

# Management of contaminated land on nuclear sites: establishing and delivering best practice guidance

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**Abstract.** The SAFEGROUNDS Learning Network is a collaborative process set up by nuclear liability holders with the regulators, contractors and consultants to the nuclear industry. Its purpose is to deliver a continuing programme of best practice guidance about the health, safety and environmental aspects of management of contaminated land on nuclear-licensed and defence sites. The paper explains the method and results of the feasibility study carried out for the DTI Liabilities Management Group, with technical steering from representatives of nuclear site licence holders, HSE, and the Environment Agency. There is an industry need for this guidance, which requires different forms of delivery for different users – whether industry, regulators or the public. The guidance has to apply to radioactive and non-radioactive contamination, and mixtures of the two. A key objective for the guidance will be to fill gaps in the current and anticipated statutory and regulatory guidelines. Three initial tasks are described. These are to prepare guidance on site characterisation, to establish a web-site for the Network's purposes, and to catalyse stakeholder dialogue.

**Keywords.** Learning network, contaminated land, site characterisation, nuclear-licensed sites, defence sites, remediation, best practice

## 1

## INTRODUCTION

Many nuclear-licensed sites and defence sites have ground that is potentially contaminated with radioactive and chemical contaminants so sustainable management of land on these sites is of national interest. Currently there are over thirty nuclear-licensed sites in the UK and dozens of defence sites. Several of the nuclear sites have now ceased operations, and many of the defence sites are closed and scheduled for redevelopment. Regulatory guidance on the management of contaminated land on operational and closed sites is still under development.

The SAFEGROUNDS Learning Network was established in September, 1999. It is a collaboration initially between nuclear liability holders and the regulators, contractors, and consultants to the nuclear industry but, as it progresses, it will increasingly involve other stakeholders representing public or environmental interests. Its purpose is to deliver a continuing programme of best practice guidance about the management of contaminated land on nuclear and defence sites, so as to protect people and the environment, now and in the future.

The management of land that may be contaminated is, for sites in the nuclear sector, perhaps more complex, generally more onerous, and certainly requiring

very much longer strategic planning and operations than would be usual for industrially contaminated development sites. While the following aspects are relevant to all forms of land contamination, they apply in much greater degree to nuclear sites.

1. The contamination results from legacy and operational causes.
2. There is a complicated regulatory structure.
3. There are potentially large financial liabilities.
4. There is a high level of public concern.

## 1.1

### **The regulatory background in the UK for radioactively contaminated land on nuclear-licensed sites**

The Nuclear Installations Inspectorate (NII) of HSE has responsibilities for the regulation of radioactive waste management, which can include radioactively contaminated land, on nuclear-licensed sites. Nuclear site licences contain conditions attached by NII with respect to the handling, treatment and disposal of nuclear matter. These conditions would apply to contaminated land which 'houses' or acts as a 'store' of radioactive waste. The conditions involve matters such as: arrangements for storage of nuclear matter; record-keeping; safety cases; monitoring, minimisation and containment of wastes.

NII's Safety Assessment Principles (NII, 1992) can be applied to contaminated land. The safety case should cover storage, remediation work, eventual disposal and, if appropriate, eventual de-licensing. Soils that are contaminated should be contained, segregated and characterised. A presumption would be that, where remediation is reasonably practicable, it should be performed sooner rather than later.

In respect of remediation strategies, the following is taken from Delaney (2000). 'Radioactively contaminated land on licensed sites needs to be included in site-specific strategies for management of radioactive waste and will be included in HSE's future quinquennial reviews of licensees' radioactive waste management and decommissioning strategies. If localised radioactive contamination is found, the licensee should consider removing it. Although capacity is finite, disposal facilities for low level waste can be used for contaminated soil to allow restoration of a site to an acceptable condition. Licensees should also consider other options, since transferring risks and liabilities to another location does not necessarily solve the problem. The overall environmental impact must be acceptable to HSE, which must consult the Environment Agency (EA) or Scottish Environment Protection Agency (SEPA) on matters involving radioactive wastes.'

Licensees who want to develop that land for other uses would have to undertake works of dismantling and clearance sufficient for the site to be de-licensed. Robinson (1999) and Robinson and Simister (1999) describe the high standards achieved on some sites that have been de-licensed after clearance works to a condition representing no danger. On other sites, while HSE cannot de-license them if they contain significant radioactive contamination, partial remediation or improved containment to reduce spread of radioactivity could be an appropriate strategy.

## 1.2

### Involving stakeholders

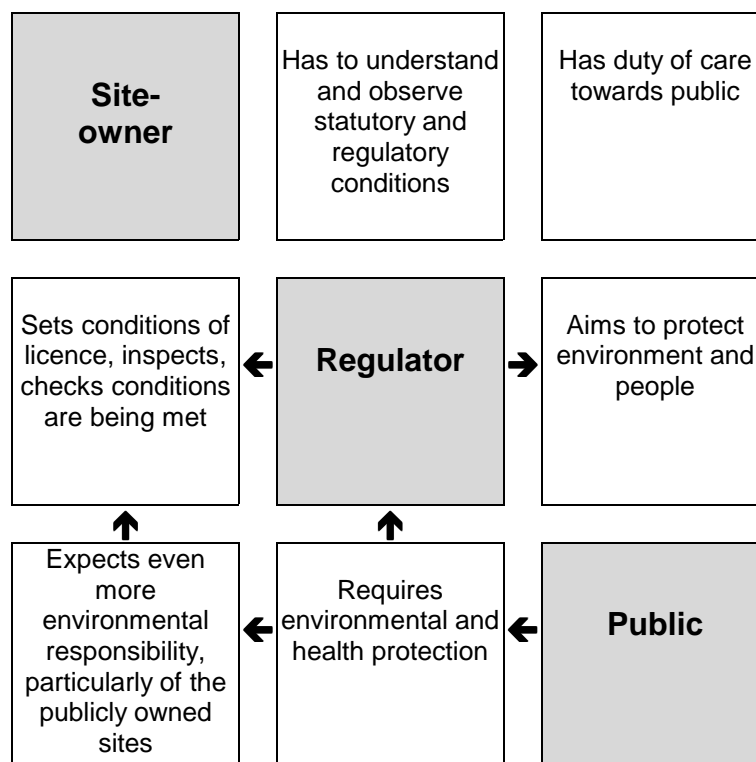
There is a very wide range of types of people and organisations that are or can (and perhaps should) be considered as stakeholders in matters to do with contaminated land on nuclear sites. They include, for example:

- the public (individuals, local authorities, pressure groups, liaison committees, politicians)
- those with a duty to oversee (policy makers, advisers, regulators)
- the liability owners (nuclear licensees, MoD, site purchasers, lenders, insurers) and those working on their behalf to manage the land
- the managers and operatives of those undertaking works of remediation (contractors, consultants, site-workers, unions).

Each stakeholder or group of stakeholders will have their own positions to promote, and an open approach to involving them should take into account:

- many of the liabilities being publicly held
- the desirability of the public becoming engaged in the land management strategy
- large sums of money being required whether to manage or remediate the land
- the stakeholders having a diverse range of expectations
- consultation only having value if it is 'real'
- the need to encourage ownership of the solutions.

Mutual understanding will need a basis of effective dialogue and transparency of purpose. This can be attained by identifying and building on the interests and more basic needs (as in Figure 1) which underlie each stakeholder's declared position.



**Figure 1** Some interactions of the principals (in an interaction matrix the interaction of agency A on agency B is not the same as that of agency B on agency A, Hudson, 1992)

## PROCESS OF ESTABLISHING THE NETWORK'S SCOPE

The DTI Liabilities Management Group through its Safety Issues Task Force (SITF) arranged to commission CIRIA (Construction Industry Research and Information Association) to carry out a feasibility and scoping study about how to manage and deliver best practice guidance in the management and remediation of contaminated land on nuclear-licensed and defence sites. The work was authorised on 27 October 1998.

CIRIA has a long and successful track record in establishing and delivering best practice guidance on matters to do with construction and the environment. A particularly successful programme of guidance is that on the remedial engineering of contaminated land (Harris *et al.*, 1995-8). This programme includes guidance for safe working on contaminated sites (Barry *et al.*, 1998), on good practices in the more established forms of remedial treatment (Privett *et al.*, 1996; Holden *et al.*, 1998). A recently completed project established and explains what good practice should be in the treatment technologies still relatively little used in UK (Evans *et al.*, in press). CIRIA's processes involve consultation and consensus-building by collaborative research on subjects where good practice has not yet been formalised.

For the scoping study, CIRIA employed the expert services of Ms M D Hill of WS Atkins for her knowledge of the nuclear industry and its regulators in order to make sure that their views were properly recorded and reflected in the study. With an initial role of facilitation at a workshop, staff of The Environment Council were also brought into the study team. This was so that they could advise on and start the potentially very sensitive process of liaison with public and environmental interest groups. The particular expertise of The Environment Council in creating and developing the conditions for effective stakeholder dialogue is likely to be of increasing importance in the development, acceptance and implementation of the eventual guidance.

The scoping study team worked in association with and under the guidance of a project steering group that comprised staff from the organisations represented on the SITF and representatives from HSE and EA.

The scoping study was based on consultation and on an appraisal of what information and guidance for practice is already available.

### 2.1

#### Consultation

The consultation process combined advice from the steering group interviews with individuals, and a facilitated workshop with an invited attendance. The steering group advised on the brief and methodology for the scoping study, commented on the draft report, and approved the final report. Ms Hill interviewed experts to elicit their views as to what topics should be included in the best practice guidance and to obtain pointers to sources of information, etc.

The workshop was held at the National Exhibition Centre on 3 November 1998 with an invited attendance of 29, including the steering group and the CIRIA team. With the help of an appointed facilitator and a combination of plenary and group discussions, the aim was to 'download' from industry experts and

practitioners their knowledge and experience of what would be required from a project to achieve guidance on world best practice. There was a considerable swell of support from those present and very clear advice as to what was required and how it should be delivered.

## 2.2 The results of the scoping study

The scoping study report (CIRIA, 1998) comprised:

- the review of available information
- the coverage of the required guidance as ascertained from the consultations and workshop
- a proposal to set up what was termed a learning network
- a funding plan
- a programme for the preparation of guidance.

The conclusion of the study was that guidance was needed, in different forms and for different sectors of the nuclear industry, the regulators and the public. Its principal recommendation was that a network should be set up as an appropriate mechanism to deliver guidance that could be updated to respond to improvements in standards and changes in legislation.

## 2.3 The SAFEGROUNDS Learning Network

The message that came across strongly from consultees was to learn from previous experience, i.e. from:

- the management of ‘conventional’ contaminated land
- recognition of similar types of problems
- overseas as well as UK experience.

This prudent advice, however, is set in the context of new ideas and new solutions being examined and developed by the scientists and technologists of leading-edge organisations. The big gains are likely to come from: the sharing of ideas and experience; from common solutions to common problems; from working together with regulators and others in order steadily to improve safety, health and the environment. These are old ideas and long-tried processes. CIRIA and The Environment Council exist, for example, for just these purposes. The learning network is the formalisation of the various arrangements that can make these exchanges happen. It should also be noted that many of the exchange and learning mechanisms can be informal and the network’s boundaries are flexible – widening and contracting at need and as tasks shift in priority.

Figure 2 is a representation – deliberately oversimplified – of what was first envisaged. The nucleus is not fixed; there can be different ‘hubs’ at different times and for different purposes. The orbits of the outer particles are not fixed either; they can switch from one energy level to another and set up separate orbits around a new hub or even around themselves. The less rigid and the more dynamic the system, the more successful is it likely to be. A recent CIRIA report (Holti and Whittle, 1998) describes the ideas behind learning networks and how they can operate.

A learning network was felt to be appropriate because:

- clear learning objectives were already established

- guidance on management of contaminated land on nuclear sites will have to change over time as regulations and stakeholder expectations develop
- successful management strategies will require input from all stakeholders
- it exists to encourage inter-organisational learning
- it can include systems for learning at different levels, e.g. operational and strategic levels.

For this new entity the acronym SAFEGROUNDS was coined from **SAF**ety and **ENV**vironmental **G**uidance for the **REM**ediation of **N**uclear and **DEF**ence Sites. Its brief covers:

- contaminated land on nuclear-licensed and defence sites (and may also include adjacent operational land outside the licensed site boundary)
- health, safety and environmental management
- sustainable land management, including remediation where appropriate.

The aim for the SAFEGROUNDS network therefore is to :

- deliver core guidance on managing contaminated land on nuclear-licensed and defence sites in a sustainable way
- exchange information and experience
- encourage continuous improvement in performance
- use independent, transparent processes that will instil confidence in its methods and outputs.

## The learning network

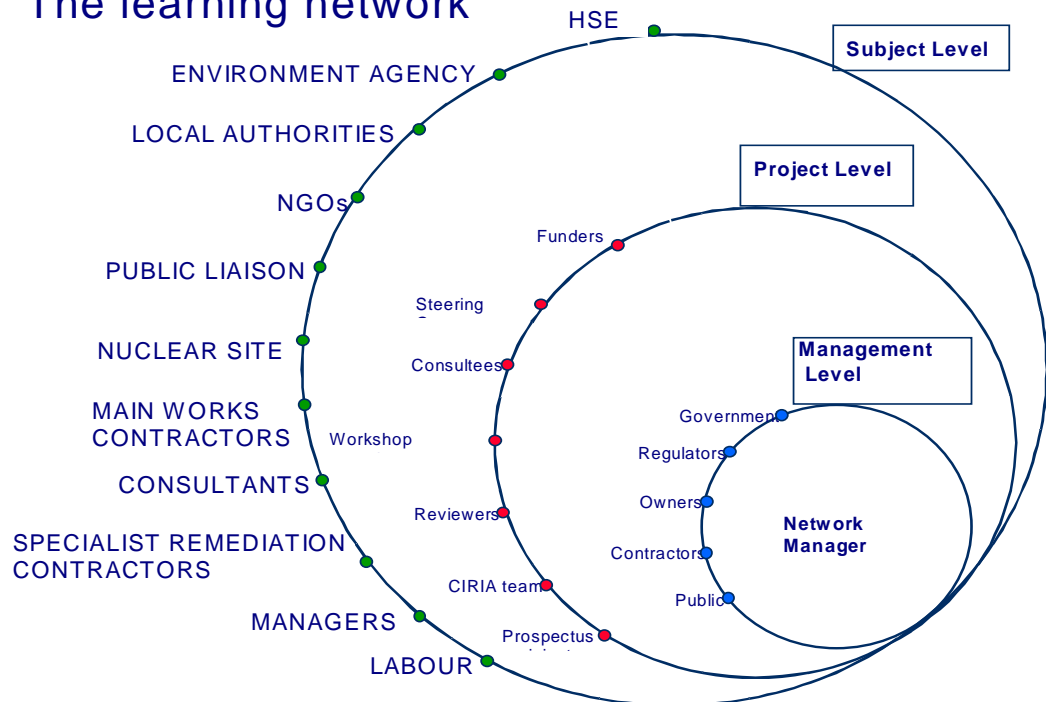


Figure 2 Representation of the learning network

### 3

## SAFEGROUNDS MECHANISMS

### 3.1

## Setting up

On completion of the scoping study and acceptance of its general recommendation for the network, CIRIA in association with WS Atkins and

The Environment Council was asked to set up and manage the SAFEGROUNDS Project. This project is sponsored by the Liabilities Management Group through the Safety Issues Task Force and initiated with funding from BNFL, UKAEA, AWE, and British Energy. It has the support of HSE, the Environment Agency, the Scottish Environment Protection Agency, DETR, DTI and MoD. See Table 1.

**Table 1** SAFEGROUNDS funders and supporters (February 2000)

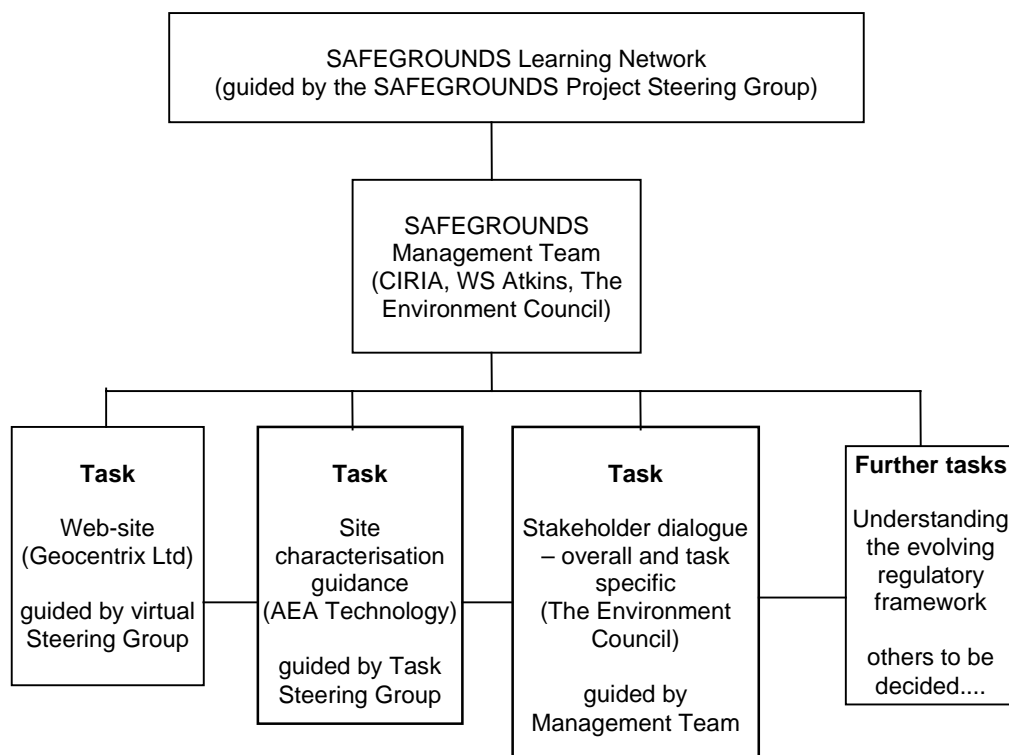
<b>Project-wide funders</b>	<b>Task-specific funders</b>	<b>Network supporters</b>
Atomic Weapons Establishment	Haswell Consulting Engineers	DTI DETR
BNFL	Mott MacDonald Group	Ministry of Defence
British Energy		Health & Safety Executive
UKAEA		The Environment Agency
IMC		Scottish Environmental Protection Agency

Part of the brief for the network management is to increase the membership and to bring in project funding from other sources. Recently, funding has been obtained from the Waste Management (and Decommissioning) sub-group of the Industry Management Committee, which administers the reactor operators research levy. Also shown in Table 1 are two organisations, consultants to the industry and CIRIA Core Programme members, who are contributing more specific funding to SAFEGROUNDS.

## 3.2 Operations

A staged sequence of operations has been initiated. The constraints were the funding available and a requirement that tangible outputs of the first tasks had to be delivered before the end of the current financial year (i.e. end March 2000). The three initial tasks should be seen, however, within the following larger context.

1. There will be a two-year programme to initiate core guidance and establish SAFEGROUNDS as a self-standing network.
2. Stakeholders of all types will become increasingly involved. This aim underlies all the operations, but needs careful management in order not to frustrate expectations by promising too much too soon.
3. Research contracts will be placed to engage experts to prepare guidance with the review and steering of peer groups.
4. Publications and a web-site will be used to make the guidance available and updateable.



**Figure 3** Initial tasks

## 4

### TASKS

The three initial tasks for the network are shown in Figure 3. The first was to establish and develop a web-site. This is [www.safegrounds.com](http://www.safegrounds.com). It contains links to the various organisations in SAFEGROUNDS. The second task was to specify and commission a contractor to prepare guidance on site characterisation. This is described below. The third task was to hold a facilitated workshop with stakeholders that would contribute to the acceptability of the guidance about site characterisation. This workshop was held on 10 January 2000 at the NEC.

#### 4.1

### Web-site

The SAFEGROUNDS web-site will be used initially as a publicity mechanism for the Network and as a dissemination mechanism for the best-practice guidance. It is planned that in the long term, the web-site would also provide a mechanism for providing feedback on the application of the guidance, and a route by which revisions to the guidance could be made available. The development of the site has used a 'virtual' steering group; the feedback being given electronically, not at formal meetings. An initial proposal to keep part of the site accessible only to network members was overruled as being counter to the principle of transparency.

#### 4.2

### Workshops

Two facilitated workshops have been held. The first not only influenced the scoping for the network, but it also generated 'ownership' and expectation amongst those who attended. The second was the first 'technical' workshop held to support the site characterisation task. In neither case was a formal

report issued (although a brief note about the later meeting was put on the web-site). Rather, all who attended were sent a photo-report; a compilation of photos of the flip charts which resulted from the debates and interactions of the workshop groups.

The questions that were considered at the site characterisation workshop included the focus of the guidance, in terms of:

- What should be in the guidance?
- What should not be in the guidance?
- What mistakes can we learn from, what must we do differently in the future?
- What emerging techniques and technologies will be available?

The workshop also considered the delivery mechanisms appropriate for the different stakeholder groups. Here, the importance of the Internet came through, and this will be reflected in the use of the SAFEGROUNDS web-site to carry the guidance, and to receive feedback on its use.

Alongside the technical research, a programme of dialogue with stakeholders is being established, managed by The Environment Council. The stakeholder dialogue process will arrive at the technical subjects to be addressed through guidance, and provide support to each separate research task.

### 4.3

#### Site characterisation

The SAFEGROUNDS Steering Group, having agreed that the guidance programme should start with site characterisation, a competitive tendering and selection process resulted in AEA Technology plc being awarded the contract in November 1999 to prepare the guidance. The timing of this is:

November 1999:	Preparing for consultation, identifying existing documents
January 2000:	Consultation workshop
March 2000:	Drafting complete
May 2000:	Interim guidance on web-site; guidance document sent to funders.

Subsequently, the guidance can be revisited at suitable times.

The technical content of the site characterisation task and the expected eventual guidance document is outlined in the next section.

## 5

### SITE CHARACTERISATION GUIDANCE

This task is to establish what is best practice and to prepare needed guidance about how to characterise land on nuclear and defence sites (including operational land that may be outside the boundary of a licensed site) that may be contaminated.

Some of the terms needed definition, e.g.:

characterisation	the understanding of a site, its nature, geology, hydrogeology, history, artefacts, and including the presence, spatial distribution and movement over time of contaminants on and within the land and all the information required firstly to assess the risks posed by
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	the contamination and secondly to identify and evaluate potential remedial measures, if such measures are required
best practice	established methods accepted after consultation with experts as being world leading
contamination	chemical, radioactive, and both chemical and radioactive contaminants present on and within a nuclear site
nuclear site	the land of a nuclear-licensed site and operational land associated with it or defence site where there are or have been operations involving radioactive materials

Using case histories, laboratory and field studies, and other published data and experience, the guidance will cover:

1. The selection, design, and execution of methods to investigate and understand the nature and properties of the ground of a contaminated nuclear site.
2. Health and safety aspects associated with site characterisation on a nuclear or defence site.

The guidance already available to cover contaminated land is voluminous, extensive, and scattered. The scope of this task, therefore, is rather to set out rationales, protocols, and procedures as a ‘head’ document which refers to and draws upon other guidance.

## 5.1 Methodology

The method being followed in preparing the guidance includes the following stages:

1. Consulting UK and international experts and practitioners knowledgeable in characterisation of contaminated land, including the liability owners.
2. Reviewing published information, from UK and abroad, on the strategies for and design, specification, execution and reporting of contaminated land investigations taking into account the context and framework of the characterisation - i.e. for site investigation, land quality assessment, site specific risk assessment, routine monitoring and validation of a remedial action, de-licensing.
3. Explaining the different methods available for characterising the different materials, types, and situations of contamination and the reasons for needing to characterise a site. This should specifically include sampling strategies, non-invasive and invasive sampling methods, soil and groundwater collection, in-field measurements (especially for radioactive contaminants), sample preparation, chemical and radiochemical analytical considerations, logging and reporting to recognised standard protocols. Health and safety and regulatory aspects (e.g. backfilling boreholes) should be highlighted.
4. Using case studies to demonstrate appropriate lessons about site characterisation.

5. Setting out the rationales for the characterisation of contaminated land on nuclear sites, with reference to established procedures, such as 'due diligence' enquiries.

6. Preparing a report drawing together the above information as guidance for best practice.

## 5.2

### **Suggested structure of characterisation report**

The report structure presented as the Appendix to this paper was discussed at the Task Steering Group meeting on 29 November 1999. As it forms the basis for the development of the best practice guidance, it is presented in some detail to show the range of matters that have to be addressed. In general terms, it is likely that other of the Network's technical 'best practice' tasks will be of the same degree of complexity.

## 6

### **NEXT STAGES**

The current plans for the operations of the SAFEGROUNDS network in 2000/01 are:

- to present an explanation of the 'current' regulatory framework
- to establish needs of stakeholders
- to produce core guidance on further priority topics
- to make the transition to a self-standing learning network.

The core guidance is likely to be in the form of the learning cycle of 'Plan – Do – Check – Act'.

Probably in mid 2001, the network will:

- revisit the site characterisation guidance
- examine regulatory developments
- report on international developments
- expand and improve the guidance formats.

An increasingly important task will be to publicise the work and results of SAFEGROUNDS.

## 7

### **CONCLUDING REMARKS**

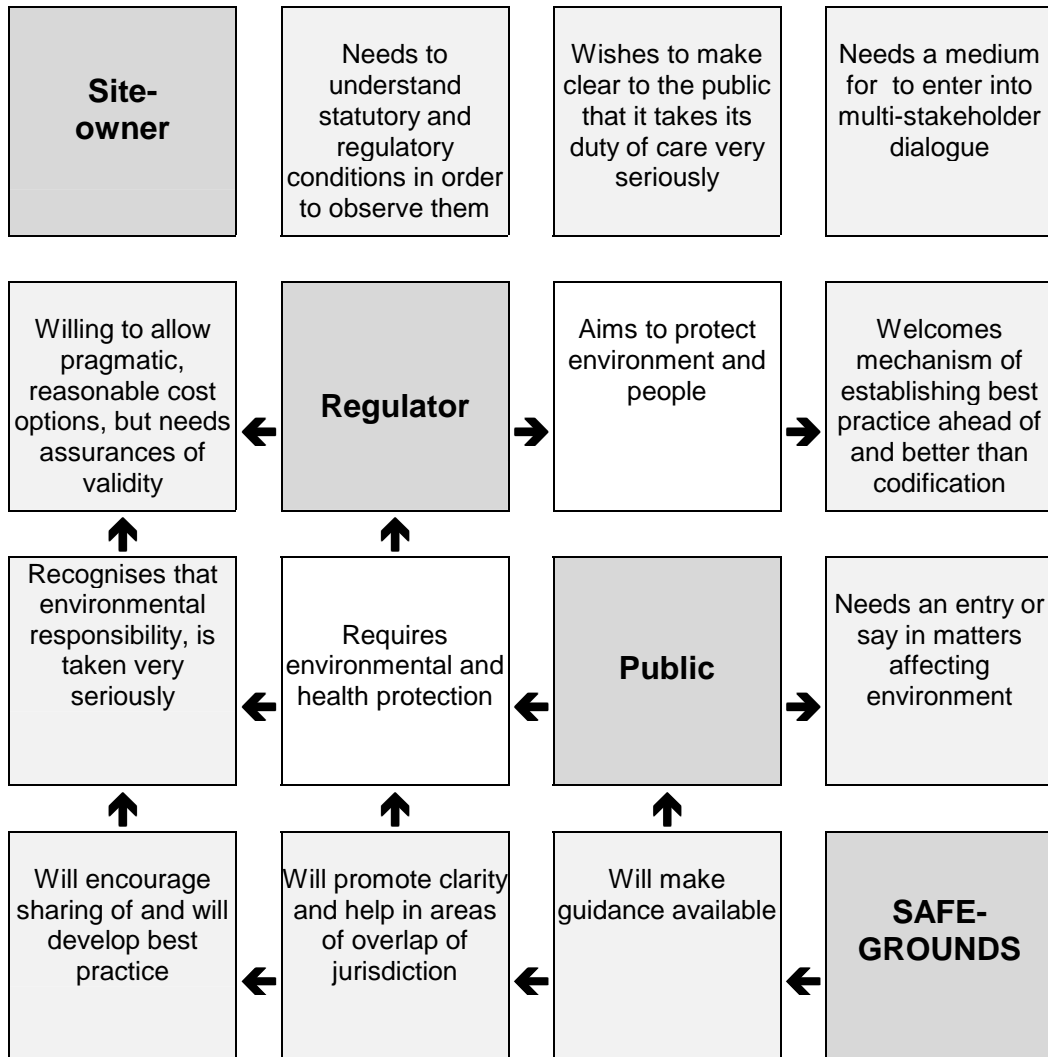
The SAFEGROUNDS Learning Network is being established over a two-year period, with initiating funding from the principal liability holders (BNFL, UKAEA, AWE, British Energy, IMC) and support from DETR, DTI, MoD, HSE,EA and SEPA. Additional funding and support is also being sought.

The remit of the SAFEGROUNDS Learning Network is to prepare and disseminate world-class best practice on the health, safety and environmental aspects of the management of contaminated land on nuclear and defence sites. The approach being followed is:

1. To find out what is needed.
2. To establish the safety implications of the current situations.
3. To decide what to do and how to do it.
4. To provide guidance to the strategy for implementation.

5. To monitor the results.

The interaction matrix of Figure 4 represents some of the ways in which SAFEGROUNDS will catalyse the developing relations between the principal stakeholders. In this figure, the right hand and bottom lines of squares are where the learning network has a direct role, but note in comparison with Figure 1 how it can also influence the interactions between the others.



**Figure 4** Some possible results of a learning network on the interactions of the principal agencies (see note to Figure 3)

The potential benefits of SAFEGROUNDS will be realised in the following ways.

1. *Protection of people and the environment.* The SAFEGROUNDS Project and Learning Network is attempting to establish in consultation with all stakeholders (regulators, industry, operators, government, public, environmental groups, etc.) an interim framework for managing contaminated land which will protect people and the environment, and within which all nuclear and defence site liability managers can work. In addition the SAFEGROUNDS Project and Learning Network will develop

guidance that will help site owners plan for the eventual safe decommissioning of some or all of specific nuclear and defence sites.

2. *Cost.* The liability cost of cleaning up this land is considerable (approx. £1-2 billion for BNFL sites alone). In the case of state-owned site operators (MoD, UKAEA, BNFL), much of this will have to be found from the public purse. There is much societal benefit to be gained therefore, not only in knowing how to discharge these liabilities safely, but also economically. This is one of the key objectives of SAFEGROUNDS. In addition the participating liability managers consider that a collaborative project, such as the establishment of the SAFEGROUNDS Project, is also the most cost-effective way of preparing the guidance that is required and provides for sharing of both cost and best practice.
3. *Public reassurance.* It is the view of the SAFEGROUNDS participants that public acceptability requires that independence of the guidance is maintained and that it be prepared by consensus rather than as a partisan exercise. This is and will be the policy of the SAFEGROUNDS network project.

## Acknowledgements

The authors gratefully acknowledge the many organisations and individuals supporting the SAFEGROUNDS Network. The views expressed in this paper are those of the authors and not necessarily those of their organisations or of the member organisations in the Network. Particular acknowledgements are due to Mr B Delaney of HSE Policy Directorate for material in Section 1 of the paper. The Network's contractor for the development and operation of the SAFEGROUNDS web-site is Dr A J Bond of Geocentrix, and its contractor for the preparation of the site characterisation guidance is AEA Technology plc.

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## Appendix

### Draft contents of guidance document on site characterisation

#### Glossary

##### 1. Introduction

- 1.1 Purpose and scope:
- 1.2 Overview of potential activities at nuclear and defence sites
- 1.4 Legislative aspects
- 1.5 Signpost reference list as appendix at end of document

##### 2. Health, safety and environmental protection

###### 2.1 Introduction:

- 2.2 Procedure to address health, safety issues (both by contractor and client)
- 2.3 General safety
- 2.4 Radiological safety
- 2.5 Environmental protection associated with the site investigations
- 2.6 Role and selection of PPE/RPE

##### 3. Objectives of the site investigation

- 3.1 Reasons for site investigations
- 3.2 Site investigation as an input to decision making
- 3.3 Overall framework of activities in a site investigation

##### 4. Planning the site investigation

- 4.1 Roles during the site investigation process
- 4.2 Desk study and site reconnaissance
- 4.3 Design of the site survey

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- 5.2 Non-intrusive chemical surveys
- 5.3 Geophysical surveys
- 5.4 Intrusive investigations
- 5.5 Waste management
- 5.6 Off-site transport
- 5.7 Chemical and radiochemical analysis

5.8 Monitoring

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6.1 Reporting

6.2 Evaluation of site investigation data

6.3 Recommendations for future work

**7. Current capabilities, lessons for practice**

7.1 Case studies– to highlight specific issues

7.2 Summary of key factors/issues to be considered when assessing output (reliability, uncertainty etc.) from a site investigation

7.3 Recommendations for practice improvement

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