
  - occasional or seasonal use because of an attraction such as a food source;
- organisms that use the area for only a portion of their life-cycle.

Sources of useful information when considering receptors include:

- the conservation section of the Natural England website, which provides details on designated areas (http://www.naturalengland.org.uk/conservation/designated-areas/default.htm);
- the SNH SiteLink website, which provides access to data and information about sites of national and international importance across Scotland (http://www.snh.org.uk/SNHi/);
- the 'Special Landscapes and Sites' section of the CCW website (http://www.ccw.gov.uk), which provides information on protected locations

across Wales (click on ‘Landscape & Wildlife, then ‘Protecting our landscape’).

3.8 Step 7: identify Pathways of Potential Concern

‘Pathways’ are defined by the Statutory Guidance for Part 2A (DEFRA 2006, WAG 2006 and SE 2006) as:

> *One or more routes or means by, or through, which a receptor:*
>
> *(a) is being exposed to, or affected by, a contaminant, or*
>
> *(b) could be so exposed or affected.*

The pathways that may exist between contaminants and ecological receptors will depend upon many factors and may be direct, indirect or both.

At this stage of the ERA process, the risk assessor may not have any site-specific information on the nature of the contamination or detailed information on the behaviour of RoPCs. In the first instance, it may be necessary to consider a wide range of generic potential exposure pathways based on the scientific understanding of the identified CoPCs and RoPCs. These can be refined as further site-specific information becomes available to focus on those pathways of most significance.

Examples of potential direct exposure pathways include:

- soil invertebrates, amphibians and terrestrial plants that are in direct contact with elevated concentrations of CoPCs in soil;
- mammals, birds, amphibians and reptiles that ingest elevated concentrations of CoPCs via:
  - incidental soil/sediment ingestion (e.g. via consumption of plant roots covered in soil);
  - water ingestion;
  - consumption of prey items (particularly for those chemicals known to bioaccumulate);
- aquatic species (macrophytes, plankton, invertebrates, amphibians and fish) that are in direct contact with elevated concentrations of CoPCs in surface water or sediment;
- ingestion by some aquatic species (e.g. planktivores and piscivores[6]) of elevated concentrations of CoPCs via consumption of prey items;

In addition, dermal exposure (direct contact with soil and sediment) of wildlife should be considered for species that burrow or groom extensively. Dermal exposure can also be a relevant exposure pathway for amphibians and reptiles. It is usually assessed through food chain models, by making assumptions about incidental ingestion from the literature.

Inhalation exposure through wind-blown dust or inhalation of vapours is not usually assessed for wildlife, but this may change if appropriate data become available. Note that wind-blown dust can contribute to the incidental ingestion of soil pathway.

[6] Species that feed primarily on plankton and fish respectively.

Examples of potential indirect exposure pathways include:

- loss of prey species;
- alterations within the ecosystem as a result of contamination, leading to increased competition or a prevalence of undesirable or pest species.

The risk assessor should establish all the Pathways of Potential Concern (PoPC) and their relative importance in consultation with the appropriate conservation organisation. If any potential pathways are to be excluded at this early stage in the ERA process, a strong justification must be provided and the conservation organisation must agree to the exclusion.

3.9 Step 8: create a Conceptual Site Model

The information about potential contaminants, pathways and receptors should be summarised within a CSM. This will help the risk assessor to visualise and describe all the potential pollutant linkages.

The development of a robust CSM should also help to ensure that:

- the focus of any subsequent site investigations is appropriate;
- all potential pollutant linkages are considered during subsequent stages of risk assessment.

General guidance and other useful references for developing a CSM are also available from other sources (e.g. BSI 2001 and Environment Agency 2004a).

The requirements of a CSM as part of an ERA and the format of its presentation are outlined below.

3.9.1 Requirements of a Conceptual Site Model as part of an ERA

Although many aspects of a CSM in an ERA will be the same as a CSM developed for any other purpose, an ERA CSM poses a number of challenges for the risk assessor.

Under other land contamination scenarios, the receptors may be relatively straightforward (e.g. controlled waters in the form of a river, or human beings on a housing estate). In an ERA, the behaviour of the receptors and their interaction with the area of potential contamination may be far more difficult to understand. This makes the CSM and associated food web diagram a crucial element of the risk assessment process.

The main requirements of a CSM constructed as part of an ERA are summarised in Table 3.1.

Table 3.1 Requirements of a CSM forming part of an ERA

Aspect	Requirements
Contaminants	• Describe all the features identified during the documentary review that may be associated with contamination (e.g. underground fuel storage tanks, process areas etc). • Include the CoPCs along with their likely environmental compartment (e.g. contaminated groundwater, soil, sediment, surface water, air). • Where appropriate, include other significant sources of contamination in the locality (even if unrelated) that may be affecting ecological receptors.
Routes of contaminant fate and transport	• Illustrate, as far as possible, the processes affecting the fate and transport of the CoPCs (e.g. dispersion of CoPCs into groundwater, sorption to soil, microbial degradation, etc.)
Receptors of Potential Concern (RoPCs)	• Represent all relevant RoPCs. • Include, if possible, a simplified food web narrative or diagram. This is helpful because: (1) it documents the process of selecting the RoPCs; (2) it illustrates the interrelationships between organisms and therefore the potential indirect effects that may complicate the risk assessment. For example, a food web diagram may indicate that CoPCs in soil may affect soil invertebrates as well as a small mammal insectivore (i.e. insect eater). The potential indirect effect is that food sources for the mammal may be depleted by direct toxicity of CoPCs to the soil invertebrates. • Illustrate, where necessary, factors such as the different life-cycle stages of the receptor, or the spatial or temporal aspects of receptor behaviour (e.g. seasonal use of the area).
Pathways	• Depict all relevant PoPC (direct and indirect). • Use the food web diagram (see above) to help identify PoPC.
Potential pollutant linkages	• Provide, where possible, an assessment of the reasonable possibility of each potential source–pathway–receptor linkage (pollutant linkage). • Justify why any potential pollutant linkages are to be discounted at this early stage of the ERA and obtain agreement for this from the appropriate nature conservation organisation.

3.9.2 Presentation of the CSM

All CSMs should be linked to a narrative that provides a detailed rationale for each decision made (e.g. source identification and selection of CoPCs, RoPCs and PoPC).

The two main types of CSM are described below together with examples. Both have certain advantages and disadvantages:

- **Pictorial.** A schematic CSM that incorporates visual representations of the pathways and receptors. Pictorial CSMs usually include text or arrows to summarise pollutant linkages. This style is well suited to communicating contaminant sources, pathways, major fate and transport processes, and feeding guilds/trophic levels to a non-technical audience. A disadvantage is that some fate processes and indirect effects cannot be represented easily in a pictorial manner. Examples are provided in Figures 3.2 to 3.4.
- **Box diagram.** This type of CSM is essentially a 'flow chart' style. An advantage of this approach is that it makes it easier to carry out a more rigorous examination of the pathways and connections among and between contaminant sources, pathways and receptors. This type of model incorporates a tabular summary of potential pollutant linkages, indicating where pathways are reasonably possible. Examples are provided in Figures 3.5 and 3.6.

For particularly complex sites, the use of both types of presentation should be considered as each has unique advantages.

Figure 3.2 Pictorial CSM – example 1

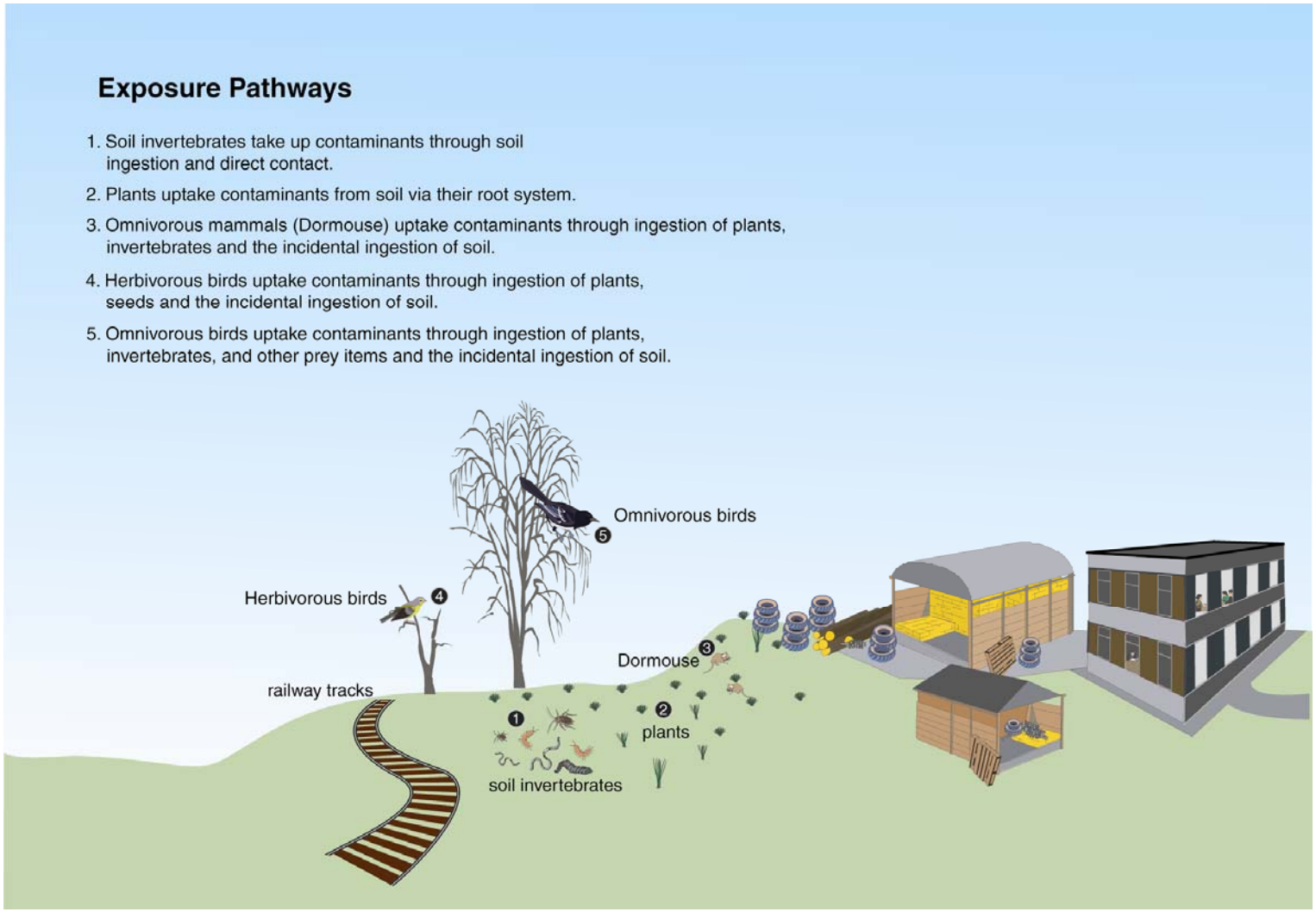


Figure 3.3 Pictorial CSM – example 2

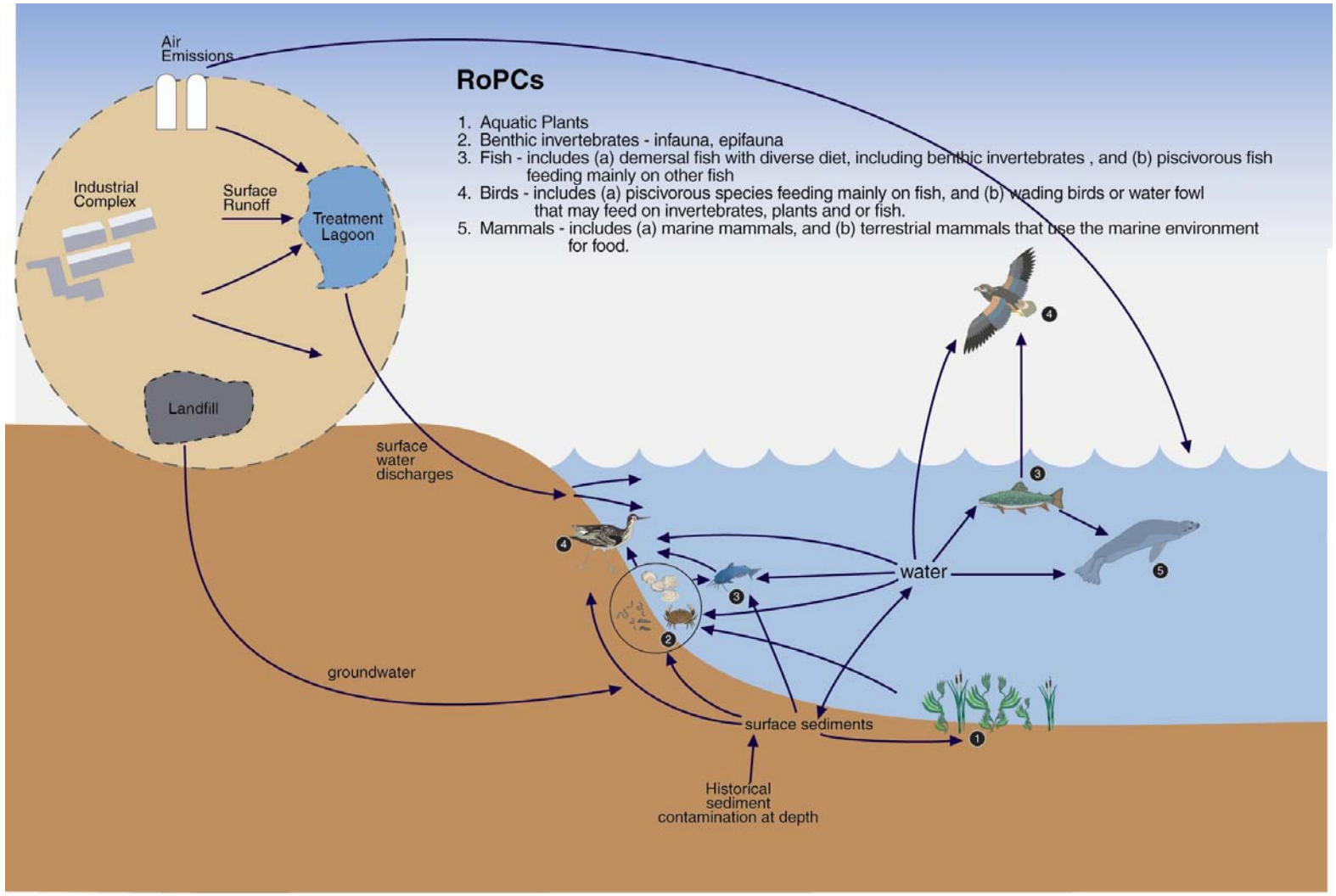


Figure 3.4 Pictorial CSM – example 3

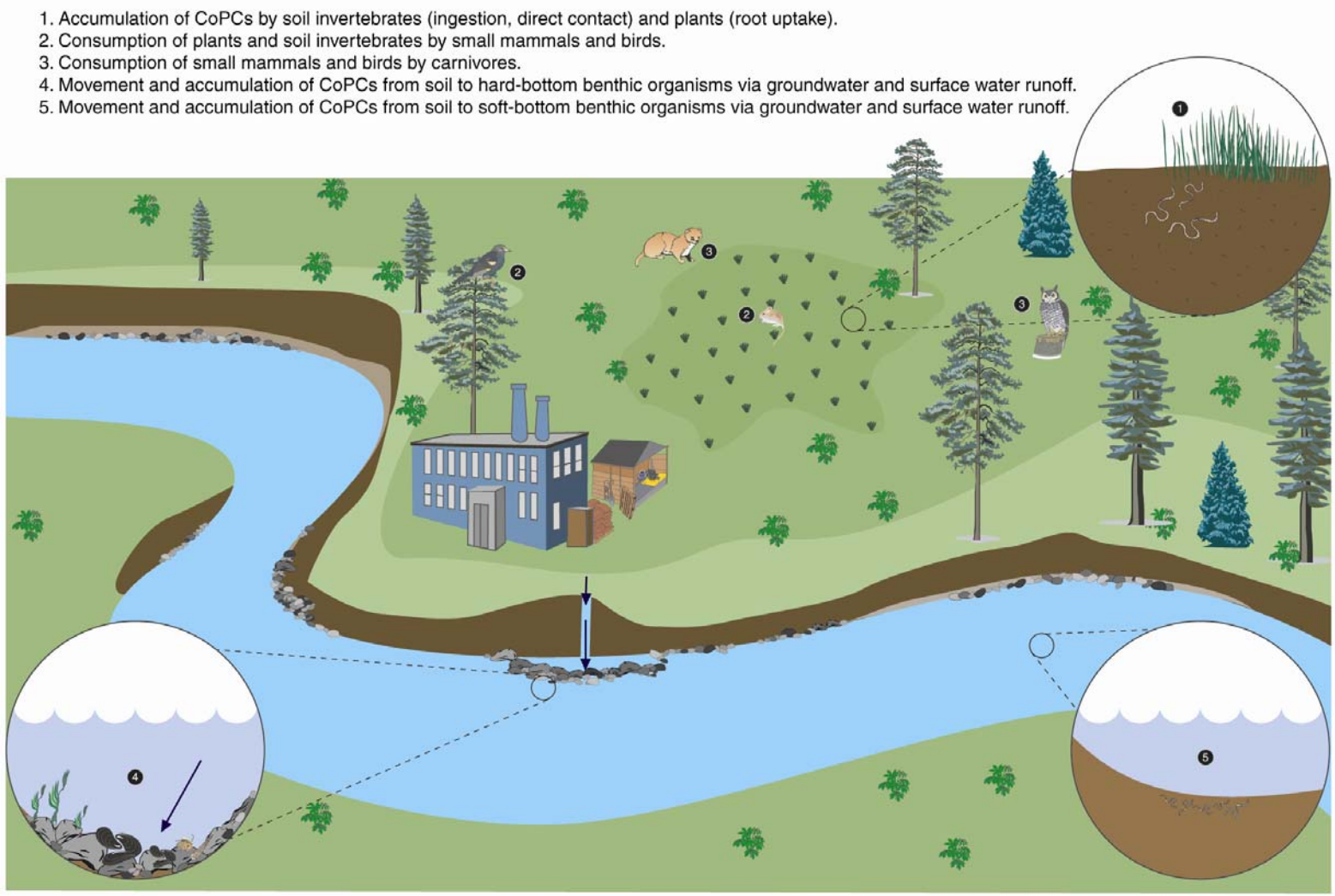
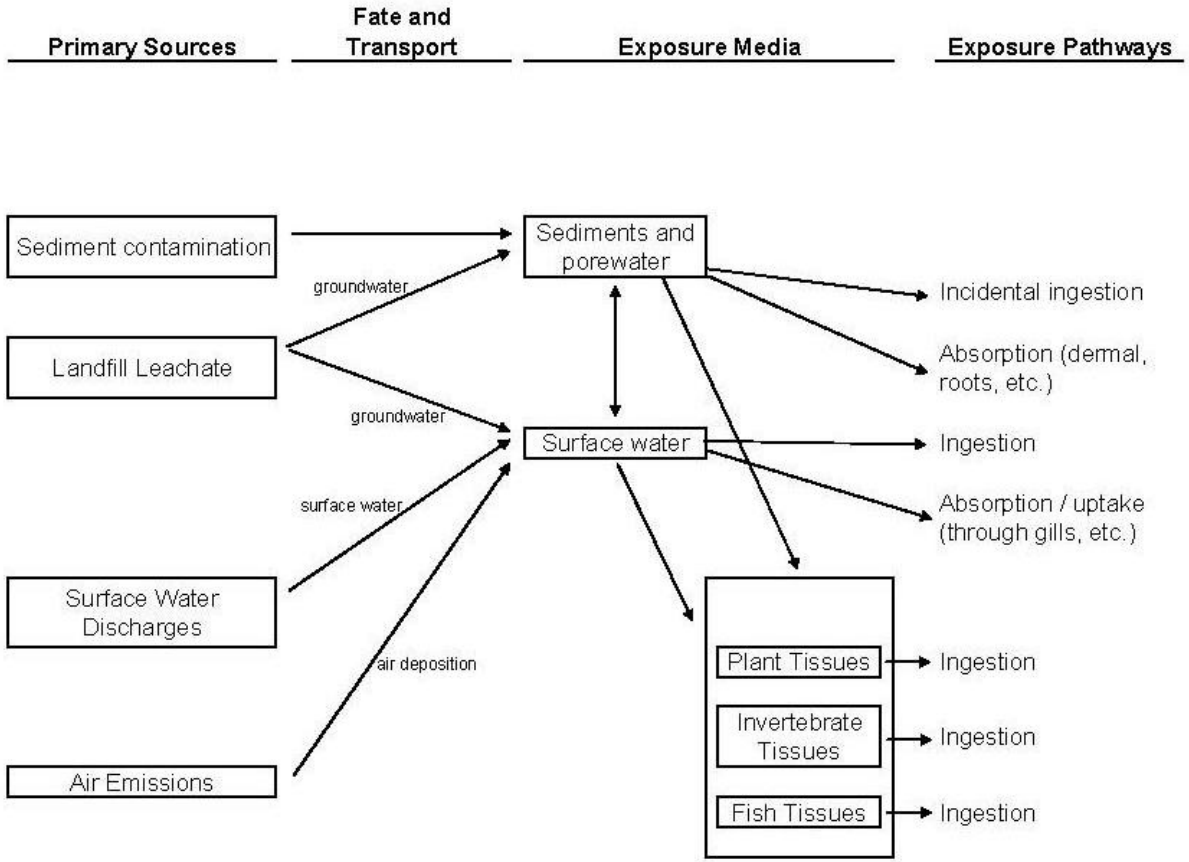


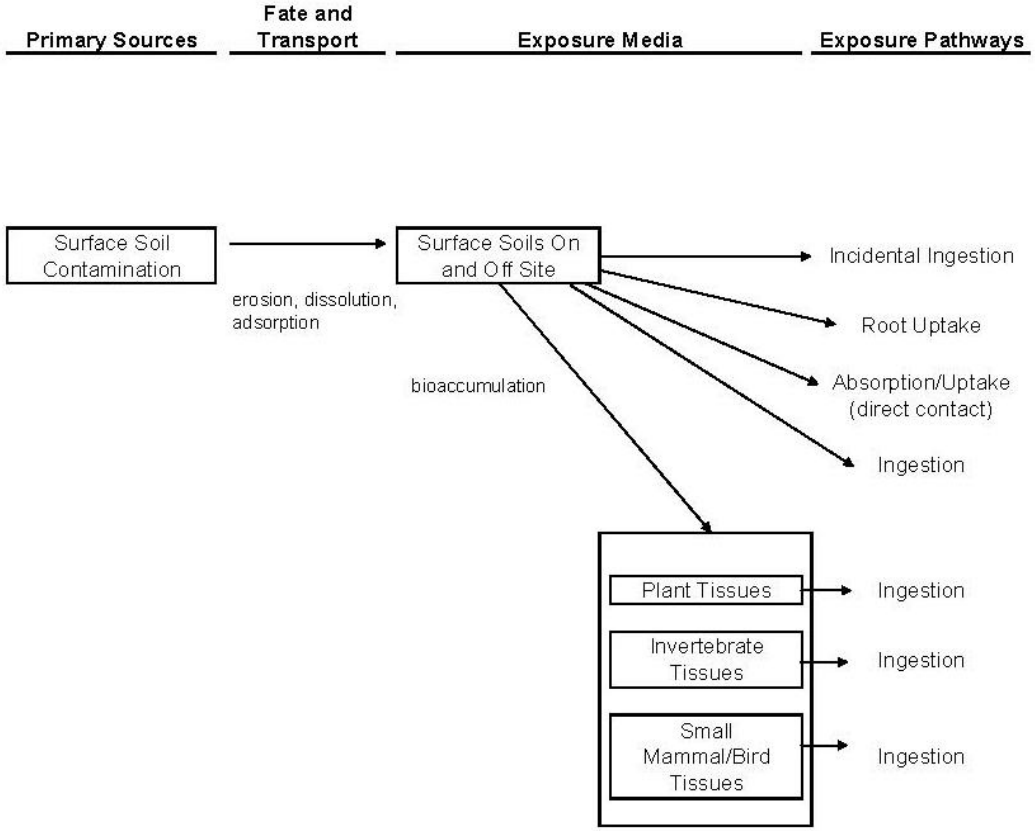
Figure 3.5 Box diagram CSM – example 1



Receptors of Potential Concern							
Aquatic Plants	Benthic Infauna	Benthic Epifauna	Demersal Fish	Piscivorous Fish	Piscivorous Birds	Wading Birds & Waterfowl	Mammals
○	●	●	●	○	○	●	●
●	●	●	○	○	○	○	○
○	○	○	○	○	●	●	●
●	●	●	●	●	○	○	○
○	●	●	○	○	○	●	●
○	●	●	●	○	○	●	●
○	○	○	●	●	●	●	●

Note: solid bullets indicate pathways that are likely to be operational

Figure 3.6 Box diagram CSM – example 2



Receptors of Potential Concern								
Soil Invertebrates	Plants	Small Insectivorous Mammals	Small Herbivorous Mammals	Small Omnivorous Mammals	Insectivorous Birds	Herbivorous Birds	Omnivorous Birds	Predatory Birds and Mammals
○	○	●	●	●	●	●	●	●
○	●	○	○	○	○	○	○	○
●	○	○	○	○	○	○	○	○
●	○	○	○	○	○	○	○	○
○	○	○	●	●	○	●	●	○
●	○	●	○	●	●	○	●	●
○	○	○	○	○	○	○	●	●

Note: solid bullets indicate pathways that are likely to be operational

3.10 Step 9: identify possible assessment and measurement endpoints

Having established that pollutant linkages to ecological receptors are reasonably possible through the completion of Steps 1–8, the risk assessor now needs to identify possible assessment and measurement endpoints in consultation with the appropriate nature conservation organisation and the regulator.

This process involves defining the protection goals / conservation objectives and how any impacts on them can be measured. It is necessary for subsequent tiers of risk assessment.

3.10.1 Assessment endpoints

An assessment endpoint is:

> *'an explicit expression of the environmental resource that is to be protected. It is defined operationally in structural terms (e.g. a population of a particular species) or functionally (e.g. supporting processes that are typical of a particular habitat).'* (Environment Agency 2004b)

In the ERA Framework, the assessment endpoints are derived directly from Table A of the Statutory Guidance and are the:

- Functioning of the ecosystem;
- species of special interest;
- favourable conservation status.

In reality, it is rarely possible to carry out experimental analysis of species defined as assessment endpoints because it is likely these species will be endangered or protected.

The ERA process therefore uses surrogate measures termed measurement endpoints.

3.10.2 Measurement endpoints

Measurement endpoints are

> *'quantifiable indicators that relate directly to assessment endpoints, for example, viable offspring per female bird'.* (Environment Agency 2003)

To be consistent with Part 2A , the risk assessor must identify a suite of measurement endpoints that are relevant to the assessment endpoints as defined in the Statutory Guidance. These should be quantifiable and provide information about the probability that adverse change is occurring or will occur. For instance, measurement endpoints should:

- be relevant to the assessment endpoint. If biological assays are used, then it should be possible to link the results of the assays to the functioning of the ecosystem or an organism forming part of such a system.

- be capable of determining how likely it is that harm is occurring, or will occur. If ecological surveys are used, then it should be possible to compare the outcomes to either historical data or to a similar uncontaminated site in order to assess the degree and extent of any adverse change.

When selecting measurement endpoints the stakeholders should agree at the outset what changes, their magnitude and extent would constitute an adverse change in each measurement endpoint. For a unique site supporting particularly rare species, these criteria might be more exacting than at a site that does not support such a unique assemblage.

For the purposes of the ERA Framework adverse change is defined as:

> 'change in the growth, reproduction or mortality of organisms which endangers the *functioning of the ecosystem, any species of special interest at that location*, or the *favourable conservation status* of the natural habitats at that location or species typically found there'.

Where the functioning of an ecosystem is a concern, adverse change refers to significant changes in biodiversity or microbial activity/nutrient cycling etc. Where species of special interest are involved, adverse change refers to significant changes in abundance and distribution, survival and growth or reproductive success.

3.10.3 The relationship between RoPCs and assessment and measurement endpoints

Table 3.2 provides an example of some possible relationships between RoPCs and assessment and measurement endpoints.

Table 3.2 Example of possible relationships between RoPCs and assessment and measurement endpoints

RoPCs at subject site*	Importance of receptor	Assessment endpoints from Statutory Guidance	Measurement endpoints that might be used at Tier 2 of the ERA
1. Lowland Heath Habitat	Habitat type is regionally scarce and is important for supporting a diverse heathland bird community and uncommon insects.	Functioning of the ecosystem	• Ecological surveys to assess directly the extent and quality of habitat type. The results can be compared to previous surveys or reference sites to identify any potential adverse changes; • Nitrogen mineralisation bioassay / bait lamina bioassay to assess general soil health and functioning; • Plant toxicity bioassays such as seedling emergence and/or plant growth to assess potential impacts of contaminants on plants and the potential for adverse impacts on habitat or food availability to species of special interest; • Earthworm and collembolan bioassays to assess potential adverse effects of contaminants on soil function and the potential for reduced prey availability to species of special interest.
2. Bog Bush-Cricket (*Metrioptera brachyptera*)	Nationally scarce	Species of Special Interest	• Ecological surveys designed to estimate the number of individuals. Results can then be considered against baselines or reference sites; • Results of bioassays listed above will assess potential for harm via indirect effects such as loss of habitat extent or quality, or harm through reduced food availability; • For CoPCs that may bioaccumulate, a survey designed to measure the levels of contamination in food sources could be undertaken.
3. Nightjar (*Caprimulgus europaeus*)	Breeding population of rare Biodiversity Action Plan species	Species of Special Interest	• Ecological surveys designed to estimate the number of individuals or the number of offspring per female bird. Results can then be considered against baselines or reference sites; • Results of bioassays listed above will assess potential for harm via indirect effects such as loss of habitat extent or quality, or harm through reduced food availability; • For CoPCs that may bioaccumulate, a survey designed to measure the levels of contamination in food sources could be undertaken

* Identified from published conservation objectives for the protected location and through discussion with the nature conservation organisation.

3.11 Step 10: identify gaps and uncertainties

After completing the documentary review and producing the CSM, the risk assessor should consider where the key gaps and uncertainties lie. This will highlight areas where further information needs to be collected, either as part of the desk study exercise or during any subsequent site investigations.

When considering the gaps and uncertainties, it can be helpful to produce a narrative (or tabular) summary that includes:

- identification of uncertainty regarding the type of contaminants present or fate and transport processes useful for characterising the CoPCs;
- identification of gaps in ecological information necessary or useful for determining the RoPCs at the site adequately;
- identification of gaps in the understanding of potential pathways between sources of contamination and RoPCs;
- an assessment of the quality of existing data and their suitability for further risk assessment (e.g. sample locations, analytical detection limits, etc.);
- an assessment of uncertainties surrounding the potential pollutant linkages. For example, modes of uptake by RoPCs, predator – prey relationships or bioavailability etc.

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List of abbreviations

BCMELP	British Columbia Ministry of Environment, Lands and Parks
CCW	Countryside Council for Wales
CLR	Contaminated Land Report
CoPC	Contaminant of Potential Concern
cSAC	candidate Special Area of Conservation
CSM	Conceptual Site Model
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
DoE	Department of Environment
EC	European Commission
EPA 1990	Environmental Protection Act 1990
ERA	Ecological Risk Assessment
EU	European Union
Kow	octanol–water partition coefficient
MAGIC	Multi-Agency Geographic Information for the Countryside
PoPC	Pathway of Potential Concern
PPS	Planning Policy Statement
pSPA	potential Special Protection Area
pSAC	possible Special Area of Conservation
RoPC	Receptor of Potential Concern
SAB	Science Advisory Board for Contaminated Sites in British Columbia
SAC	Special Area of Conservation
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPOSH	Significant Possibility of Significant Harm
SSV	Soil Screening Value
SSSI	Site of Special Scientific Interest
TGD	Technical Guidance Document [EU]

Glossary

Adverse effect	An impairment of biological functions or description of ecological processes that results in unfavourable changes in an ecological system.
Aquatic	Living or growing in water.
Assessment endpoint	An explicit expression of the environmental resource that is to be protected. It is defined operationally in structural terms (e.g. a population of a particular species) or functionally (e.g. supporting processes that are typical of a particular habitat).
Bioaccumulate	Net uptake of a chemical into the tissues of an organism as a result of direct contact with a medium (e.g. water or soil) or through the diet.
Bioavailability	The degree to which a chemical can be taken into the tissues of an exposed organism.
Biomagnify (biomagnification)	A measure of the degree of increase in the tissue concentration of a chemical with each trophic step in a food chain. For example, a biomagnification factor of 5.0 indicates that the concentration of a given chemical in the tissues of a predator is five times the concentration of the chemical in the tissues of its primary prey species.
Community	Interacting populations of species (plants or animals) living in the same habitat.
Concentration	The amount of a chemical substance expressed relative to the amount of environmental medium, e.g. µg/g (micrograms of chemical per gram of soil).
Conceptual Site Model (CSM)	A representation of the characteristics of the site in diagrammatic or written form that shows the possible relationships between contaminants, pathways and receptors.
Contaminant	In general terms, a substance that is in, on or under the land and that has the potential to cause harm or to cause pollution of controlled waters. Within ecological risk assessment the specific emphasis will be on contaminants that have the potential to cause harm to ecological receptors.
Contaminant of Potential Concern (CoPC)	A contaminant identified as being present or likely to be present at the study site, included in the CSM and agreed to be of concern by all the stakeholders.
Data quality, defined in terms of:	• **Completeness** – Extent to which the available information adequately describes the characteristics of sources, pathways and receptors. • **Clarity** – Extent to which the available information presents a clear and unambiguous account of the situation being

assessed.

- **Relevance** – Extent to which the available information is relevant to the sources, pathways and receptors.
- **Reliability –** Extent to which measurements or observations accurately reflect the true or likely site conditions taking into account the implications of any gaps in the information.

Dermal exposure	Dermal exposure occurs when contaminants are absorbed through the skin.
Desk Study	Interpretation of historical, archival and current information to establish where previous activities were located, and where areas or zones that contain distinct and different types of contamination may be expected to occur, and to understand the environmental setting of the site in terms of pathways and receptors.
Dose	The amount of chemical taken into an organism per unit of time.
Dose-Response Relationship	The relationship between the dose of a contaminant administered or received and the incidence of adverse effects in the exposed population. From the quantitative dose-response relationship, values are derived that can be used to estimate the likelihood of adverse effects occurring at different exposure levels.
Ecological Receptor	In general terms, [a receptor is] something that could be adversely affected by a contaminant, such as people, an ecological system, property or a water body. Within ecological risk assessment, an ecological receptor will be an organism, population or community that might be affected by exposure to a contaminant of concern.
Ecological Risk Assessment (ERA)	Evaluation of the likelihood of adverse effects on organisms, populations and communities from chemicals present in the environment.
Ecological Survey	Surveys for habitats and species; a method of gathering spatial and / or temporal ecological data on a site.
Ecosystem	An ecological community of plants and animals together with its physical environment or habitat, regarded as a unit.
Effect	A change in the state of an organism or other ecological component resulting from exposure to a chemical or other stressor.
Endpoint	The biological or ecological entity or variable being measured or assessed (see measurement endpoint and assessment endpoint).
Exposure	The amount of a chemical available for intake by a target population at a particular site. Exposure is quantified as the concentration of the chemical in the medium (e.g. air, water,

	food) integrated over the duration of exposure. It is expressed in terms of mass of substance per kg of soil, unit volume of air or litre of water (e.g. mg/kg, mg/m^{-3} or mg/l).
Fate	The disposition of a chemical in various environmental media or biota as a result of the transport, partitioning, uptake, elimination and degradation.
Feeding guild	A group of organisms that use the same ecological resource in a similar way for feeding (e.g. insectivores, granivores, detritivores, carnivores, etc.) or a group of species that overlap significantly in their niche requirements. In risk assessment, a feeding guild is sometimes also refined further by body size, since body size is related to food consumption rate.
Food web	Interconnected food chains that describe the pathways of energy and matter flow in nature.
Habitat	A place in which a particular plant or animal lives. Often used in the wider sense referring to major assemblages of plants and animals found together.
Insectivore	An insect-eating mammal (order insectivore). These include shrews, hedgehogs and moles, and make up the order called Insectivora (Insect Eaters). These creatures have in common a diet of insects. Other small invertebrates such as worms and crustaceans are eaten, while aquatic species may add small fish and even amphibians to their meals.
Kow	The octanol–water partition coefficient is the ratio of the concentration of a chemical in octanol and in water at equilibrium and at a specified temperature. Octanol is an organic solvent used as a surrogate for natural organic matter.
Life stage	A developmental stage of an organism (e.g. juvenile, adult, egg, pupa, larva).
Measurement endpoints	Quantifiable indicators that relate directly to assessment endpoints, for example, viable offspring per female bird.
Medium (plural media)	The substance in which a chemical may exist such as air, soil, sediments and water.
Non-detects	Laboratory analytical results which are below the laboratory analytical detection limit for that parameter.
Organism	An individual plant or animal.
Pathway	A route or means by which a receptor could be, or is exposed to, or affected by a contaminant.
Pathway of Potential Concern	A pathway identified as being present or likely to be present at the study site, included in the CSM and agreed to be of concern by all the stakeholders.
Pollutant linkage	The relationship between a contaminant, pathway and receptor.

Population	A group of individuals of the same species interacting within a given habitat.
Protected location	A location protected by a nature conservation designation of a type listed in Table A of the Statutory Guidance on Contaminated Land.
Receptor of Potential Concern	An ecological receptor identified as present or likely to be present at the study site, included in the CSM and agreed to be of concern by all the stakeholders.
Remediation	Action taken to prevent or minimise, or remedy or mitigate the effects of any identified unacceptable risks.
Routes of transport	The migration of contaminants from sources to environmental media (groundwater, surface water, soils, sediment and air).
Soil Screening Values	Concentrations of chemical substances found in soils below which there are not expected to be any adverse effects on wildlife such as birds, mammals, plants and soil invertebrates, or on the microbial functioning of soils.
Species of Special Interest	A species within a protected location that, through discussion with relevant conservation organisations, has been established as being of special interest.
Stressor	A physical, chemical or biological agent that can induce an adverse response in organisms or other components of ecosystems.
Terrestrial	Living or growing on land.
Transport and fate	A description of how a chemical is carried through the environment. This may include transport through biological as well as physical parts of the environment.
Trophic level	Broad class of organisms within an ecosystem characterised by mode of food supply.

Appendix 1: Further information on types of protected location

The following text is based on English Nature[7] (2001).

The Statutory Guidance on Part 2A of the EPA 1990 lists eight types of protected site which are to be regarded as 'eco-receptors' for the purposes of the Act. These are the receptor sites listed in Table A of the Statutory Guidance (DEFRA, 2006). A summary of these different types of designated sites is given in Table A1.

Sites of international importance for their nature conservation interests can broadly be divided into three groups:

- Special Areas for Conservation (SACs);
- Special Protection Areas (SPAs) – together these constitute the Natura 2000 sites;
- Ramsar sites.

Except for subtidal areas of marine cSACs, these internationally important sites are also required to be notified as SSSIs; this should assist local authorities when they are identifying sites within their search area. The SSSI may include features of national importance as well as the interests which are selected in a European context.

Table A1 Categories of significant harm – modified from Table A, Annex 3 of DEFRA (2006)

Site ('eco-receptor') type	Legislation	Brief description
Sites of Special Scientific Interest (SSSI)	Wildlife & Countryside Act 1981, section 28, as incorporated by the Countryside and Rights of Way Act 2000	Site of national importance for its flora, fauna, geological or physiographical features
National Nature Reserve (NNR)	Wildlife & Countryside Act 1981, section 35	Natural England designates a number of SSSIs in England as National Nature Reserves. These sites include the most important areas for wildlife conservation and geology in the country.
Marine Nature Reserve (MNR)	Wildlife & Countryside Act 1981, section 36	Nationally important intertidal and marine area designated for conservation and research.
Areas of Special Protection for Birds	Wildlife & Countryside Act 1981, section 3	Designated area to protect birds and their nests.
(candidate) Special Area for Conservation (SAC)	The Conservation (Natural Habitats & c.) Regulations 1994 PPS 9, paragraph 6	Site of international importance that contains habitat types and/or species which are rare or threatened within a European context.

[7] Now Natural England

(potential) Special Protection Area (SPA)	The Conservation (Natural Habitats & c.) Regulations 1994 PPS 9, paragraph 6	Site of international importance for rare or vulnerable bird species listed in Annex I (Article 4.1) and for regularly occurring migratory species (Article 4.2) and for the protection of internationally important wetlands.
Ramsar site	Ramsar Convention 1971 on Wetlands of International Importance especially as Waterfowl Habitat PPS 9, paragraph 6	Site of international importance for wetland habitats, especially as waterfowl habitat.
Local Nature Reserve	National Parks and Access to the Countryside Act 1949, section 21	Site designated by a local authority to conserve nature and provide for research; utilised to increase accessibility to, and understanding of, nature and geology.

SACs are designated under the 1994 EC Habitats and Species Directive. These sites represent wildlife habitats and species in the UK deemed to be of international importance for either the extent of the available habitat resource or the populations of particular species, or both. Lists of possible SACs (pSACs) are submitted to DEFRA. Those confirmed as UK submissions to the European Commission are known as candidate SACs (cSACs). Candidate SACs and pSACs have similar legal protection to SACs.

SAC sites also cover the marine environment. The UK Marine SACs LIFE project, led by English Nature (now Natural England), was set up in 1996 to kickstart the UK marine SACs programme and to help characterise and effectively manage England's finest habitats and species on the seashore and in the sea. The project set up demonstration sites around the UK to explore the problems of identifying, managing and monitoring marine SACs. This experience has led to guidance being produced and promoted for others, both in the UK and in Europe.

SPAs are sites of international importance for their rare and migratory birds and associated habitat interest. They are designated under the 1979 EC Birds Directive, and during 1999/2000 Natural England contributed to the UK review of the SPA site series, resulting in the publication by Government of the full UK SPA site series - a list of all the terrestrial SPAs that have been, or are proposed to be, classified. Ramsar sites are of international importance for wetland conservation and are designated under the Ramsar Convention.

Many 'eco-receptor' sites will qualify under a number of criteria, which should be taken into consideration during the desk study and CSM stage. For example, the Severn Estuary, is one of the largest estuaries in Britain with the second largest tidal range in the world. As well as extensive inter-tidal and associated wetland areas being designated as SSSI, the site also has Ramsar, SPA and pSAC status. Although overlap exists, the boundaries to these areas may not be contiguous, because each designation is specific to different features. Ramsar features include the immense tidal range, the unusual estuarine communities resulting from extreme physical conditions of liquid mud and tide-swept sand and rock, and the presence of rare and vulnerable fish and birds, as well as migratory bird species during spring and autumn and overwintering waterfowl. The SPA designation covers areas important to internationally important numbers of migratory species. Finally, the Severn Estuary pSAC includes the Estuary habitat, subtidal sandbanks, Atlantic salt meadows and intertidal mudflats and sandflats.

National Nature Reserves (NNRs) represent the very best of England's natural (terrestrial and marine) habitats, species, geology and geomorphology. Like SSSIs, NNRs play a key part in contributing to biodiversity targets, but they are also playing an increasing role in developing public appreciation and understanding of the countryside and nature conservation.

Sites of Special Scientific Interest (SSSIs) are of national importance and are notified as the best sites for wildlife (including habitats and species), geological and geomorphological features in the UK. They support many characteristic, rare and endangered species, habitats and Earth heritage features and encompass a whole range of ecosystems including grasslands, heathlands, woodlands, bogs and fens, rivers, coastal areas, farmland, urban areas, estuaries, lagoons and intertidal flats.

Further information on designated areas is available from Natural England[8] and JNCC.[9]

[8] http://www.naturalengland.org.uk/conservation/designated-areas/default.htm
[9] http://www.jncc.gov.uk/page-4

Appendix 2: Conservation Agency contact details

Natural England head office

1 East Parade, Sheffield, S1 2ET
Tel: 0114 241 8920
Fax: 0114 241 8921

Email: enquiries@naturalengland.org.uk

Website: www.naturalengland.org.uk

A list of regional offices may be obtained from the following weblink:
http://www.naturalengland.org.uk/contact/default.htm

Countryside Council for Wales head office

Maes y Ffynnon, Penrhosgarnedd, Bangor, Gwynedd, LL57 2DW
Tel: 0845 1306229
Fax: 01248 355782

Email: enquiries@ccw.gov.uk

Website: www.ccw.gov.uk

A list of regional offices may be obtained from the following weblink:
http://www.ccw.gov.uk/about-ccw/ccw-offices.aspx

Scottish Natural Heritage head office

Great Glen House, Leachkin Road, Inverness, IV3 8NW
Tel: 01463 725000
Fax: 01463 725067

Email: enquiries@snh.gov.uk

Website: www.snh.org.uk

A list of regional offices may be obtained from the following weblink:
http://www.snh.org.uk/about/ab-hq.asp

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