SAFEGROUNDS Good Practice Guidance for the Management of Contaminated Land on Nuclear and Defence Sites

Participation (by organisations or individuals) in the SAFEGROUNDS project must not be taken as an indication of either support for or disagreement with the content of this guidance in its entirety. This is the first version of the guidance and it is not yet tried and tested. It is intended that the guidance will be revised at intervals, taking into account experience in using it and regulatory and other changes.

CIRI-6349A
CR0117001

September 2002

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Foreword

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Stakeholder dialogue

This guidance was drafted following a stakeholder dialogue process, designed and managed by the project management team (see below), which included stakeholder workshops, questionnaires and one-to-one discussions. The specific outcomes from this process were: a deeper understanding of the issues important to stakeholders from different backgrounds; suggestions for the key principles that should underpin the guidance and the phrasing of those key principles; suggestions for other principles to be encapsulated in additional explanation and amplification; and detailed comments on the draft guidance prior to publication.

The issues for management of contaminated land on nuclear-licensed sites and defence sites were explored at a SAFEGROUNDS stakeholder workshop in July 2000, facilitated by The Environment Council. The suggestions for key principles were identified through a series of postal and web-based questionnaires. The process for this was designed under the guidance of a Consultation Steering Group representing civilian and defence nuclear liability owners, regulators, local authorities and community-based organisations. The wording of the key principles was discussed at two stakeholder workshops held in May 2001 and July 2001. All the stakeholder workshops and the meetings of the Consultation Steering Group were organised by The Environment Council. Allen Hickling of Allen Hickling & Associates led the facilitation team.

Detailed comments on the draft guidance were also sought from all those previously contacted by the project, and about 120 copies of the draft were distributed in March 2002 for this purpose.

CIRIA, on behalf of all those involved in preparing this guidance, would like to thank everyone who participated in the SAFEGROUNDS project.

Project steering group

The SAFEGROUNDS project was guided by a steering group comprising project funders, and regulatory and policy-making stakeholders. CIRIA and the research contractors wish to express their appreciation for the technical guidance and support given by the group during the project and in their additional review of drafts of the guidance. The members of the group were:

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SAFEGROUNDS project management

The SAFEGROUNDS project was managed by a team comprising CIRIA, WS Atkins (to July 2001) and The Environment Council. CIRIA would especially like to acknowledge the valuable roles played by:

Ms M Hill	WS Atkins (to July 2001), Enviros (from August 2001)
Ms J Stanbury, Ms D Marock, Ms H Ashley, Ms L Parnall	The Environment Council
Mr A Hickling	Allen Hickling & Associates.

Funding

At the time of this work, the SAFEGROUNDS Learning Network project was funded by Atomic Weapons Establishment, British Energy, BNFL, Defence Estates, DEFRA, HSE, the Industry Management Committee Technical Working Group on Waste Management and Decommissioning, and UKAEA.

The SAFEGROUNDS project was sponsored by the Safety Issues Task Force of the Liabilities Management Group at DTI.

Funding and sponsoring of the project does not imply acceptance of all the views expressed in this report.

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1 Introduction

1.1 SCOPE

The guidance describes good practice for the management of contaminated land on two types of site:

- *nuclear-licensed sites* (including those being decommissioned, whether or not they are to be delicensed) and
- non-nuclear *defence sites* for which a change of use and/or ownership is planned.

These types of site are distinguished by the potential for radioactive contamination, but non-radioactive and mixtures of radioactive and non-radioactive contamination may also be present. The guidance is for land on these sites where any of these three types of contamination has been found or is suspected to be present.[1]

The guidance contains key principles (Section 2), amplification of these principles (Section 3) and a structured approach to the management of contaminated land that will assist in putting the key principles into practice (Section 4). Guidance on carrying out the major steps in the structured approach is given in Section 5-8. Further guidance for nuclear-licensed sites and defence sites is given in Appendices A and B, respectively.

1.2 PURPOSE

The guidance has been developed primarily to assist those responsible for the management of contaminated land. It will also inform other stakeholders who are involved in the processes of determining how contaminated land is managed.

Although it is aimed at a technical readership, most of the guidance is not detailed nor highly technical. It deals mainly with general approaches and focuses on issues outside of the technical sphere that practitioners need to be aware of when planning and carrying out their work.

The guidance is intended to be relevant both in planning the future management of contaminated land (including making liability estimates) and in managing the land in practice. It is particularly relevant to strategic planning for the overall management of contaminated land on a site, but can also be applied to specific situations or cases. It takes account of the variety of situations on nuclear-licensed sites and defence sites and is not intended to be prescriptive.

[1] The guidance may also be useful for other types of site where contaminated land is present. One example is defence sites that would be classed as nuclear-licensed sites if the Ministry of Defence (MoD) were subject to the Nuclear Installations Act. Another example is radioactively contaminated sites other than nuclear-licensed sites and defence sites where a change of use and/or ownership is planned. (Such sites in their current use will be covered by the regulatory regime being developed for radioactively contaminated land to mirror that which already exists for non-radioactively contaminated land under Part IIA of the Environmental Protection Act.)

1.3 STATUS

This guidance is a living document. It is intended to be revised at intervals in the light of experience in using it and in response to policy, regulatory and other changes. It is not binding; it supplements regulations and associated guidance but has no legal standing.

Participation (by organisations or individuals) in the SAFEGROUNDS project must not be taken as an indication of either support for or disagreement with the content of this guidance in its entirety. Experience gained in using this first version of the guidance will be collected through the SAFEGROUNDS Learning Network and used in producing subsequent versions. This experience will enable the degree of commitment to the guidance to be determined and may or may not result in a change to the status of the guidance .

1.4 DEFINITIONS

1.4.1 Contaminated Land

The term 'contaminated land' is used in a general way in the guidance and means any land in, on or under which there are radioactive or non-radioactive contaminants at levels above the natural and artificial background levels that are typical of the area of the UK in which the site is located. This definition is broader than the statutory definition in Part IIA of the Environmental Protection Act 1990, which applies only to land in its current use (including any use for which planning permission has been granted), and which reflects the intention of the Part IIA regime to focus on sites with the potential to give rise to the highest risks to people and the environment. The broader definition is employed so as to cover all cases where the presence of contaminants is or could be a cause for concern to the owners or operators of the site, the regulators and other stakeholders. [2]

1.4.2 Management of Contaminated Land

The term 'management of contaminated land' is used in this guidance to mean the taking of any actions to control, monitor or remove (wholly or partially) contamination once it has been discovered, and all the processes that lead up to the decisions to take such actions. This definition excludes actions to prevent contamination occurring in the first place, because these are outside the scope of the SAFEGROUNDS project. It also excludes the characterisation of sites to determine whether and to what extent the land is contaminated, because this is covered by separate SAFEGROUNDS guidance [Baker et al, 2000].

[2] The definition is similar to that of 'land affected by contamination' in the 2002 government consultation paper on draft technical advice for local planning authorities [DTLR, 2002]. For further discussion of definitions for contaminated land see Hill [2002].

1.5 RELATED SAFEGROUNDS DOCUMENTS

Other documents produced by the SAFEGROUNDS project and which are referenced in this guidance are as follows.

The Regulatory Framework for Contaminated Land on Nuclear-Licensed Sites and Defence Sites [Hill, 2002]

Community Stakeholder Involvement in the Management of Contaminated Land [Collier, 2002]

Technical Options for Managing Contaminated Land [Mallett, 2002]

Assessments of Health and Environmental Risks from Contaminated Land [Smith, 2002]

Status of SAFEGROUNDS Advocacy Issues [CIRIA, 2002]

SAFEGROUNDS Site Characterisation Guidance [Baker et al, 2000]

2 Key Principles for the Management of Contaminated Land

The SAFEGROUNDS project has identified five key principles for the management of all contaminated land on nuclear and defence sites. The principles have been established through a consultative process in which representatives of a variety of stakeholder groups were involved. The principles are non-overlapping and complementary and should be applied together. The key principles are as follows.

Principle 1: Protection of People and the Environment

The fundamental objective of managing contaminated land on nuclear-licensed sites and defence sites should be to achieve a high level of protection of people and the environment, now and in the future.

Principle 2: Stakeholder Involvement

Site owners/operators should develop and use stakeholder involvement strategies in the management of contaminated land. In general, a broad range of stakeholders should be invited to participate in decision-making.

Principle 3: Identifying the Preferred Land Management Option

Site owners/operators should identify their preferred management option (or options) for contaminated land by carrying out a comprehensive, systematic and consultative assessment of all possible options. The assessment should be based on a range of factors that are of concern to stakeholders, including health, safety and environmental impacts and various technical, social and financial factors.

Principle 4: Immediate Action

Site owners/operators should take measures immediately to monitor and control all known (or suspected) contamination and continue such measures until an acceptable management option has been identified and implemented.

Principle 5: Record-Keeping

Site owners/operators should make comprehensive records of the nature and extent of contamination, the process of deciding on the management option for the contaminated land and the findings during the implementation and validation of the option. All records should be kept and updated as necessary.

Most of the key principles apply primarily to options for the long-term management of contaminated land. Some apply throughout the process of identifying, implementing and validating a management option; others are mainly relevant at particular stages. Section 3 expands on the principles and subsequent sections give guidance on their application. Further guidance for nuclear-licensed sites and defence sites is in Appendices A and B, respectively.

3 Amplification of the Key Principles

3.1 PRINCIPLE 1: PROTECTION OF PEOPLE AND THE ENVIRONMENT

The fundamental objective of managing contaminated land on nuclear-licensed sites and defence sites should be to achieve a high level of protection of people and the environment, now and in the future.

3.1.1 General

In applying the principle, the 'protection of people' refers to the health and well being of workers and the public. The 'environment' includes, but is not limited to, people's property (e.g. houses and land), existing and potential resources (e.g. groundwater, water quality, air quality) and natural ecosystems.[3]

It should not be assumed that protecting people will always protect the environment, or vice versa. The balance between protecting people and protecting the environment has to be resolved in the process of identifying the preferred land management option, which takes account of these and other factors (see Principle 3). This process should include the identification of appropriate indicators for environmental protection.

It is necessary to protect people and the environment both from expected situations and those with only a chance of occurring. This means taking measures, if needed, to reduce the likelihood of adverse effects occurring as well as reducing the effects themselves.

In deciding what constitutes a 'high level of protection', account should be taken of important scientific uncertainties. These are associated with the effects of radionuclides and other contaminants on people's health and the health of other organisms. There are also uncertainties in the environmental processes leading to the exposure of people or the contamination of the environment. Some stakeholders have differences of opinion on these issues that should be recognised and acknowledged. The guidance recommends a case-by-case approach to the practical specification of a high level of protection (see Section 3.1.2).

It is necessary to protect people and the environment in the future at least to standards accepted today. This is essential to uphold the concept of ' sustainability'. Putting this into practice is discussed further in Section 3.1.3.

3.1.2 Specifying a Level of Protection

Radioactively Contaminated Land

The topic of appropriate levels of protection from radioactively contaminated land ('clean-up criteria') was covered at length in the questionnaires distributed and workshops held during the SAFEGROUNDS consultation on key principles. The major

[3] In environmental protection in general, people are regarded as part of 'the environment'. The distinction is made here because it is conventional to do so in radiological protection and in health and safety contexts.

views expressed are summarised in Box 1. The outcome of the consultation was that no agreement was reached on the form of primary levels (risk, dose or radionuclide concentrations) or on any numerical levels. It is therefore recommended that, for the present, a case-by-case approach, with stakeholder involvement (see Principle 2), should be used. In this approach the appropriate level of protection is not selected in advance of comparing various land management options (see Principle 3). The levels of protection associated with each option are factors ('attributes') in option comparisons (see Section 5). The appropriate level for any particular situation is defined when the preferred option has been identified and is the level of protection that that option would achieve if implemented.

The SAFEGROUNDS project is advocating further consultation on policy and standards for radioactively contaminated land, and review and clarification of the existing legislation [CIRIA, 2002]. In doing so, participants in the project recognise that many of the points listed in Box 1 will be made again and it is likely to be difficult to resolve these conflicting views.

Non-Radioactively Contaminated Land

The topic of appropriate levels of protection for non-radioactively contaminated land was not addressed in any detail during the SAFEGROUNDS consultation on key principles. This was partly because the subject area is too large, and partly because it was known that DEFRA and the Environment Agency were due to issue guidance on the topic in the context of Part IIA. This guidance has now been published and more is planned [Environment Agency, 2002a]. It is recommended that this guidance is used in conjunction with the case-by-case approach.

Both Types of Contaminated Land

When comparing management options, it is important to include at least one option that would result in a reduction of contaminant concentrations to levels that are essentially indistinguishable from natural and artificial background, either immediately, or after a period of time (see Section 5). Background is taken to be the concentration of natural and artificial contaminants at the location, not including any contributions from the site's activities. EA [2002b] contains information on establishing and defining background levels of radioactivity. Options that achieve background levels will give the highest level of protection and could have other advantages, such as maximising the resale value of the land.

Particularly in situations where a variety of locations are contaminated, an integrated strategy for the whole site is needed to provide protection from all the contamination. Such a strategy is required if there are several radioactively or non-radioactively contaminated areas on a site. Similarly, the combined impact of both non-radioactive and radioactive contaminants should be considered where both are present together. For example, it is not appropriate to consider a small patch of radioactivity in isolation if there is a large patch of hydrocarbon contamination nearby [DOE, 1995].

Levels for the protection of people and the environment are not appropriate if they cannot be applied in practice. Due consideration should be given to the limits of monitoring equipment, as well as to uncertainties in identifying and measuring contaminants.

Box 1 Major Views Expressed during the Consultation on Levels of Protection for Radioactively Contaminated Land

- The NRPB guidance [NRPB, 1998] and the 'tolerability of risk' approach should be used. An individual risk (of death) of 10^{-6} is an appropriate target and a risk of 10^{-5} should be used as an upper limit.
- It is premature to specify levels of radiation risk, radiation dose or radionuclide concentrations while there is so much scientific debate on radiation risks to human health. Radiation risk estimates currently used by the nuclear industry and its regulators are generally too low and for intakes of some radionuclides substantially too low.
- Numerical levels in the form of radiation risk or dose to people, and radionuclide concentrations derived from risk or dose, would not necessarily provide an appropriate level of protection for the environment. Protecting the environment means protecting the health of non-human organisms and avoiding levels of contamination that could prejudice legitimate uses of water, air and land. Prejudice of legitimate use could arise at very low levels of contamination and even when estimated risks to humans and other organisms are judged by the site owner/operator to be insignificant.
- Radioactive waste 'clearance levels' (eg the 0.4 Bq/g level in the Substances of Low Activity Exemption Order) do not correspond to an appropriate level of protection for contaminated land because they were not derived for this purpose. Reducing land contamination to below clearance levels has the advantage that any wastes generated when the land is subsequently redeveloped need not be managed as radioactive wastes. However this is not the issue when specifying a level of protection for people and the environment.
- A case-by-case approach could lead to unwarranted differences between the standards applied and costs incurred at various sites, and be unduly time-consuming for site owners/operators and others.
- It is not appropriate to specify one dose or risk level, or one set to radionuclide concentrations levels, to apply to all potential future uses of land.
- Whatever levels are specified should apply to all sites.
- Delicensing of nuclear-licensed sites is a special case because of the 'no danger' criterion (see Appendix A for details of this criterion).

3.1.3 Protection in the Future

The way in which future generations and their environment are protected depends on the condition of the land after the management option has been implemented. In general there are two types of land management option:

- those that will leave the site in a state suitable for the present and next planned use; and
- those that will make the site suitable for any use that the type of land will support, without any restrictions related to the contamination.

The first type of option ensures that people and the environment will remain protected during the present and next use of the site. It relies on record-keeping to ensure that the land is reassessed when a further change of land use is planned. It may also entail monitoring, control measures and regulation. The second type of option does not entail reassessment, monitoring, control or regulation, although records should still be kept (see Principle 5).

At most sites both types of option are feasible in principle. It is recommended that both types of option are included when comparing alternatives (see Section 5). In this way the implications of differing degrees of prescription on future use can be explored.

3.2 PRINCIPLE 2: STAKEHOLDER INVOLVEMENT

Site owners/operators should develop and use stakeholder involvement strategies in the management of contaminated land. In general, a broad range of stakeholders should be invited to participate in decision-making.

3.2.1 General

Stakeholders are all the people with an interest in the situation. They include 'institutional' stakeholders, such as regulators, local and national government and senior management within site owner/operator organisations, and others who could be affected by, or have a direct interest in, land management decisions, such as local residents, community-based organisations (CBOs) and non-governmental organisations (NGOs).

The stakeholder involvement principle applies to the whole process of taking decisions on long-term management options and implementing them. It means that site owners/operators should develop, at a very early stage in their consideration of their contaminated land issues, a strategy for involving a range of people in decision-making. The strategy should take into account the potential technical and societal significance of the decision. Judgements about the potential significance of a decision (especially its societal significance) are likely to vary from one group of stakeholders to another. If it is thought that one or more groups might view a decision as significant, the best course of action is for the site owner/operator to consult key stakeholder groups during the development of the involvement strategy. If the issues are largely technical it may be sufficient to involve regulators and to keep other stakeholders informed. In other cases a much wider range of people may need to be invited to

participate and, to achieve effective participation, the stakeholder involvement strategy may need to go further than the public consultation processes required by law (see Appendices A and B for details of these). Collier [2002] addresses the key issues for designing and carrying out an effective programme for involving stakeholders from the local community and the wider public.

Every effort should be made to avoid relying on national security or commercial confidentiality as reasons for failing to involve a wide range of stakeholders or for denying them information. In the case of large scale contaminated land situations, site owners or operators should always consider the views of external stakeholders before selecting a preferred option and seeking regulatory approval. They should demonstrate a commitment to using their very best endeavours to take decisions that fully and transparently reflect these stakeholders' views, and show how these views have been taken into account.

3.2.2 Timing

In general, stakeholder involvement should be initiated as early as possible. The benefits of early stakeholder involvement include: not wasting time in carrying out technical work on options that most stakeholders will never accept; shorter public consultation processes, with less effort entailed for site owners/operators and regulators; shorter regulatory approval procedures; fewer public protests when work actually starts. Deferring the involvement, for example until after supporting technical work is well underway, can give the impression that a decision has already been taken and negate many of these benefits.

3.2.3 Groups to Involve and Level of Involvement

The range of stakeholders to involve depends on the problem being considered. Ways of identifying the relevant stakeholders are discussed in Collier [2002]. If there is substantial uncertainty about which stakeholders should be involved, the best course of action is to invite all (institutional and other stakeholders) to participate. The level of involvement is influenced by the scale and nature of the contamination of the land, but it should be mutually agreed. For smaller problems there may be more emphasis on providing information to non-institutional or external stakeholders about proposals for long-term land management. For larger problems more consultation will usually be warranted. If one or more of the land management options being considered involves transport of substantial quantities of wastes to another site, the community around this site and those along the transport route should be involved. To enable stakeholders to participate effectively there should be ready access to all relevant information.

3.2.4 Resources

The resources available to stakeholders will differ, but this should not be allowed to constrain unduly their ability to participate in the process. The adequacy of financial resources available to non-institutional or external stakeholders (such as individual members of the public) should be discussed with them at the beginning of the process. The time and effort available to such stakeholders should also be discussed, and decision-making scheduled accordingly.

3.3 PRINCIPLE 3: IDENTIFYING THE PREFERRED LAND MANAGEMENT OPTION

Site owners/operators should identify their preferred management option (or options) for contaminated land by carrying out a comprehensive, systematic and consultative assessment of all possible options. The assessment should be based on a range of factors that are of concern to stakeholders, including health, safety and environmental impacts and various technical, social and financial factors.

3.3.1 General

Site owners and operators should demonstrate a commitment to considering systematically all the options for the long-term management of contaminated land. In doing this, stakeholders should be involved in accordance with Principle 2. The result of this process should be the identification of one or more preferred options, as an input to decision-making.

The approach to identifying the preferred management option should include the following steps:

- identifying all the options,
- removing those that participating stakeholders agree need not be considered in detail,
- considering the remaining options in detail,
- using key factors ('attributes') which highlight their differences to find out which is the preferred option.

The recommended approach (see Section 5) is based on the concept of 'best practicable environmental option' (BPEO), as defined and discussed by the Royal Commission on Environmental Pollution [RCEP 1988 and 1998]. BPEO analysis is used in radioactive waste management on nuclear sites (see, for example, EA, 2001b) and has been applied in integrated pollution control [EA, 1997]. It is the most widely accepted way of identifying the 'best' option in situations where there is a possibility of harm to people and the environment.

Principle 3 is particularly important for overall strategies for managing all the contaminated land on a site. This means that options for all parts of the site should be considered together and potential strategies for the whole site be developed and compared. The principle also applies to individual cases and specific situations but here the approach can be simpler. It is emphasised that it is not appropriate to deal with a whole site only as a series of small problems that are considered sequentially: an overall site strategy is required.

3.3.2 Options

The first stage of the recommended approach is to identify all envisageable options – i.e. all options that could possibly be applied to the problem. The list is then reduced to those that are appropriate for more detailed consideration. Options should not be excluded from further consideration only because they appear to be very expensive (or have costs that are greater than existing budgets) or they appear to be technically very difficult to implement. The aim in reducing the list of options should be to end up with

a small number (RCEP [1988] recommends 3-6) that embody the key features of the range of courses of action.

As mentioned in Section 3.1, it is important to include at least one option that would return contaminated land to a state fit for any use that the type of land would support. It is also important to include an option in which land is controlled and monitored for the foreseeable future but not used for any particular purpose. Information about technical options to consider is given in Mallet [2002].

3.3.3 Attributes

Attributes are the factors that are used to distinguish between options. A range of attributes is needed that reflect the concerns of the stakeholders. Different stakeholders may see some attributes as more or less important than others. This information reflects their preferences, and it can be a valuable record.

Examples of attributes are: health risks to the public and to workers, impacts on ecosystems, effects on natural resources, the technical difficulty of implementing the options and the degree of experience with the option (and any associated uncertainty). Another important attribute is cost. Cost should always be included as an attribute, but it is helpful to consider this attribute separately from others. This can be done by comparing the options on all attributes except costs, and examining the costs afterwards (see Section 5.5).

3.4 PRINCIPLE 4: IMMEDIATE ACTION

Site owners/operators should take measures immediately to monitor and control all known (or suspected) contamination and continue such measures until an acceptable management option has been identified and implemented.

3.4.1 Requirements

Legal and regulatory requirements, backed up by HSE guidance, require this principle to be applied at nuclear-licensed sites (see Appendix A). At non-licensed defence sites, monitoring and control actions are required if contamination has been identified or is suspected (see Appendix B).

3.4.2 Types of Action

The type of action taken depends on the scale, nature and complexity of the contamination. Different measures may be needed for different areas. Where the contamination is widespread or historic it is most likely that monitoring and an interim control measure should be implemented, perhaps to persist for some time before a long-term management option is selected. For situations such as spills or other incidents immediate clean up is often preferable. For sites with several different areas of contamination it will be necessary to prioritise them, but low risks should not be used as an argument not to take prompt action to control and monitor contamination. Risk assessment is a useful tool in such cases, and guidance is provided in Smith [2002]. No short-term action should be taken that could compromise the selection and implementation of the best long-term management option.

3.4.3 Relationship to Other Key Principles

In taking immediate monitoring and control measures, site owners/operators should have regard to Principle 1 (see Section 3.1) and when measures are in place they should make records of what has been done and why (Principle 5, see Section 3.5). It is not necessary to involve stakeholders in decisions on immediate action (Principle 2, see Section 3.2) but it is desirable to inform them about what has occurred. Principle 3 (see Section 3.3) applies to identifying the management option that is to be implemented in the longer term, which may be a continuation of the initial monitoring and control measures. It will often be appropriate to apply Principle 4 during site characterisation, whereas Principle 3 applies when some characterisation has been performed.

3.5 PRINCIPLE 5: RECORD-KEEPING

Site owners/operators should make comprehensive records of the nature and extent of contamination, the process of deciding on the management option for the contaminated land and the findings during the implementation and validation of the option. All records should be kept and updated as necessary.

3.5.1 General

Most stakeholders involved in the SAFEGROUNDS consultation are in favour of the long-term keeping of records by public bodies, in a form that is accessible to the public. At present there is no mechanism for this, but SAFEGROUNDS is advocating that one be devised [CIRIA, 2002]. Site owners and operators should ensure that comprehensive records are made, bearing in mind that a mechanism may be introduced in the future. Every effort should be made to avoid relying on commercial confidentiality or national security as reasons for denying the public access to records.

3.5.2 Information to Retain

Records should cover all site characterisation work, the process of deciding how to manage the contaminated land, implementing the chosen option and validating its implementation, as well as interaction with stakeholders throughout the process. Other related information (e.g. records of waste disposal) should be included where possible. It is sensible to co-ordinate the production of this documentation with that of records required for other purposes, e.g. to meet NII requirements at nuclear-licensed sites. For further details for nuclear-licensed sites and defence sites see Appendices A and B, respectively.

3.5.3 Maintaining Records

Although there is no mechanism for the long-term keeping of detailed records by public bodies, various schemes are in place or under development for maintaining records about contaminated land. Local authorities and the environment agencies now maintain a register of land that has been designated as contaminated under Part IIA of EPA 90 and subsequently remediated, and of 'special sites'. A voluntary scheme has also been introduced by some land owners for non-radioactively contaminated land, in which 'Land Condition Records' are maintained that document the state of the land and that are passed on to new owners upon sale of the land. At nuclear-licensed sites records have to be kept for the duration of the licensee's 'period of responsibility' and passed on to any new licensee.

It is recommended that site owners/operators produce two copies of detailed records: one to be kept by the site owner and passed on to any new owner on sale of the land, and one to be sent to the relevant public body if a mechanism for long-term keeping of records is introduced. It is also recommended that site owners/operators produce several copies of a summary version of the records, to be held by the current owner, the current operator (if not the owner), the relevant local authority, the relevant environment agency, and any new owners of the land. In general, site owners/operators should hold records in the same manner as legal documents related to the site. If the site is to be sold and is to be cleaned up only for limited use, current owners or operators should discuss with the relevant local authority and environment agency the best way of holding all records for input to planning procedures when use changes again.

Documents should be maintained in formats that do not degrade significantly with time. Electronic records have advantages but will require periodic transfer to new systems, and holding of paper copies is advisable as well.

4 Recommended Approach for the Management of Contaminated Land

4.1 THE STRUCTURED APPROACH

Figure 1 shows the basic steps in a structured approach that will help in putting the key principles into practice. The approach is not intended to be prescriptive: there is a wide range of potential contaminated land situations and the application of the structured approach will need to be tailored to each case. The approach is primarily aimed at long-term management of contaminated land. In some cases the approach will need to be an iterative one, but in others it will be almost once-through.

General guidance on the steps of identifying the preferred option, deciding on the option to be implemented, implementation and validation are given in Sections 5-8. Further details for nuclear-licensed sites are in Appendix A and for defence sites in Appendix B. Section 4.3 below provides guidance on establishing objectives for the management of contaminated land.

As shown in Figure 1, key principles 1, 2 and 5 apply throughout the process of identifying, implementing and validating the best option (or strategy) for managing contaminated land. The extent to which stakeholders other than the site owner/operator and regulators are involved at various stages in the process will vary from site to site and should be commensurate with the technical and societal significance of the contaminated land problem (see Section 3.2.1). Principle 3 applies primarily at the stage when site owners/operators are identifying their preferred option or strategy (see Section 5), prior to actually deciding on the option to be implemented (see Section 6).

4.2 RELATIONSHIP OF THE STRUCTURED APPROACH TO THE REGULATORY REGIMES

This guidance supplements (but is independent from) current regulatory regimes. These regimes influence some of the steps in the structured approach (Figure 1). They affect how the steps are applied in practice; for example regulatory approvals are required for certain actions. Regulatory regimes also constrain the way that the approach is applied. In particular, they can constrain the choice of management options because some regulations set legal standards that must be met during the management of contaminated land.

Different regimes apply to nuclear-licensed sites and non-licensed defence sites, as described by Hill [2002]. There are also differences in the regulatory regimes for radioactive and non-radioactive contamination; these are noted throughout the guidance. It should be noted that some aspects of the regulatory regimes for contaminated land (particularly radioactive contamination) are currently under development.

The main regulatory regimes that apply to contaminated land on nuclear and defence sites are those under the Health and Safety at Work etc Act [1974] (HSWA) and associated regulations such as the Ionising Radiations Regulations (IRRs); the Nuclear Installations Act [1965] (NIA); and Part IIA of the Environmental Protection Act [1990] (EPA). The Radioactive Substances Act [1993] (RSA) is relevant but only applies to disposals of waste. MoD is not subject to RSA but has in place administrative arrangements to achieve a similar standard of control. The Water Resources Act [1991] is important if groundwater could become contaminated by non-radioactive substances.

The HSWA and NIA are applied by the HSE. RSA is administered by the Environment Agency (in England and Wales), the Scottish Environment Protection Agency (SEPA) and the Department of the Environment in Northern Ireland (referred to collectively as the environment agencies). Local authorities are the regulators for Part IIA, but the environment agencies have a key role, particularly at ‘special sites’ (see Hill, 2002, for further details). Site owners and operators should establish dialogue with these regulators at the earliest opportunity and maintain it throughout the process of identifying, implementing and validating the land management option or strategy..

Some guidance has been issued that is relevant to the application of these regimes to contaminated land on nuclear and defence sites. In particular, HSE [HSE 2001b] has published guidance to inspectors about radioactively contaminated land on nuclear-licensed sites and the Environment Agency et al. [2002b] has issued guidance on the management of radioactively contaminated land on non-licensed sites. Much guidance is available on the management of non-radioactive contaminants [Barry et al. 1996; DETR, 2000a; DETR, 2000b; Environment Agency 2000a].

Other legal and regulatory requirements will also be relevant, depending on the situation. In particular, if an option generates radioactive waste, the Radioactive Substances Act applies. If a nuclear reactor site is to be decommissioned, then it will be necessary to meet the requirements of legislation on environmental impact assessment [EIAD 1999]. Other new developments may fall within the requirements of general environmental impact assessment regulations [EIA, 1999].

It should be noted that the Part IIA regime for non-radioactively contaminated land [EPA 1990] applies only to sites in their current use (including any use for which planning permission has been granted) and only to sites that are contaminated in the sense defined in Part IIA. These are a sub-set of the sites addressed by this guidance. There are differences between what is recommended here as good practice and the

minimum likely to be required by local authorities and the environment agencies in implementing Part IIA. It is anticipated that following this good practice guidance will, in general, entail doing more than the minimum required under Part IIA.

4.3 ESTABLISHING OBJECTIVES

Setting out the objectives for the management of contaminated land is important because it helps to focus the identification of the preferred option and subsequent decision-making. The factors to be considered in establishing objectives include: government policy, corporate/organisational policy (both general and for the particular site) and the views of stakeholders such as regulators, local authorities and local people.

It is recommended that environment, health and safety objectives are established separately from those of a commercial or administrative nature. In keeping with the case-by-case approach (see Section 3.1.2), it is recommended that, in general, environment, health and safety objectives should be broad and qualitative rather than specific and numerical. Very specific objectives are unlikely to be acceptable to all stakeholders (see Section 3.1.2) and setting them constrains choices of options for comparison and is not consistent with a BPEO approach (see Section 3.3.1). Examples of objectives are given in Box 2.

Box 2 Examples of Objectives for the Management of Contaminated Land

Type of site	General objective	Environment, health and safety objective
Nuclear-licensed	Make site suitable for eventual delicensing	Comply with Principle 1
Defence	Make site suitable for sale within the next year or two	Comply with Principle 1

It should be recognised that objectives may need to be redefined as the process of identification and selection of the land management option progresses (see Figure 1). This is particularly the case if objectives have been imposed on the site owner/operator by people external to the process. Situations can be envisaged in which there are no options that will exactly meet an imposed objective, or in which the option that would be preferred on a wide range of attributes and by a wide range of stakeholders is not one that will meet an imposed objective. For example, it is possible to envisage a situation in which the relevant Minister has decided that a defence site should be cleaned up and sold within the shortest possible period of time, but the process of identifying the best option indicates that there would be considerable merit in delay. In such a case it is for MoD (and perhaps other stakeholders) to make representations to the Minister to ascertain whether the objective can be amended.

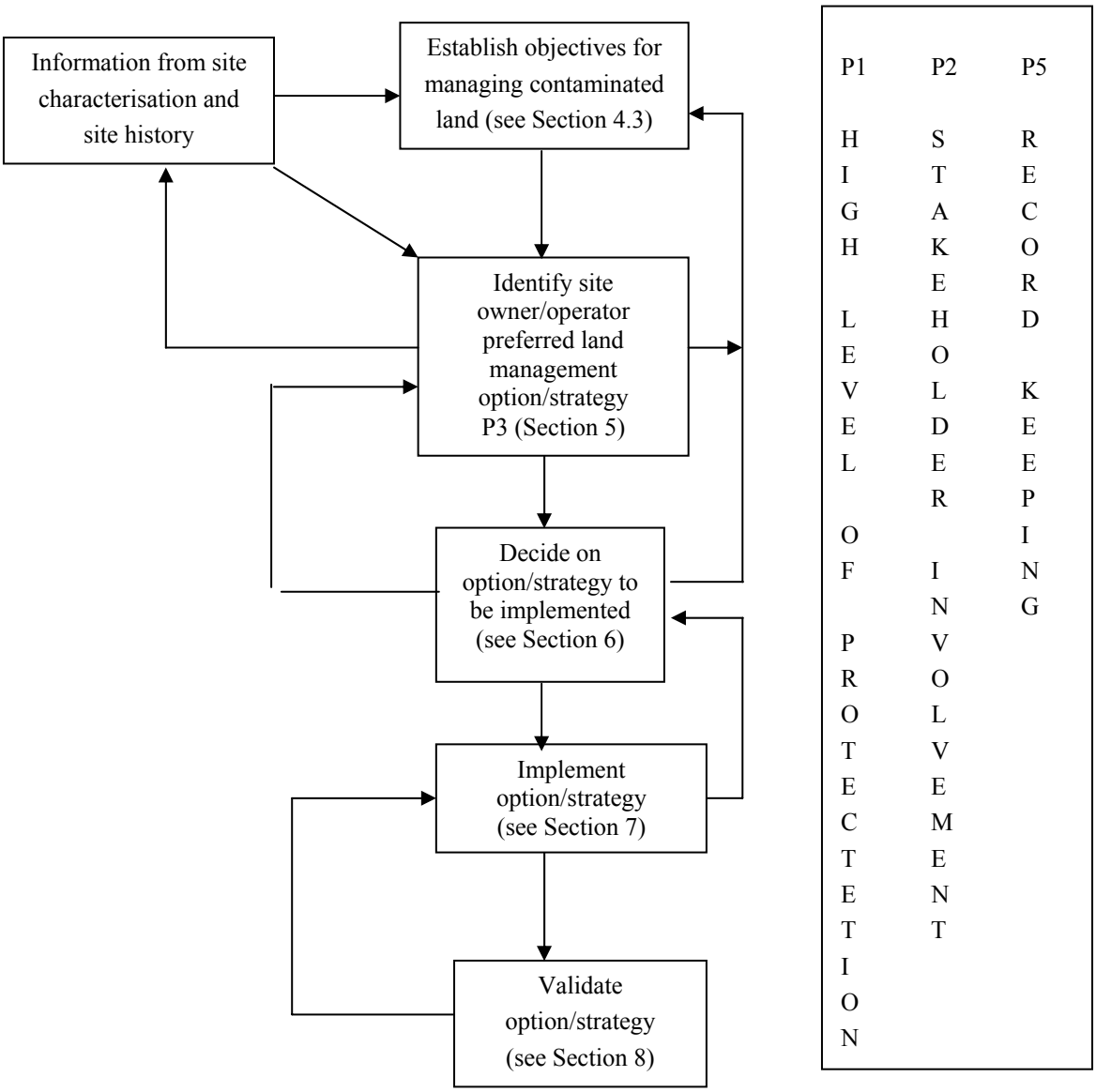
4.4 FUNDING

Appropriate funding arrangements are needed in order to deal with contaminated land,. To achieve this, estimates of the cost of the management of contaminated land should be incorporated into overall liability estimates, and sufficient provisions be made.

Fogleman [2000] discusses the general funding issues in legal terms and Finnamore et al. [2000] give guidance on managing financial risks.

The approach and sources of funding is different for nuclear and defence sites. Funding activities for nuclear-licensed sites are addressed in Appendix A. For defence sites, it is necessary to decide whether the liability will be dealt with before the land is sold, or passed on with an appropriate adjustment in the value of the land (see Appendix B).

Figure 1 Basic Steps in the Structured Approach



Note: P1, P2 etc are references to the key principles (see Section 2)

5 Identifying the Preferred Option for the Management of Contaminated Land

The recommended approach to identifying the site owner/operator's preferred option is shown in Figure 2. Sections 5.1 – 5.5 describe the general application of this approach. Issues specific to nuclear-licensed sites are dealt with in Appendix A, and defence sites are addressed in Appendix B. This part of the guidance is particularly important for identification of long-term management options. Its essence is compliance with key principle 3 (see Sections 2 and 3.3).

The length and complexity of the steps within the approach varies with the scale of the contamination and the information available. The length of the identification process could range from a few days to a few months, and the length of the documentation produced could range from a few pages to a large report. The extent of stakeholder involvement will depend on the technical and societal significance of the problem (see Section 3.2) and will be a major factor in determining how long the identification process takes. Although all possible options are to be assessed (see Section 5.2), many will be eliminated at an early stage and only a few need be compared on the basis of their health, safety and environmental impacts and various technical and social factors (see Section 5.3). The comparison may be qualitative or largely quantitative (see Sections 5.4 and 5.5). Its outcome may or may not be clear cut. The important point is that the comparison is done and that it provides a useful input to decision-making (see Sections 5.6 and 6).

5.1 INFORMATION AVAILABLE FROM CHARACTERISATION OF THE SITE

It is assumed that the site has been characterised to some extent and that contamination has been found or is suspected to be present. The available information about the characteristics of the site and the contamination should be gathered together at the outset and communicated to those stakeholders who will be participating in the process of identifying the preferred option.

Guidance has been developed in SAFEGROUNDS for the characterisation of contaminated land [Baker et al. 2000]. If considerable site characterisation work has been performed, the information available will cover the types, quantities and locations of all substantial areas of contamination. In addition, a conceptual model of the contaminated region will be available. A risk assessment will be available for non-radioactive contamination, and may also be available for radioactive contamination. If more detailed risk assessments are required at this stage, the methods outlined by Smith [2002] can be used. Low estimated risks should not be used as a reason for not considering the long-term management options for the contamination.

The information may be associated with contamination in a single location. Account should be taken of other potential areas of contamination on the same site, as well as the possibility of contaminant migration from the known sources, when deciding how best to manage it [DOE, 1995]. Such interdependencies should be addressed in an overall strategy for the management of all contaminated land on a site, although different solutions may be appropriate for different areas of contamination.

If only limited site characterisation has been carried out (e.g. a reconnaissance survey , or an examination of the site history) much less information will be available. Lack of full information need not hold up the process of identifying the preferred option. It is not essential to have very detailed information to make a preliminary identification, especially where the overall strategy for the whole site is being considered. If it becomes apparent during the option identification process that more information is required, it may be necessary to return to the stage of establishing objectives (see Figure 1).

5.2 IDENTIFICATION OF ALL THE ENVISAGEABLE OPTIONS

The 'envisageable' options are all those that would be effective in reducing or limiting the risks to people and the environment from the contaminated land in question. In compiling the list of envisageable options it is good practice to take no account of the financial cost or technical difficulty of options, or of factors such as the R&D that would be required before an option could be implemented at the specific site. It is more transparent to consider such factors in the later stages of the process of identifying the preferred option. Those stakeholders who are participating in the process should be involved in identifying the envisageable options.

Information about typical technical options to consider is given by Mallett [2002]. These fall into the following basic categories:

- partial or complete removal or destruction of the contamination,
- immobilisation or stabilisation of the contamination, and
- isolation and containment of the contaminated ground.

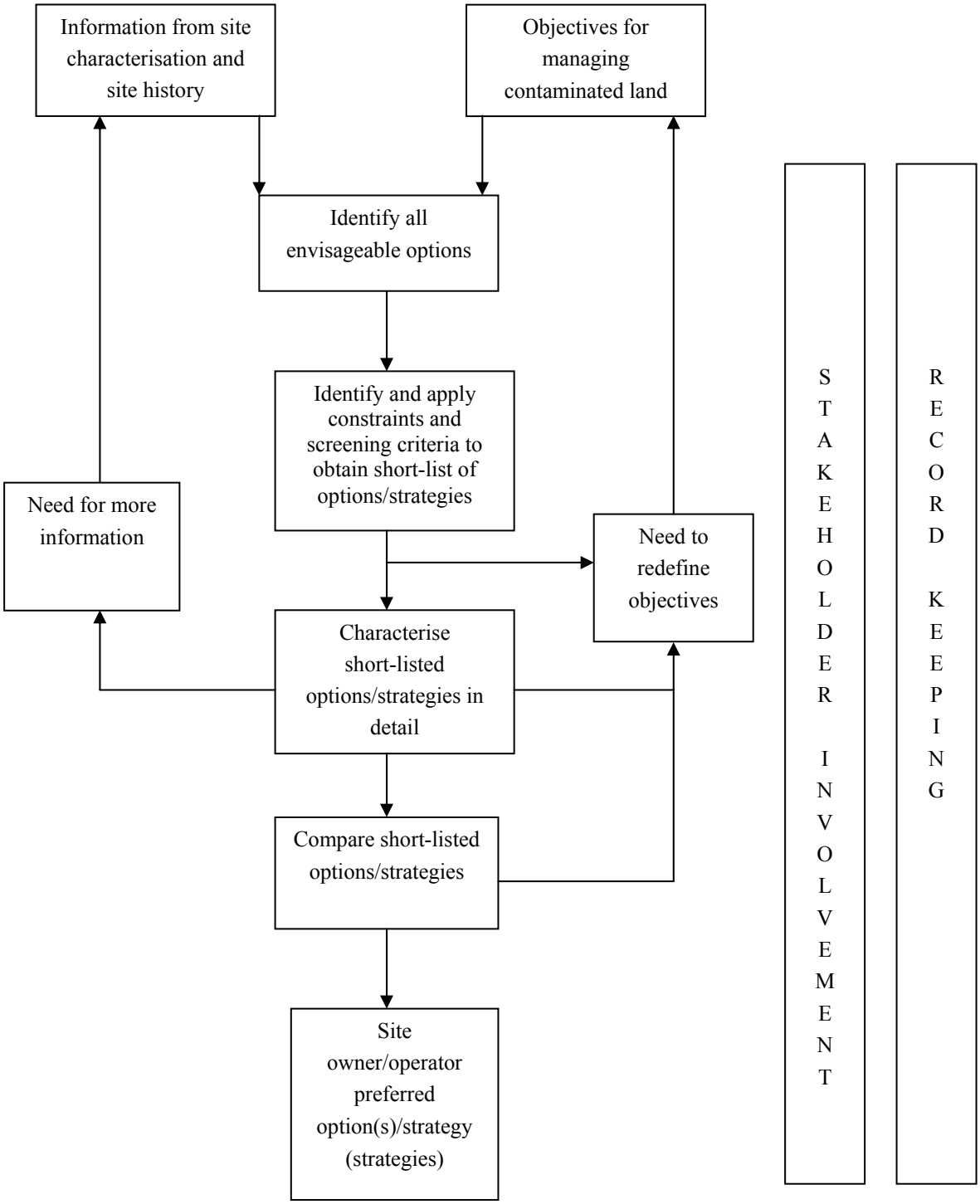
In terms of the 'source-pathway-receptor' approach, the first two categories affect the source, while the third category affects the pathways. If the focus is on an overall strategy for a site on which there are several areas with different types or different degrees of contamination, it is not appropriate to go into great detail for each one. This is particularly the case if site characterisation has been limited. In such instances it may not be worthwhile going much beyond the three basic categories when identifying envisageable options.

As well as considering different technical mechanisms for managing the contamination, it is important that an appropriate range of end uses of the site is considered. This is associated with the principle to protect people and the environment in the future (see Section 3.1.3). Options that involve similar actions but allow greater or lesser scope in the end use of the site should be considered separately.

The list may include options that do not involve any further active management of the contamination, to ensure that the full range of actions is covered. The timing of the implementation of an option is also an important factor. Where appropriate, the options considered should include those that use a period of time to reduce the concentrations of contaminants, by mechanisms like radioactive decay and biodegradation.

When identifying envisageable strategies for a whole site it is not necessary to consider large numbers of combinations of technical mechanisms, scopes for end uses and timings for each contaminated area. The aim should be only to identify sufficient strategies to encompass the range of possibilities. The details for each area can be addressed later, when the broad strategy has been agreed.

Figure 2 Steps in Identification of Preferred Option/Strategy



The outcome of this stage of the process will be a list of the envisageable options or strategies for managing the contaminated land, with a brief description of each one. The description need only be sufficient for the screening of options (see Section 5.3) and could be only a few sentences. There should also be a list of the options or strategies that have been rejected as ineffective.

The number of options or strategies that are envisageable depends on the nature of the contamination and the characteristics of the land. If the list is long (say ten options/strategies or more), then it is sensible to reduce it to make the comparison of options or strategies manageable. Whatever the length of the list, it is essential to eliminate those options/strategies that would not meet legal and other immutable constraints, and those that would not meet agreed screening criteria. This is done in the next stage (see Section 5.3).

5.3 IDENTIFICATION AND APPLICATION OF CONSTRAINTS AND SCREENING CRITERIA

Constraints and screening criteria should be identified using key principles, the objectives for the management of the contaminated land, legal requirements, regulatory guidance and stakeholders' views. They should not be ambiguous and each should relate to a set of issues that do not overlap. Examples of constraints and screening criteria are:

- legal and regulatory limits and constraints (e.g. dose limits [IRR, 1999], authorised limits on discharges, limits on storage of hazardous substances);
- non-availability of long-term management arrangements for wastes (e.g. no storage facility or disposal route);
- major conflict with land management objectives (e.g. immature technology that will not be available on a suitable timescale; scope for end use of site not consistent with local authority development plans, so planning permission unlikely to be granted).

Financial costs should not be used as screening criteria unless participating stakeholders agree to this.

The outcome of this stage of the process should ideally be a few options or strategies that are to be compared in detail (see Section 5.4). RCEP [1988] suggests that it is usually enough to compare between three and six options, but the exact number will depend on the situation.. In principle, it is possible that application of constraints and screening criteria will leave only one option but in practice there are usually at least two. If too many options remain after screening, similar ones should be combined.

Information to be recorded includes the reasoning and justification for retaining or rejecting options, and relevant supporting information.

5.4 IDENTIFICATION OF ATTRIBUTES AND DETAILED CHARACTERISATION OF OPTIONS

The remaining options need to be compared on a common basis. This is done using the key issues, expressed as 'attributes'. A list of attributes should be drawn up, documented and reviewed; participating stakeholders should be involved. The number and detail of the attributes should reflect the extent of the problem and the issues of

concern, but it should be recognised that a large number of attributes can make it difficult to compare options and identify differences between them. It is best to consider less than ten main attributes, with sub-attributes as necessary. If a large number of attributes is identified initially, it will usually be possible to reduce the number by excluding those that do not differentiate significantly between options.

Attributes are dependent on the particular contaminated land situation being considered. They should be identified by considering the issues of concern to all stakeholders and be clearly documented. The list should include attributes related to:

- impacts on human health;
- impacts on the environment;
- the technical performance of the option;
- social and political factors; and
- financial cost.

Attributes should not overlap (i.e. no two should cover the same issue, although they can be closely related – e.g. public radiation dose and occupational radiation dose). It is also useful to indicate what is 'good' and 'poor' performance for the attributes in their naming (e.g. 'low off-site discharges' is more meaningful than 'off-site discharges'). As far as possible, attributes should be at a similar level of detail. The assessment can become biased if there are many attributes concerned with one type of issue, e.g. if there are 10 'technical' attributes and only two related to human health. The degree of compliance with the 'precautionary principle' should be included as a social/political factor.

Some attributes may be readily quantifiable (e.g. cost), whereas others may not (e.g. social impacts). It is not necessary for all attributes to be quantifiable, as the comparison of options can be on a qualitative basis. However, it is useful if there is a 'yardstick' for each attribute, against which the performance of options can be unambiguously measured.

Information that characterises each option in terms of the attributes should be gathered and documented. This is used to give a sound, factual, basis when comparing them. Quantitative, semi-quantitative and qualitative information can be used. An important part of option characterisation is a health and environmental risk assessment (see Smith [2002]. Special attention should be given to characteristics of options that are strongly associated with the type of contamination present. For example, some options may be very effective for some of the contaminants that are present but less effective for others. It is not essential to make detailed estimates of the financial costs of options at this stage; broad-brush cost estimates will be sufficient. Detailed analyses of financial risks are best used in later stages of decision-making (see Section 6).

Participating stakeholders should either be involved in the detailed characterisation of options (including risk assessments) or be invited to review the option characterisation methods and results, if possible before options are compared.

5.5 COMPARISON OF OPTIONS

The systematic evaluation of the performance of each option for the selected attributes allows the options to be compared on a common basis. The information gained is used

to identify the preferred option or options. It may show that one option is clearly the best, or that there are several 'best' options that cannot easily be distinguished. It could also show that the process needs to be repeated in greater detail, because important uncertainties remain. The comparison of options should be well documented, in such a way that it provides the clearest possible input to the later stages of decision-making.

The key points when comparing options are:

- the method should be systematic, open and transparent;
- the performance of each option should be considered for each attribute;
- the performance of different options should be compared; and
- the robustness of the analysis should be tested.

Various methods can be used to compare systematically the options, depending on the complexity of the problem. These can range from a simple structured discussion of the pros and cons of each option, to detailed techniques such as multi-attribute decision analysis (MADA). The techniques can use qualitative and quantitative information – quantitative data are not necessarily the more 'accurate'.

A simple analysis of the information characterising the options may reveal that one option is obviously the best. If there is no clear best option, or if a more detailed analysis is required because of the scale of the problem, options can be scored or ranked. If even further detail is warranted, weighting factors can be applied to the attributes and weighted scores or ranks compared. If the intention is to reflect the intrinsic importance of the attributes, the weighting factors should be established before the options are scored or ranked. Weighting factors are very difficult to determine and can be contentious. It is often necessary to use several sets of weighting factors so as to reflect the range of views of participating stakeholders, or to present non-participating stakeholders with enough information about the implications of judgements about the relative importance of the various attributes. The sensitivity of results to variations in scores and weighting factors can also be examined to investigate the robustness of the analysis. An illustration of different levels of detail in which this method can be applied is given in Box 3.

Particularly when using detailed scoring and weighting, it is recommended that the comparison of options be done in two parts:

i) comparison on the basis of aggregated scores on all attributes except financial cost;

ii) comparison on the basis of aggregated scores on all attributes including financial cost.

The reason for this is that the weighting given to financial cost is likely to be the most contentious. Splitting the analysis means that it is possible to present the results in terms of both the 'best environmental option' and the 'best practicable environmental option'. This is likely to provide a more useful input to later stages of decision-making. In particular, if there are no fixed budget limits, it could allow discussions to take place on the basis of whether the 'best environmental option' is affordable. This may be a better way to reach agreement amongst a range of stakeholders than beginning with costs included.

Box 3 Approaches to comparing options in different levels of detail

Method 1: Reasoned Argument

Option A is the immediate removal of all contamination. It is simple, cheap, does not generate significant volumes of waste and does not impact on the operation of the site. For the small patch of contamination being considered, it is the best.

Method 2: Scoring and Ranking Options

Attribute	Option A	Option B	Option C
1	Good	Average	Average
2	Poor	Very Good	Average
3	Average	Very Good	Average
Rank	Third	First	Second

Option B seems best, being at least 'average' and at best 'very good'

Method 3: Detailed Scoring, Weighting and Ranking

(scores are on a scale of 1 – 5 with 5 being best).

Attribute	Weight (1-10)	Option A	Option B	Option C
1	10	4	2	3
2	1	2	5	3
3	3	3	5	3
Score		9	12	9
Rank		2=	1	2=
Weighted Score		51	40	42
Weighted Rank		1	3	2

Option B seems best if attributes are not weighted for their relative importance. However, if they are weighted (with a particular viewpoint), Option A is clearly best.

5.6 OUTCOME OF THE PROCESS

Although this whole section is entitled 'identification of the preferred option, it will be evident from Section 5.5 that the outcome of a comparison of options can be far from clear-cut. There will be instances where two or more options/strategies appear to be equally attractive on a balance of the attributes, or where the preference order depends strongly on how the attributes are weighted and it is not possible to reach agreement amongst participating stakeholders as to which set of weighting factors is most

appropriate. All these outcomes provide useful input to the decision on the option/strategy to be implemented (see Section 6).

6 Deciding on the Option to be Implemented

The approach to deciding on the option to be implemented is shown in general terms in Figure 3 and discussed below. Figure 3 is intended to be descriptive rather than prescriptive: it is a framework for giving guidance on some aspects not a recipe to be followed. Issues specific to nuclear-licensed sites are addressed in Appendix A and those specific to defence sites in Appendix B. The key principles that apply during decision-making are 1, 2 and 5.

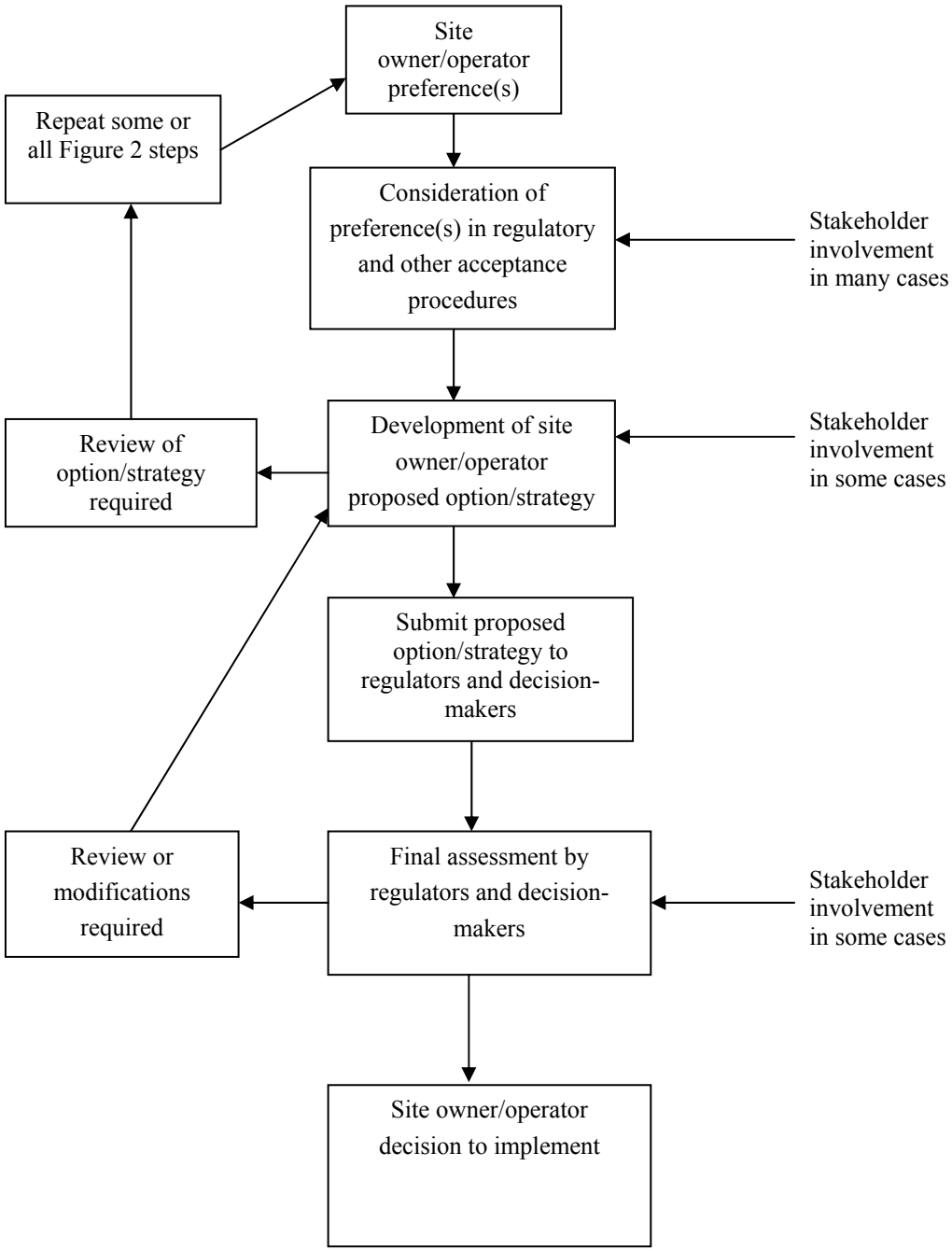
The emphasis in this section is on decisions about long-term management options and strategies. The length and complexity of the various steps depends on the scale of the contaminated land problem and on the outcome of the previous stage of identifying the preferred option/strategy (see Section 5). They also depend on whether the immediate objective is to actually decide on the option or strategy to be implemented or to reach agreement in principle, for the purposes of financial and other planning for the site.

6.1 CONSIDERATION OF THE SITE OWNER'S/OPERATOR'S PREFERRED OPTION(S)

Figure 3 shows consideration of the site owner's/operator's preferred option(s) or strategy (strategies) in regulatory and other acceptance procedures as the first step in deciding on the option to be implemented. The procedures that are relevant depend on the nature of the site and could be (see also Appendices A and B):

- those under EIAD 99 (for reactor sites being decommissioned)
- those under EIA 99 (for sites where the proposed development requires planning permission within the Town and Country Planning regime)
- part of periodic reviews by NII (in consultation with the relevant environment agency) of decommissioning strategies for each nuclear-licensed site (for reactor sites not yet being decommissioned, and non-reactor sites)
- those under Part IIA (non-radioactively contaminated land)
- procedures put in place by the site owner/operator organisation (e.g. by MoD at defence sites).

Figure 3 Steps in Deciding on the Option/Strategy to be Implemented



Most of these procedures involve consultations with stakeholders outside the site owner/operator organisation. These range from the formal public consultations required by EIAD 99 and EIA 99 to informal consultations with regulators as part of site owner/operator procedures. At nuclear-licensed sites the consultations about contaminated land will often only be part of larger consultations on decommissioning plans (see Appendix A).

It is for site owners/operators to decide how they wish to present the outcome of the identification of their preferred option (see Section 5) within these consultations. If there is one option/strategy that is clearly preferred then the documentation of the identification of this option could be presented as it stands. If there is no clear preference, then the site owner/operator may wish to leave the matter open and request views, or to select one option and explain why, appending the documentation on the identification process. In the latter case the reasoning may include factors not considered in the option comparison (e.g. a detailed analysis of financial risks) and/or the site owner's/operator's explicit views on the most appropriate weights for attributes.

6.2 DEVELOPMENT OF THE SITE OWNER'S/OPERATOR'S PROPOSED OPTION

In this step the site owner/operator who put forward the preferred option(s) considers the views expressed by other stakeholders and uses these views to establish the option that they wish to implement. They may or may not consult other stakeholders (e.g. they may wish to consult regulators, and perhaps local authorities).

Depending on the views expressed in consideration of the preferred option (Section 6.1), developing the proposed option may involve a return to the preferred option identification stage (Section 5). If the option is to be implemented soon, there should be no return to option identification unless further information has come forward that would substantially affect the comparison of options, or introduce an option not previously considered at all. If the option/strategy is not to be implemented for some considerable time, then the development of the proposed option/strategy may be a long process. In such cases it is sensible to revisit the identification of the preferred option/strategy in the light of changed circumstances (e.g. policy changes, technical advances, changes in societal views).

It is important to be open and transparent when developing the proposed option and to document fully what is done. It is good practice to make documentation publicly available.

6.3 SUBMISSION OF THE PROPOSED OPTION

In this step the proposed option/strategy is formally submitted to regulators and decision-makers for approval to implement. At nuclear-licensed sites the submissions for radioactively contaminated land are to NII (with an implementation safety case) and to the relevant environment agency (if authorisations are required to dispose of radioactive wastes); submissions for non-radioactively contaminated land will be to the relevant environment agency (see Appendix A). At defence sites submissions may be only to internal MoD regulatory departments. Submissions to decision-makers (e.g. government funding departments, government Ministers, boards of directors) may be made in parallel or in series with those to regulators. It may also be necessary to

resubmit planning applications. For land designated as 'special sites' under Part IIA copies of submissions should also go to local authorities as designators of such land.

Much of the documentation associated with this step is likely to be in the public domain but some may not be. A special case occurs if a Public Inquiry has been called. In such cases the proposed option is submitted to the Inquiry and regulatory submissions are usually made afterwards, when the result of the Inquiry is known.

6.4 FINAL REGULATORY AND DECISION-MAKER ASSESSMENT

At this step stakeholder involvement is out of the hands of the site owner/operator, as is release of information into the public domain. Some regulatory assessments entail public consultations (e.g. assessments of RSA authorisation submissions) and most documentation will be publicly available in the event of a Public Inquiry.

If this guidance has been followed, the outcome of this last step is likely to be approval for the preferred option/strategy or a requirement for small modifications. In rare cases major modifications may be required or the option/strategy may be completely rejected, prompting a return to the preferred option identification stage (see Section 5).

7 Implementing the Chosen Management Option

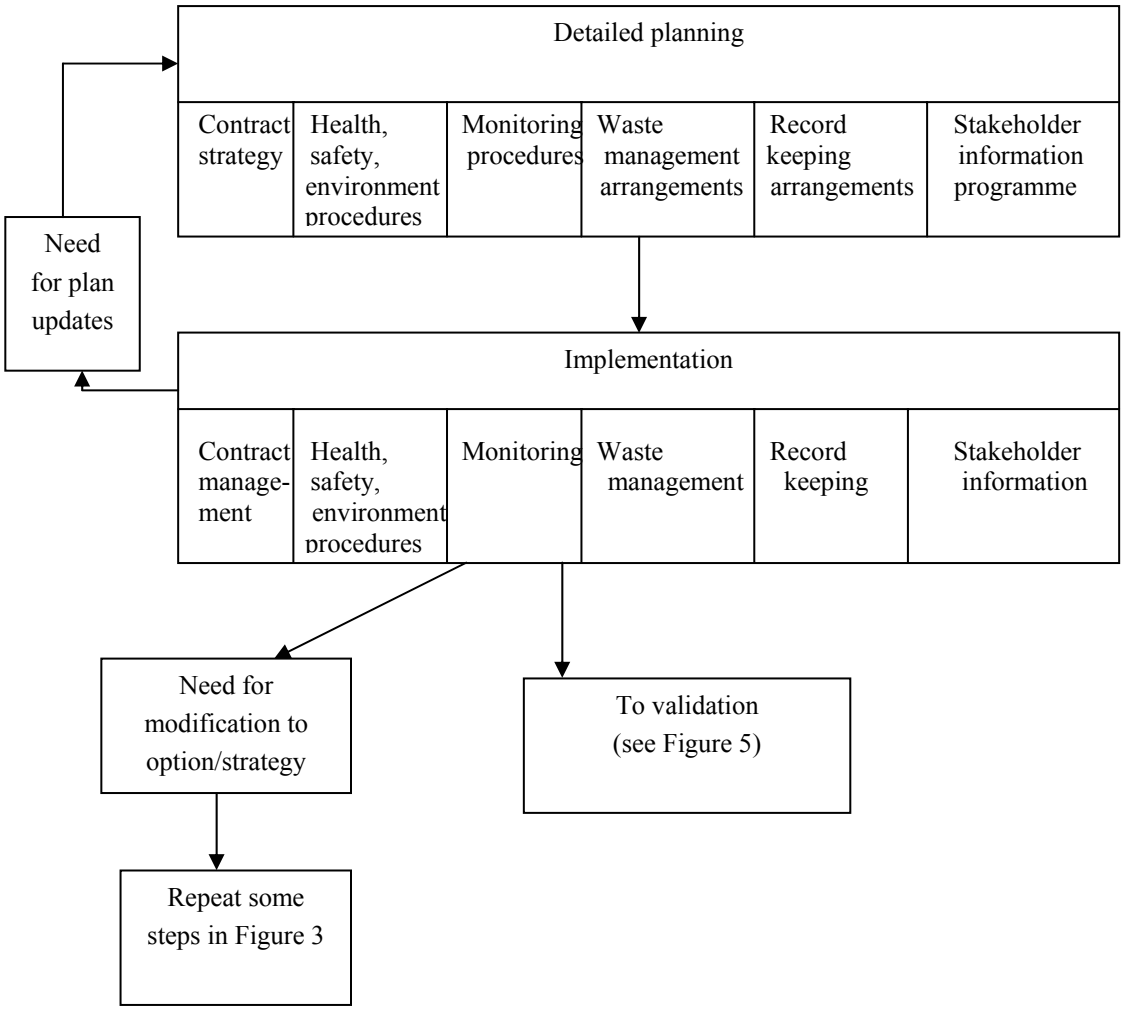
The steps in implementing the chosen management option are shown in Figure 4 and are discussed in turn below. The most important key principles during implementation are principles 1, 2 and 5. Principle 1 underlies everything that is done and is applied particularly through appropriate operational health, safety and environmental protection procedures (see Section 7.4). Compliance with principle 2 entails reporting on progress and plans (see Section 7.5). Compliance with principle 5 means that records should be kept throughout implementation (see Section 7.6).

7.1 PLANNING THE IMPLEMENTATION

Detailed planning of the practical implementation of the option should be completed before work starts. Planning is especially important for large projects and those that take place on large or complex sites. Much guidance is available on this topic, for example Harris et al. [1995], Barry et al. [1996], DETR [2000a], EA [2000a] and HSE [1999]. This section is only concerned with issues within the scope of the guidance.

The planning should develop a systematic approach to implementing the chosen option ('who, where, what and when') using appropriate procedures. Issues to consider include the interdependence of the option with other activities on the site, the staffing and their roles and responsibilities, financial resources, waste management routes and contingencies. Performance measures, such as residual contaminant concentrations, should be made clear, as should quality assurance indicators that demonstrate that procedures were followed.

Figure 4 Steps in Implementation of the Selected Option/Strategy



Contingency measures should be specified (e.g. if contamination is found to be more extensive or at higher concentrations than expected), if necessary on the basis of a risk assessment (which should be separate from assessments undertaken in the identification of the preferred option, although it may draw on them).

Waste management is likely to be a very important consideration if large quantities of contaminated material are to be excavated. Non-radioactive contaminated material in solid form will need to be disposed of at an appropriate landfill (municipal, inert or hazardous waste landfill). Depending on its characteristics, current options for the management of solid radioactive waste are disposal to municipal landfills under 'Exemption Orders', disposal to specified landfills under the 'Controlled Burial' regime, disposal to the UK national facility at Drigg, or storage (see HSE [2001b], Environment Agency [2002b]). Waste could also be disposed of on-site, if an authorisation is held under RSA. The route available is largely dependent on the radionuclide concentrations, although the volume may also be a significant factor. The requirements for waste management should have been considered in the choice of land management option. At the planning stage the arrangements for their use should be put in place; it should be noted that this may take some time (many months for disposals to Drigg).

The documented plan will provide a specification for the site owner/operator or contractor to implement the option. If contractors are used, they can also assist in the planning stage. It is recommended that external stakeholders are kept informed about the plans that are being developed (see Principle 2).

7.2 CONTRACTUAL STRATEGY AND CONTRACT MANAGEMENT

Guidance on contract strategy is primarily required for defence sites and is discussed in further detail in Appendix B. For these sites the contract is a key document that describes the responsibilities and methods to be applied. The planning stage should address the requirements and roles and responsibilities of contractors and others in the implementation of the option. It is important to agree contingencies should the contamination be found to be more significant than expected. The contract should also address health and safety requirements, specific targets and monitoring requirements. Adversarial forms of contract should be avoided. Hold points and milestones will help to ensure that the implementation of the option is undertaken in a stepwise way and that key stages of the plan are met on time and completed satisfactorily.

7.3 MONITORING

A sampling, monitoring and testing programme will be required during the implementation of the chosen option. For example it will be necessary to ensure that any imported materials conform to specifications, and to sentence any extracted material. The monitoring and collection of samples during the implementation of the option will also provide important data for the validation phase of the management of the contaminated land. The SAFEGROUNDS Site Characterisation Guidance identifies the main elements of a monitoring programme [Baker et al. 2000], as well as referring to supporting guidance.

Within the monitoring programme, instrumentation and its detection limits should be specified. Prior to commencement, the monitoring instruments should be checked and calibrated. (This is a requirement under the IRRs for radiological instruments.) The

areas and volumes over which measurements are averaged should be specified and documented.. The monitoring can be carried out by those implementing the chosen option (e.g. the site owner and/or the contractor) or by an independent organisation.

The regulatory organisations have sponsored a number of pieces of work to assist them in assessing proposed monitoring programmes [HSE and EA refs to be added]. These may also be useful to site owners/operators and contractors.

7.4 OPERATIONAL HEALTH, SAFETY AND ENVIRONMENTAL PROTECTION

All actions must be carried out in conformance with regulations under the Health and Safety at Work etc Act. These include the IRRs, COSHH and CDM. Nuclear-licensed sites will have operational procedures in place that should cover all of the requirements of relevant regulations. At defence sites it may be necessary to establish suitable procedures. A Radiation Protection Advisor (RPA) should be engaged for this purpose and any other RPAs that have been involved should be consulted. Additional guidance is available from Barry et al. [1996], Harris et al. [1995], HSE [2001b], HSE [1999a] and HSE [1991].

Environmental protection should be considered. Regimes for environmental protection will already be established at nuclear-licensed sites. For other sites, guidance on objectives and methods is available from Harris et al. [1995], for example.

7.5 REPORTING PROGRESS, UPDATING PLANS

It is good practice to keep external stakeholders, particularly local authorities and local people, informed of progress during implementation of major contaminated land operations. At nuclear-licensed sites regular progress reports to Local Liaison Committees provide a means of doing this. At defence sites special mechanisms may need to be devised. Progress reporting should include any changes to implementation plans, or to the option being implemented. Option modifications may be required as a result of what is found during implementation or, if the implementation period is long, because of changes in circumstances.

7.6 RECORD KEEPING

Records are best kept throughout the process of implementing the option, not completed retrospectively at the end. Relevant records are likely to include surveys, working methods and other operational records. Important information includes residual contaminant concentrations and distribution, any groundwater contamination, the physical characteristics of the site, the quantity and characteristics of any waste that was removed and any ongoing requirements (for monitoring, etc). It is important to record any deviation from the planned implementation of the option. These records form key quality assurance documentation. Guidance on quality assurance in relation to contaminated land is presented in DOE [1997].

8 Validating What has Been Done

The purpose of validation is to check that the management option for the contaminated land has been implemented correctly, so that it will achieve the desired high level of protection of people and the environment (principle 1, Section 2). The steps involved are shown in Figure 5. The first two steps are the carrying out of monitoring and surveys (see Section 8.1) and the evaluation of the results of these (see Section 8.2). These results should be communicated to stakeholders, some of whom will be involved in deciding whether the option has been implemented correctly (principle 2). Records should be kept of all validation activities (principle 5 and see Section 8.3).

8.1 MONITORING AND SURVEYS

Monitoring is usually required after the option has been implemented as well as during it. There are specific requirements for monitoring at nuclear-licensed sites. At defence sites MoD has to be satisfied that work is completed in accordance with contractual conditions. Completion surveys and independent monitoring can be required by regulators, for example in order to discharge a planning condition, or surrender a Pollution Prevention and Control permit (which has replaced waste management licensing). In some circumstances there will be a need for third party independent monitoring under the conditions of a contract for the implementation of the option, or because it has been agreed with stakeholders that this will be done.

A description of typical of monitoring, planning and requirements is given in Harris et al. [1995], and approaches are recommended in EA [2000a]. Guidance in Baker et al. [2000] is also relevant. The post-implementation monitoring should make use of, and be consistent with, the approach used during implementation if possible. It is good practice to keep stakeholders informed throughout the process.

8.2 EVALUATION OF RESULTS

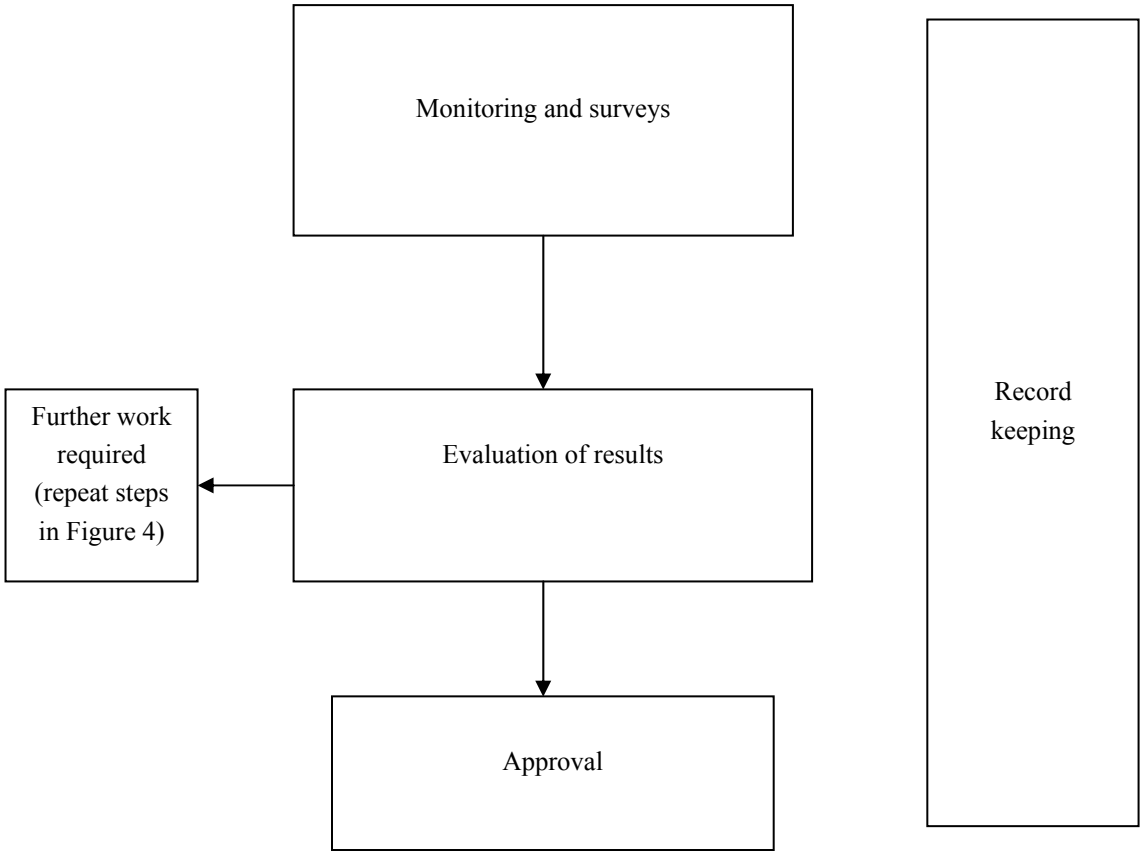
The results of validation monitoring and surveys will be evaluated by the site owner/operator, regulators and perhaps by other stakeholders. The outcome could be agreement that the option has been fully and correctly implemented, or a requirement for further implementation work. The Land Quality Assessment described in Part IIA guidance is a useful reference to determine that the state of the site meets the intended objectives.

8.3 RECORD KEEPING

It is particularly important to keep records of validation monitoring and surveys and of the evaluation of results. While each organisation involved (site owner/operator, regulators, independent monitoring organisations) will need to keep their own records, it is recommended that one organisation takes the responsibility for holding a complete set. It will usually be most appropriate for site owners/operators to do this and to

include material about regulatory and independent validation in their own summary records (see Section 3.5.3).

Figure 5 Steps in Validation



9 References

Baker A J, Darwin C J, Jefferies N L, Towler P A and Wade D L (2000). Best Practice Guidance for Site Characterisation. A report from the SAFEGROUNDS Learning Network. CIRIA, London. See www.safegrounds.com

Barry D L, Steeds J and Shephard E (1996). Safe Working Practices on Contaminated Sites. CIRIA Report 132. CIRIA, London.

CIRIA (2002). Report on progress with advocacy issues. See www.safegrounds.com.

Collier D (2002). Community Stakeholder Involvement in the Management of Contaminated Land. A paper from the SAFEGROUNDS Learning Network. See www.safegrounds.com.

Department of the Environment (1997). Quality Assurance in Environmental Consultancy - Contaminated Land Report 12. Department of the Environment, London.

Department of the Environment (1995). Prioritisation and Categorisation Procedure for Sites that may be Contaminated - Contaminated Land Report 6. Department of the Environment, London.

Department of the Environment, Transport and the Regions (2000a). Model Procedures for the Management of Contaminated Land. Research Report No. 11. Department of the Environment, Transport and the Regions, London (in press).

Department of the Environment, Transport and the Regions (2000b). Contaminated Land – Environmental Protection Act 1990: Part IIA. DETR Circular 02/2000/ Department of the Environment, Transport and the Regions, London.

Department for Trade and Industry (2002). Managing the Nuclear Legacy. Cm 5552. London, DTI.

Department for Transport, Local Government and the Regions (2002). Development on Land Affected by Contamination. Consultation Paper on Draft Planning Technical Guidance. DTLR, London.

Environment Agency (2002a). Assessment of Risks to Human Health from Land Contamination: An Overview of the Development of Soil Guideline Values and Related Research. R&D Publication CLR7. Environment Agency and DEFRA. (See also the other related publications listed at * at the end of this section.)

Environment Agency (2002b). Guidance on the Characterisation and Remediation of Radioactively Contaminated Land. Environment Agency, Bristol. See www.environment-agency.gov.uk.

Environment Agency (2001). BNFL Sellafield RSA 93 Authorisation Review Consultation Documents (available from project.sellafield@environment-agency.gov.uk).

Environment Agency (2000a). Guidance for the Safe Development of Housing on Land Affected by Contamination. R&D Publication 66, Environment Agency, Bristol.

Environment Agency (2000b). Technical Support Material for the Regulation of Radioactively Contaminated Land. R&D Technical Report P307. Environment Agency, Bristol.

Environment Agency (2000c). Land Contamination, Technical Guidance on Special Sites, MOD Land. R&D Report P5. 042/TR/01.

Environment Agency (1999). Methodology for the Derivation of Remedial Targets for Sol and Groundwater to Protect Water Resources, R&D Publication 20. Environment Agency, Bristol.

Environment Agency (1997). Best Practicable Environmental Option Assessments for Integrated Pollution Control. Technical Guidance Note (Environmental) E1.

Finnamore J R, Denton B and Nathanail C P (2000). Land contamination - management of financial risk. CIRIA Publication C545. CIRIA, London.

Fogleman V M (2000). Contaminated Land Liability Issues: a legal perspective. *J. Rad. Prot.* **20** p301 – 314 .

Harris M R, Herbert S R and Smith M A (1995). Remedial Treatment for Contaminated Land. Volumes I-XII. Special Publication 101 – 112. CIRIA, London.

Health and Safety Executive (2001a). Safety Assessment Principles for Nuclear Plants http://www.hse.gov.uk/nsd/saps.htm

Health and Safety Executive (2001b). Guidance for Inspectors on the Management of Radioactive Materials and Radioactive Waste on Nuclear Licensed Sites. Nuclear Safety Directorate of HSE, 13 March 2001. See www.hse.gov.uk/nsd.

Health and Safety Executive (2001c). Guidance for Inspectors on Decommissioning on Nuclear Licensed Sites. Nuclear Safety Directorate of HSE, 13 March 2001. See www.hse.gov.uk/nsd.

Health and Safety Executive (1999a). Work with Ionising Radiations. Ionising Radiations Regulations Approved Code of Practice and Guidance. TSO, London.

Health and Safety Executive (1999b). Nuclear site licence condition 36. Available at www.hse.gov.uk/nsd/cond36htm.

Health and Safety Executive (1994). Nuclear Site Licenses under the Nuclear Installations Act 1965 (as amended). Notes for Applicants. Sheffield, HSE Books.

Health and Safety Executive (1991). Protection of Workers and the General Public During the Development of Contaminated Land. TSO, London.

Hill M D (2002). The Regulatory Framework for Contaminated Land on Nuclear-Licensed Sites and Defence Sites. A Paper for the SAFEGROUNDS Learning Network, Version 3, August 2002. www.safegrounds.com/bookshelf

Hill, M D, Steeds, J E and Slade, N J (2001). Land Contamination: Technical Guidance on Special Sites: Nuclear Sites. Environment Agency R&D Publication P158. Bristol, Environment Agency.

Mallett, H (2002). Technical Options for Managing Contaminated Land. A paper from the SAFEGROUNDS Learning Network. See www.safegrounds.com.

NRPB (1998). Radiological Protection Objectives for Land Contaminated with Radionuclides. *Doc. NRPB* **4** No. 1

Royal Commission on Environmental Protection (1988). Best Practicable Environmental Option. 12th Report.

Royal Commission on Environmental Protection (1998). Setting Environmental Standards. 21st Report.

RWMAC (2000). The Radioactive Waste Management Advisory Committee's Advice to Ministers on the Ministry of Defence Arrangements for Dealing with Radioactively Contaminated Land. HMSO Norwich.

Smith, GM (2002). Assessment of the Health and Environmental Risks from Contaminated Land. A Paper from the SAFEGROUNDS Learning Network. See www.safegrounds.com.

Taylor, Derek M (2001). The future of radioactive waste management – a European view. Proc. IBC's 3rd International Two-day Conference on Managing Radioactive Waste, London, 11 & 12 December 2001.

Tromans, Stephen and Fitzgerald, James (1997). The Law of Nuclear Installations and Radioactive Substances. London, Sweet & Maxwell.

*Other publications in this series are:
CLR 8 Potential contaminants for the assessment of land
CLR 9 Contaminants in soil: collation of toxicological data and intake values for humans
CLR 10 The contaminated land exposure and assessment model (CLEA). Technical basis and algorithms.
SGV 1, 3, 4, 5, 7, 9, 10. Soil guideline values for arsenic, cadmium, chromium, inorganic mercury, nickel, selenium, lead
TOX 1, 2, 3, 4, 5, 6, 7 8, 10. Contaminants in soil, collation of toxicological data and intake values for humans for arsenic, benzo(a)pyrene, cadmium, chromium, inorganic cyanide, lead, mercury, nickel, selenium.

Legislation

Acts

Nuclear Installations Act, 1965 (as amended).

Control of Pollution Act, 1974.

Health and Safety at Work etc. Act, 1974.

Environmental Protection Act, 1990: Part IIA Contaminated Land (inserted by the Environment Act, 1995).

Water Resources Act, 1991.

Radioactive Substances Act, 1993.

Regulations

Construction (Design and Management) Regulations, 1994 and Construction (Design and Management) (Amendment) Regulations, 2000. SI 1994 No. 3140 and SI 2000 No. 2380.

Control of Substances Hazardous to Health Regulations, 1999. SI 1999 No. 437.

Contaminated Land (England) Regulations, 2000. SI 2000 No. 227.

Ionising Radiations Regulations, 1999. SI 1999 No. 3232.

Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations, 1999. SI 1999 No. 2892.

Radioactive Materials (Road Transport) (Great Britain) Regulations, 1996. SI 1996 No. 1350.

Special Waste Regulations, 1996. SI 1996 No. 972, as amended.

Town and Country Planning (Environmental Impact Assessment, England and Wales) Regulations, 1999. SI 1999 No. 293.

Other Statutory Instruments

The Radioactive Substances (Phosphatic Substances, Rare Earths etc) Exemption Order 1962. SI 1962 No. 2648.

The Radioactive Substances (Substances of Low Activity) Exemption Order 1986. SI 1986 No. 1002.

10 Glossary

10.1 GLOSSARY OF TERMS

Attribute	A factor that is used to compare the performance of different *options*. Attributes should be mutually exclusive and reflect issues of concern to stakeholders. It can be helpful, but is not necessary, if a quantitative measure of performance is associated with an attribute. Attributes generally fall into the following categories: health and safety, environmental, technical, social and cost factors.
Characterisation of sites	Establishing information on the presence and characteristics of contaminants, details of the environment in which they are present and potential pathways to man and other environmental receptors. This can be achieved by various investigative methods. Guidance on site characterisation has been developed by SAFEGROUNDS [Baker et. al., 2000].
Constraint, screening criterion	A basic requirement that must be met for any *option* to be considered in detail. Constraints/screening criteria should be capable of being agreed to by all *stakeholders*, be mutually exclusive and unambiguous. They can be identified by considering the SAFEGROUNDS *key principles* and other factors such as legal or regulatory requirements. Financial issues should not be used as constraints unless all stakeholders agree to this.
Contaminated land	Any land on or under which radioactive or non-radioactive contaminants are suspected to be present at concentration levels above the natural and artificial background concentration levels that are typical of the location of the site. This is not the same as the statutory definition in Part IIA of the Environmental Protection Act, 1990 which defines the presence of contamination by the possibility of significant harm or the pollution of controlled waters.
Decommissioning	The set of actions taken at the end of a nuclear facility's operational life to take it permanently out of service. It includes actions to systematically and progressively reduce the level of hazard on a site and may include the physical dismantling of facilities. The ultimate aim of decommissioning of a *nuclear-licensed site* is to make the site available for other purposes. The endpoint for decommissioning may be *delicensing* or re-use of the site for nuclear purposes, or the keeping of the site under institutional control.
Defence site	In this guidance, non-nuclear sites that have been or are being used for defence activities and for which a change of use and/or ownership is planned. Nuclear sites that are operated for MoD by contractors and that are licensed and regulated by HSE under the Nuclear Installations Act are *nuclear-licensed sites*.

Delicensing	The process of releasing a *nuclear-licensed site* from regulation under the Nuclear Installations Act and of releasing the operator from his period of responsibility for any nuclear liability.
Environment	The environment includes, but is not limited to, people's property (e.g. houses and land), existing and potential resources (e.g. groundwater, water quality, air quality) and natural ecosystems. In this guidance, *people* are regarded separately from the environment. The distinction is made for consistency with health and safety, and radiological protection, terminology.
Envisageable options	All the options that would be effective for managing the *contaminated land*.
Future	The period over which the potential effects of the *contaminated land* need to be considered when evaluating the *options* that may be applied to it. Many contaminants have long half-lives in the environment, and so it may be necessary to consider hundreds of years or more.
Future use	The range of uses to which the *contaminated land* will be able to be put after the selected *option* has been implemented successfully. The range of future uses may be restricted to reduce the potential hazards associated with residual contamination. Alternatively, the site may be made available for any future use, in which case lower levels of residual concentrations of contaminants are likely to be required.
High level of protection	The level of potential impacts on *people* and the *environment* that all stakeholders agree can be tolerated. SAFEGROUNDS does not recommend a particular level of protection, rather it is recommended that the level of protection should be defined on a case-by-case basis.
Key principle	A fundamental principle that should be adhered to during *land management*. Through consultation, SAFEGROUNDS has developed five key principles on the protection of *people* and the *environment*, *stakeholder* involvement, the identification of the preferred *land management option*, taking immediate action and record keeping.
Licensee	The organisation that is the holder of the nuclear site licence on a *nuclear-licensed site.* The licensee is responsible for nuclear safety on the site and for discharging all the obligations and liabilities associated with the nuclear site licence.
Management of contaminated land	The taking of any actions to control, monitor or remove (wholly or partially) contamination once it has been discovered and all the processes that lead up to decisions to take such actions.
Nuclear-licensed site	Sites that are regulated by HSE under the provisions of the Nuclear Installations Act 1965 (as amended) with a nuclear-site licence. The Act applies to fixed sites for the purposes of constructing and operating nuclear reactors and other prescribed nuclear installations. The guidance applies to operating sites and those being *decommissioned*, whether or not they are to be *delicensed*.

Objective	An aim set for the management of contaminated land. Objectives are set by considering factors such as government policy, corporate/organisational policy and the views of *stakeholders*. It is recommended that environment, health and safety objectives are established separately from those of a commercial and administrative nature.
Option	A method, approach or technology that can be used for *land management*. Options can include, but may go further than, some or all of the actions defined as 'remediation' in Part IIA of the Environmental Protection Act, 1990. In evaluating options, consideration should always be given to 'doing nothing more' to the contamination or to removing contamination to background levels. See also *strategy*.
Owner/operator	The organisation with responsibility for the *site* and any associated *contaminated land*. At *nuclear-licensed sites* the operator is the *licensee*. Owners/operators are responsible for taking final decisions to implement the *proposed option* for *land management*.
People	Those individuals that could be affected by *contaminated land*. People are distinguished from *environment* following health and safety and radiological protection convention. Separate consideration may be given to 'workers' (who receive a direct financial benefit from the *owner/operator*) and the public (who do not). Consideration should also be given to people at present and in the *future*.
Preferred option	The option that is identified by an *owner/operator* as their preferred one following a comprehensive, systematic and consultative assessment in which all the *envisageable options* are considered.
Preferred strategy	The strategy that is identified by an *owner/operator* as their preferred one following a comprehensive, systematic and consultative assessment of potential strategies derived by considering the *options* for the various areas on a site.
Proposed option	The *option* that is formally submitted by an *owner/operator* to regulators and decision-makers for approval to implement, following the comparison of options, identification of a *preferred option,* and consideration of this preferred option in regulatory and other acceptance procedures.
Proposed strategy	The *strategy* that is formally submitted by an *owner/operator* to regulators and decision-makers for approval to implement, following the comparison of strategies, identification of a *preferred strategy,* and consideration of this preferred strategy in regulatory and other acceptance procedures.
Records	Information including details of site *characterisation* work, the process of deciding on the *land management* option/strategy, implementing the option/strategy and validating its implementation, as well as interaction with *stakeholders* throughout the process. There is a *key principle* about the keeping of records.

Risk assessment	A systematic process that establishes the existence, nature and significance of risk. Different methods are used to evaluate different types of risks. The approach to assessing risks to *people's health* and to the *environment* from non-radioactive contamination is largely described in regulatory guidance. The approach to assessing risks to *people* and the *environment* from radioactive contamination is different and an approach is outlined in the guidance.
Safety case	Documentation for a nuclear installation that demonstrates safety. Safety cases must be produced and maintained during the design, construction, manufacture, commissioning, operation and *decommissioning* of the installation.
Score	The performance of an *option* in respect of a particular *attribute*, when options are being compared. Scores can be assigned using an absolute (i.e. compared with a scale including ideal and unacceptable levels of performance) or relative (i.e. relative to the performance of other options) measure of performance. The latter approach is sometimes referred to as ranking.
Site	A contiguous area of land on which *contamination* is known or suspected to be present. In most cases, a site will have a single *owner/operator*. Sites considered in this guidance are further classified as *nuclear-licensed sites* or *defence sites*.
Stakeholder	A person or organisation that has an interest in (or is affected by) the *contaminated land.* There are various groups of stakeholders: institutional stakeholders include the *owner/operator*, regulators and government departments. External stakeholders are all those outside the owner/operator organisation. Those stakeholders involved in decisions on the management of contaminated land are participating stakeholders.
Strategy	A broad plan for the management of all the *contaminated land* on a *site*, probably comprising of several *options*.
Weighting factor	A weighting factor accounts for the importance of an *attribute* relative to others when *options* are being compared. This is usually done by multiplying *scores* for an attribute by the chosen weighting factor. Several sets of weighting factors are often needed, so as to reflect the views of various *stakeholders*.

10.2 ACRONYMS AND SYMBOLS

ALARA	as low as reasonably achievable
ALARP	as low as reasonably practicable
BNFL	British Nuclear Fuels plc
BPEO	best practicable environmental option
Bq	Becquerel – a unit of radioactivity (one nuclear transformation per second)
CBO	community based organisation
DE	MoD Defence Estates Organisation
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions (no longer exists; most of its responsibilities relevant to this guidance have been transferred to DEFRA, the remainder to DTLR)
DRPS	Dstl Radiological Protection Services (formerly Defence Radiological Protection Services)
DTI	Department of Trade and Industry
DTLR	Department for Transport, Local Government and the Regions
EA	Environment Agency
EIA	environmental impact assessment
EIAD	Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations, 1999
HSE	Health and Safety Executive
HSWA	Health and Safety at Work etc. Act, 1974
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IRR	Ionising Radiations Regulations, 1999
LLW	low-level radioactive waste
LQA	Land Quality Assessment (see Appendix B)
LQS	Land Quality Statement (see Appendix B)
MADA	multi-attribute decision analysis

MoD	Ministry of Defence
NGO	non-governmental organisation
NIA	Nuclear Installations Act, 1965 (as amended)
NII	Nuclear Installations Inspectorate, part of HSE
NRPB	National Radiological Protection Board
Part IIA	Environmental Protection Act, 1990: Part IIA Contaminated Land (inserted by the Environment Act, 1995)
PPC	Pollution Prevention and Control regime
RCEP	Royal Commission on Environmental Pollution
RPA	Radiation Protection Advisor
RSA	Radioactive Substances Act, 1993
SAFEGROUNDS	SAFety and Environmental Guidance for Remediation Of Uk Nuclear and Defence Sites
SEPA	Scottish Environment Protection Agency
SI	Statutory Instrument
SoLA	Substances of Low Activity Exemption Order (made under RSA)
Sv	Sievert, a unit of dose from ionising radiation