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SAFEGROUNDS
Review and commentary on site end-points and radioactively contaminated land management

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A report by Enviros Consulting Limited

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SAFEGROUNDS Learning network

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SAFEGROUNDS

Review and commentary on site end-points and radioactively contamined land management

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Executive summary

This report has been prepared by Enviros Consulting Ltd for CIRIA on behalf of the SAFEGROUNDS Learning Network. This is Draft 3.0 prepared after review by CIRIA and the SAFEGROUNDS Project Steering Group. To inform the document, a discussion session was held on the topic of site end-points at the SAFEGROUNDS Learning Network conference on 10 March 2005 and Draft 2 was circulated for consultation amongst interested attendees.

The report is intended to provide an understanding of the role of contaminated land management in site end-point decision making and to consider how the end-point objective may affect the land management programme. Accordingly, consideration is given to the potential site end-uses and site release end-points for radioactively contaminated land and the issues that need to be taken into account to facilitate regulatory compliance and stakeholder support. This report, as indicated in the title, introduces the key issues surrounding site end-points and radioactively contaminated land. This is an overview document from which it is expected that further work and discussions will take place.

Through the report, consideration is given to experience from radioactively contaminated land management activities at a number of sites in the UK and overseas. These examples are illustrative rather than comprehensive. They do not necessarily represent so-called international best practice (which does not exist), but are intended to indicate the implications arising from adoption of one strategy or another. References are provided at the end of the report, Chapter 8.

After a discussion of the report objectives and some background information, Chapter 2 provides a review of the basic concepts and terminology that is used specifically with respect to site end-points. This section attempts to discuss the use of particular terminology with regard to decommissioning and remediation of radioactively contaminated sites, and provides working definitions for the purpose of this paper.

A review is then provided in Chapter 3 of national and international guidance and recommendations, and their application in the UK within the UK regulatory framework. The review is focussed on radioactive contamination issues, since this is the main focus of SAFEGROUNDS. However, there are some important issues to address related to other hazards, not only non-radioactive hazards of radioactive materials, but also non-radioactive contaminants and physical hazards. Such factors would need to be taken into account in any framework for a coherent land use risk management strategy.

Recent legislation identifies that the NDA should establish end-points for each of the sites for which it has responsibility, taking into account the results of consulting stakeholders and overall government policy. The NDA has indicated that the views of the communities local to the sites will be a major factor in establishing end-points. The interaction between the UK Nuclear Decommissioning Authority (NDA), end-points and the SAFEGROUNDS principles are explored in Chapter 4.

Chapter 5 considers the relationship between interim land management options and site end-points. Depending on the requirements of the local community and other factors, the end-point may change over time as further information is obtained. Implementation of an option should only prejudice future actions to the extent that this is justified by protection objectives which apply today. At the same time, implementation of interim measures that meet present day needs should not be delayed indefinitely, simply on the basis that circumstances may change.

The roles of stakeholders and local communities are considered in Chapter 6. Land owners should take care to account for the contribution that local stakeholders and the public can make to discussions and the decision-making process of site remediation for future land use. Progress can be significantly facilitated if the results of consultation are fed into the management process in a clear and transparent way.

Finally, some issues for further consideration are discussed in Chapter 7. It is suggested that a discussion within the SAFEGROUNDS project steering group needs to take place to determine the next steps in this process. Through defining aims (and the work, priorities and methods needed to achieve these aims), the understanding of site end-points can be developed.

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1 Introduction

1.1 Objective

The objective of this report is to provide readers with an understanding of the role of contaminated land management in site end-point decision making, discussing the potential site end-uses and site release end-points for radioactively contaminated land and the issues that need to be taken into account to ensure regulatory compliance and stakeholder support. Examples from a number of national and international case histories have been used to demonstrate these interrelationships.

The paper does not provide guidance or recommendations for action. However, it complements the guidance given in the SAFEGROUNDS Good Practice Guidance for the Management of Contaminated Land on Nuclear and Defence Sites issued in 2002, and other SAFEGROUNDS papers on risk assessment and on community stakeholder involvement. This paper has been produced as a starting point for discussions on the decision making process for site end-points.

1.2 Background

In 2002 five key principles for good practice were outlined in the SAFEGROUNDS Good Practice Guidance for the Management of Contaminated Land on Nuclear and Defence Sites. These stressed the requirement for open and transparent consultation in the identification of the preferred management option (or options) for a given site, given the constraints of radiological protection and government policy.

Principle 3 of the Good Practice Guidance states that the site owners/operators should identify their preferred management option or options, based on their assessment of all relevant factors and stakeholder inputs. Such options will include definition of site end-points. Given the central role in remediation decision making of future site use, some discussion, with reference to the SAFEGROUNDS Principles, is necessary to assist site owners/operators in demonstrating adherence to wide stakeholder involvement and industry best practice in their activities.

Discussion within SAFEGROUNDS has noted that the derivation of end-points for radioactively contaminated sites involves issues much broader than those associated with other types of contaminated land. In addition, it would be useful for SAFEGROUNDS to produce information on the end-points that are being worked towards in other countries and thereby to consider what different stakeholders interpret the term "end-point" to mean. This allows lessons to be learnt regarding both successes and failures and will help in strategy development.

Accordingly, the report is intended to provide an understanding of the role of contaminated land management in site end-point decision making. In particular the report:

- reviews the relevant safety and environmental factors that both drive and constrain management decisions on end-points from the point of view of management of radioactively contaminated land

- provides examples from both within the UK (eg some MoD sites have already been sold for redevelopment) and abroad (USA, Europe etc), to show how these factors have impacted on actual cases in the past
- identifies issues linking future alternative politically and socio-economically preferred site end-points eg international guidance and recommendations, updates of government policy, NDA mission statements, BNFL Business Futures, SAFEGROUNDS guidance etc
- provides stakeholders and decision makers with knowledge of a range of potential remediation scenarios for radioactively contaminated land in the light of developing experience.

2 Basic concepts and terminology

This section attempts to discuss the use of particular terminology with regard to decommissioning and remediation of radioactively contaminated sites, and provide working definitions for the purpose of this paper. Often, in both the technical literature, and in organisational communication with the public, there is conflation of terms such as **end-point**, **end-state** and **end-use**. While in many cases this is not particularly significant, it is useful to clarify how they impact upon certain aspects of remediation planning and implementation.

2.1 End-point, End-state and End-use

The definition of an "end-point" or an "end-state" for decommissioning and remediation activities has been widely recognised as being crucial to the entire process, governing as it does both the choice of remediation technique to be used and the degree of acceptance by the local community. It may also be the case that no further action is necessary to meet the objectives, in which case the end-state will be the current state.

An ***end-point*** is a criterion or set of criteria defining the level of remaining contamination at or below which the site may be used for a defined purpose (which may be its current use, unrestricted use, or a specific subset of uses defined by inclusion or exclusion). This level needs to be transparently related back to the level of protection referred to in SAFEGROUNDS Principle 1. It can therefore be expressed in many ways which relate health risks to humans and the environment, such as, for radioactively contaminated land, radiation doses or activity levels for residual contamination.

The ***end-state*** of a site can be defined as "*the physical condition reached when cleanup actions are complete*" (US DOE, 2001), ie it is the physical state of the site when the end-point is achieved. It has been recognised as "*probably the most important single factor*" in the planning, managing and organisation of decommissioning activities. Further, it is suggested that "*end-states must be derived from the goals and objectives of the organization responsible for the tasks and also be acceptable to the organization taking over the facility at the end of decommissioning and any remaining stakeholders*". (IAEA, 2004a).

The ***end-use*** is the use (or set of uses) to which land may be put once the end-state has been reached, ie once the end-point has been satisfied. Hence, it is the combination of the end-state and end-use of the site that determine the risk to people using the site. There are of course many possibilities of what might be considered by stakeholders to be an acceptable ***end-use*** for a decommissioned nuclear facility site. In particular the ***end-use*** does not necessarily have to be unrestricted use. Some buildings or facilities may remain on the site, as long as they meet the end-point. For example, depending on national waste management policy, a portion of a decommissioned reactor site may remain under a new type of nuclear licence for storage of spent fuel in special storage casks. However, as the NEA has pointed out (NEA, 2003a), "*there may be public concern that the delicensed site not be viewed as a nuclear waste site*". Many communities may well wish to see no continuation of nuclear activities once a facility or reactor has ceased operation (see for example Box 6.3).

As recognised in the decommissioning policy statement of the UK Government and the devolved administrations in 2004 (DTI, 2004), sites of decommissioned nuclear facilities may represent a potentially valuable resource. The future use of the site, once decommissioning operations have been safely completed, could therefore be a significant factor in determining decommissioning operations. It may be possible in some cases to complete decommissioning operations to the point where unrestricted use is possible, although an overriding consideration will be whether this represents the Best Practicable Environmental Option (BPEO) for the site. Hence, this policy leaves open the choice of end-use, rather than assuming or prescribing a specific end-use. Experience to date suggests that potential uses will range from industrial and commercial use to unrestricted use. Consistency with the broad objectives of sustainable development may also need to be taken into account.

2.2 Brownfield and greenfield

Confusion sometimes arises regarding the use of such terms as ***greenfield*** and ***brownfield***. In strict planning terms, "brownfield site" is an informal term for "previously developed land", a definition for which[1] is given in Planning Policy Guidance (DTLR, 2000), and a greenfield site is one that is not brownfield, ie in simple terms, one that has never been used for anything other than agriculture, horticulture or forestry. Greenfield is sometimes used as a proposed end-state following remediation, which of course it could never be, when what is usually meant is "unrestricted use" (see for example Box 1 below).

2.3 Soil Guideline Values

Soil Guideline Values are derived from the Contaminated Land Exposure Assessment (CLEA) model developed for DEFRA and the Environment Agency in the context of non-radioactive contamination (see discussion in the SAFEGROUNDS Assessment of Health and Environmental Risks of Management Options for Contaminated Land paper (see www.safegrounds.com)). They are tools intended to help to answer the question "Does the soil concentration of contaminant X pose a significant risk to human health if the land is used for use Y?", and thus whether action may be needed. They indicate to an assessor that soil concentrations above this level could pose an unacceptable risk to the health of site users and that further investigation and/or remediation is required. Soil Guideline Values combine both authoritative science and policy judgements. However, being based only on human health considerations, they do not address the 'risk to the environment' aspects of the definition of "contaminated land".

A version of the CLEA model adapted for radioactively contaminated land – to be called RCLEA – is currently being developed for DEFRA (Penfold *et al*, 2005). The new model will calculate, for a range of land uses, radionuclide concentrations in soil that would be expected to result in radiation exposure at the level of defined dose or risk criteria.

1 Previously-developed land is that which is or was occupied by a permanent structure (excluding agricultural or forestry buildings), and associated fixed surface infrastructure. The definition covers the curtilage of the development. Previously-developed land may occur in both built-up and rural settings. The definition includes defence buildings and land used for mineral extraction and waste disposal where provision for restoration has not been made through development control procedures.

The definition excludes land and buildings that are currently in use for agricultural or forestry purposes, and land in built-up areas which has not been developed previously (eg parks, recreation grounds, and allotments - even though these areas may contain certain urban features such as paths, pavilions and other buildings). Also excluded is land that was previously developed but where the remains of any structure or activity have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings), and where there is a clear reason that could outweigh the re-use of the site - such as its contribution to nature conservation – or it has subsequently been put to an amenity use and cannot be regarded as requiring redevelopment.

2.4 Practices and intervention

Radiation exposure situations can be divided into two fundamental types:

1. ***Practices*** - planned activities that increase the existing human exposure above the pre-existing natural background, for example by discharging radioactive effluents or producing radioactive residues.
2. De facto exposure situations in which exposure is occurring and protective or remedial actions (***intervention***) may be undertaken with the purpose of reducing the existing exposure. Intervention situations include exposure to naturally occurring radiation sources (eg radon in buildings) and the aftermath of accidents.

The current ICRP system of protection for practices requires that:

- the practice, overall, should do more good than harm (the justification principle)
- radiation protection should be *optimised* such that exposures are as low as reasonably achievable, economic and social factors taken into account (the ALARA or optimisation principle), with doses and risks to individuals being subject to constraints
- the total exposure (dose or risk) to individuals from all controlled practices should be limited (dose and risk limits).

These principles are intended to be applied prospectively at the planning stage of any practice expected to produce radioactive residues. They include dose limits for workers and the public, as well as dose constraints, intended to constrain inequity that might otherwise arise from the application of the ALARA principle.

ICRP's system of protection for intervention situations includes justification and optimisation principles, but not dose or risk limits.

The categories of practice and intervention were defined to fit the majority of situations in which radiation protection is important. However, there are some situations – including many radioactively contaminated land situations – that do not clearly and obviously fit into one of the two categories. Since the dose criteria typically applied to practices and intervention can differ by orders of magnitude, the issue of how to categorise situations in this "grey area" may have a significant impact on decisions about end-points.

For off-site contaminated land, an intervention regime can be applied, according to ICRP's guidance on prolonged exposures from residues (ICRP, 2000b). This goes further to suggest that residues from past practices should also be considered under an intervention regime. ICRP note, however, that where the organisation responsible can still be identified, more stringent remediation criteria may be appropriate. ICRP (2000b) also suggest that for residues from current practices, or practices to be authorised in the future, practice criteria should be applied to the long-term exposures.

It is also relevant to note that ICRP is currently considering the possibility of revising the system of radiological protection in a way which would dispense with the need to distinguish between practice and intervention, and simplify the application of radiation protection to these situations.

2.5 Exemption, clearance and exclusion

Exemption and clearance relate to the regulations for keeping and use of radioactive materials and the disposal of radioactive waste, and so neither is directly applicable to the setting of end-points for radioactively contaminated land. However, clearance in particular has some indirect relevance: for example, if a site end-point is higher than clearance levels, then any soil subsequently dug up from the site might be considered radioactive waste. A brief discussion of the concepts is therefore considered relevant.

Exemption is a process by which practices using radioactive material can be designated as not subject to certain (or all) aspects of the regulatory control framework for radiation protection, on the grounds that they pose such a small radiological risk that regulation is not warranted. ***Clearance*** is a process by which regulatory controls are lifted from radioactive substances that had previously been controlled, on the basis that regulation is no longer warranted. Although these are distinct concepts, they are often confused, and the criteria applied are often numerically the same. For example, criteria for both exemption and clearance are typically based on a "trivial" individual dose of 10 μSv per year (as recommended by ICRP in its 1990 Recommendations).

The radionuclide-specific exemption levels in the Basic Safety Standards Directive (and also in the International Basis Safety Standards) were derived on the basis of 10 μSv/y as the primary criterion applied to likely exposure routes, with an additional criterion that the doses from unlikely scenarios should not exceed 1 mSv in a year. A collective dose criterion of 1 man Sv per year of the practice was also used. The exemption levels, expressed in terms of total activity (Bq) and activity concentration (Bq/g), were derived using simple exposure scenarios considering small amounts of material likely to be exempted. The Directive does not specify levels for clearance.

The IAEA has recommended clearance levels for a number of key radionuclides in solid materials (IAEA, 2004b), designed to assist national regulatory agencies in their deliberations. These were derived on the basis of 10 μSv/y for likely exposures and 100 μSv/y for unlikely exposures, and took account of the large amounts of waste that may arise, for example during decommissioning. The clearance levels (Bq/g) derived for many radionuclides are consequently lower than the exemption levels.

The European Commission's Article 31 Group has also recommended clearance levels, generally for practices (EC, 2000a) and specifically for buildings and building rubble from the dismantling of nuclear installations (EC, 2000b).

Exclusion is a distinct concept whereby certain types of exposure are excluded from the scope of legislation or regulations on the grounds that they are "essentially unamenable to control". Common examples include exposure due to cosmic rays at sea level and exposure due to naturally occurring potassium-40 in the human body. A specific case in UK legislation is that Schedule I of the Radioactive Substances Act 1993 excludes from the scope of the Act substances containing only naturally occurring radioactive elements below concentrations set out in the Schedule.

3 Existing guidelines on end-points

3.1 International standards and recommendations

There is no single international regulatory regime that covers all aspects of the management of radioactively contaminated land. The following guidelines and recommendations are, however, relevant:

- international recommendations on radiological protection (ICRP-60 in general (ICRP, 1991), ICRP-77 on waste generally (ICRP, 1998), ICRP 81 (ICRP, 2000a) on solid waste and ICRP 82 (ICRP, 2000b) on situations involving prolonged exposure, typical of contaminated land);
- international Basic Safety Standards designed to meet the protection objectives (IAEA, 1996)2; and
- international guidance on how to meet those standards in IAEA safety standards documents and TECDOCs, eg (IAEA, 2003).

3.1.1 ICRP

ICRP, the International Commission on Radiological Protection, is an advisory body of experts providing recommendations on radiation protection. ICRP is non-governmental, and its recommendations have no legal force, but ICRP recommendations are used as a primary basis for radiation protection legislation and/or regulation in most countries, and by international organisations such as the IAEA (see below). However, the interpretation and application of ICRP recommendations vary, leading to some practical differences in, for example, criteria for contaminated land.

ICRP's 1990 Recommendations (ICRP, 1991) provide the basic framework for radiation protection. The main issue of interest with regard to radioactively contaminated land management arising from these Recommendations – namely the concepts of practices and intervention – is discussed in Section 2.4.

ICRP has made specific recommendations in its Publication 82 on protection in situations of "prolonged radiation exposure" (ICRP, 2000b), which includes situations of radioactively contaminated land. The recommendations draw upon the concepts of practices and intervention discussed above. ICRP recommends the application of existing criteria for practices when contaminated areas that are currently under control are to be put to a new use that will lead to new groups of people being exposed, and suggests an additional dose constraint of 0.1 mSv per year for the contribution to dose from very long lived radionuclides contaminating such areas. For intervention in existing situations, however, ICRP recommends much higher criteria:

- if current exposure is below 10 mSv per year, intervention to reduce the existing dose is unlikely to be justified
- if current exposure is above 100 mSv per year, intervention will almost always be justified

2 It may be noted that the IAEA BSS are said to be consistent with the ICRP principles, and arguably are. However, there is no obvious correspondence between the IAEA BSS and the IAEA's own principles of radioactive waste management (IAEA, 1995), which among other things explicitly include protection of the environment.

- if current exposure is between 10 mSv and 100 mSv per year, intervention decisions should be taken on a case by case basis, using the justification and optimisation principles.

These criteria refer to the levels that would trigger intervention, and if intervention is undertaken then its form and duration should be determined by the optimisation principle. Hence, the criteria do not directly indicate an end-point, except that it would usually be below 10 mSv per year (otherwise, further intervention would need to be considered).

ICRP are revising their fundamental recommendations, and an update to the 1990 Recommendations is likely to be published within the next year or two. The main principles of protection are likely to remain largely the same, although there may be greater recognition of a "grey area" between practices and intervention. There is however, a new framework proposed for the protection of non-human species. This may need to be taken into account and involve the assessment of radiological end-points which were not previously considered. The IAEA and European Commission both have on-going projects to develop internationally recognised bases for protection of non-human biota, but in the mean time Copplestone *et al* (2001) provides a useful UK perspective.

3.1.2 IAEA

The IAEA is an intergovernmental organisation of the UN family, and its Statute authorises it to establish safety standards, inter alia for radiation protection. IAEA safety standards represent an international consensus of the IAEA Member States (including the UK, and the IAEA is bound, by a decision of its Board of Governors, to take into account ICRP recommendations). The safety standards are legally binding only on the Agency itself and on IAEA-sponsored projects: Member States are not legally obliged to comply with the standards in their national activities.

The International Basic Safety Standards for Protection Against Ionising Radiation and for the Safety of Radiation Sources (IAEA 1996) are endorsed by the IAEA and five other international organisations. These set out the main principles of radiation protection, and follow fairly closely the recommendations of ICRP, including the framework of practices and intervention. They also include radionuclide-specific exemption levels, which effectively define the lower bound of application of the Standards. These levels are expressed in terms of total activity or activity concentration estimated to lead to "negligible" doses (less than 10 ìSv per year) under reasonably foreseeable circumstances, and practices that use only materials below the exemption levels are not considered to require radiation protection regulation.

More specifically, the IAEA has issued Safety Requirements for the remediation of areas contaminated by past activities and accidents (IAEA, 2003). These Requirements address only those situations classified as intervention. For such situations, they specify essentially the same criteria as recommended by ICRP.

As regards future activities, the IAEA has established a group that is now addressing the question of how to deal with protection of the environment, as opposed to humans, from the effects of radiation. The initial deliberations of this group are included in a report for discussion, "*Protection of the Environment from the Effects of Ionising Radiation*", TECDOC-1091, 1999. It observes that, although the traditional ICRP approach of assuming that if man is protected the environment will be adequately protected is still widely retained, several countries recognise the need to develop guidance and criteria explicitly for protection of the environment. It notes that there is no clear consensus on what guidelines, end-points or targets may be used as a basis for environmental protection, but a number of ideas have been put forward and it concludes that there is sufficient knowledge of the effects of radiation on organisms other than man to move forward on the subject.

3.1.3 European Commission

In May 1996 the Council of the EU issued a Directive laying down its Basic Safety Standard (BSS) for radiation protection (EC, 1996), with radionuclide-specific exemption values equal to those in the International BSS. The Directive defines "practices" as processes utilising the radioactive, fissile or fertile properties of natural or artificial radionuclides (ie the nuclear industry) and "work activities" where radioactivity is incidental but can lead to significant exposure of workers or the public.

The Basic Safety Standards Directive is binding on the UK, and its provisions have been transposed where necessary into UK legislation and regulations. The Directive takes a similar form to the International Basic Safety Standards, and includes the same exemption levels.

3.1.4 Alternative views

It is should be stated that there is a continuing debate related to the concept and calculation of dose and the subsequent risks associated with the exposure from radioactive material. There are a number of alternative views that are divergent from the linear non-threshold dose risk relationship as advocated by ICRP and used in most countries as the basis for radiation protection legislation. These alternative views include, but are not limited to:

- one representing the view that the risks from some internal radiation exposure regimes are substantially underestimated by ICRP models – as advocated in the 2003 Recommendations of the European Committee on Radiation Risks
- one representing the view that the risks from radiation exposure are substantially overestimated by ICRP models – as advocated by the US Health Physics Society.

A more complete discussion of these considerations is provided in Appendix 1 of the "Assessment of Health and Environmental Risks of Management Options for Contaminated Land" (SAFEGROUNDS, in preparation).

3.2 National approaches

It appears generally true that only where there is clear policy on future use of nuclear power is there clarity about site end-use. For example, in Germany and Holland, where nuclear power is to be phased out, the ultimate goal is to release former facility sites for unrestricted use. Conversely, in Japan, which is still committed to nuclear power, policy foresees the site of a decommissioned plant being continuously utilised as a controlled nuclear site.

Plans for decommissioning a site might therefore consider different sections of a site for different end-uses within the above range and might even foresee such end-uses changing over time. This is reflected in strategies in other countries that involve combinations of immediate dismantling, deferred dismantling and safe enclosure, waste treatment and storage, waste disposal, decontamination and clearance of buildings, plant and materials, and site remediation. In practice, planning of end-uses or, perhaps, "interim end-uses", is likely to be a matter of assigning such end-uses on the basis of what is reasonably achievable within the framework of regulations, funding and contemporary Government policy.

In the UK, the 2004 policy statement on decommissioning lays out clear criteria that should be applied in the development of site specific decommissioning strategies, either by the NDA or other relevant site operators. In the case of NDA sites, these will be subject to ministerial approval (DTI, 2004).

The HSE has recognised that a site licensee 'may decide that the end-point for decommissioning on a nuclear site is delicensing (which) involves the release of the land from regulation under NIA65 and the release of the operator of the facilities from his period of responsibility for any nuclear liability. Delicensing may not always be the end-point of a decommissioning project, for example, the licensee may plan to operate another nuclear facility on a site or to maintain institutional control' (HSE 2001). At sites where decommissioning and/or remediation have taken place, there are few examples of the site licensee being able to give up his licence. In part this is because the next use of the land concerned has not been finally decided.

Box 3.1 *Variations in national policies regarding decommissioning end-points (taken from NEA 2003b)*

More than 60 per cent of respondents (to a detailed questionnaire) answered that a required end-point of decommissioning exists. Some reported that national policy does not require a specific end-point but that one is specified in strategy development for cost analysis (Belgium), agreed by the plant operator and the decommissioning operator only (Spain). In some countries (eg Switzerland), "greenfield conditions", ie essentially unrestricted release of the site, are assumed as end-point for the purpose of cost estimates.

Five responding countries (Finland, Hungary, Italy, the Netherlands and the Czech Republic) stated that the required end-point is unrestricted use of the site (removal of contamination and radioactive sources above clearance levels or 'greenfield'). In Finland, responsibility of the site owner only ends when all radioactive wastes have been disposed of and approved by the regulator.

In Armenia and the Russian Federation the site is foreseen for nuclear or other industrial use. In the UK, US and Slovak Republic unrestricted use, restricted use or use for a new nuclear facility are seen as viable options. In Japan it is recommended that the site of nuclear power reactors shall be re-used for nuclear power generation.

In the United States, the DOE issued a Policy in July 2003 outlining how the derivation of what are referred to as "Risk-Based End-States" should be developed for all sites undergoing cleanup (US DOE 2003). Once an initial End-State Vision has been developed in conjunction with all relevant stakeholders, an Implementation Strategy is to be developed which accords with the Vision. The end-states are to be driven by the proposed future land uses envisaged for the site. These documents are generally similar to the NDA's Life Cycle Baseline Documents but emphasise the need to have wide agreement on proposed uses for sites prior to selection of remediation strategies.

3.3 The UK approach

3.3.1 Non-radioactively contaminated land

The contaminated land regime which is set out in Part IIA of the Environmental Protection Act 1990 was introduced in England on 1 April 2000, and on 1 July 2001 in Wales. A similar regime was introduced in Scotland on 14 July 2000. Part IIA provides a risk based approach to the identification and remediation of land where contamination poses an unacceptable risk to human health or the environment (see Box 2). Local authorities are the primary regulator; EA or SEPA take responsibility if the land is designated as a special site during characterisation of the contamination (see Box 3). These sites are often already regulated by the Agency through other regimes or the Agency is better placed to deal with the issues, for example, where important groundwater is affected.

Part IIA deals with sites where historical contamination has made them unsuitable for their current use. In this sense, the Part IIA regime may be considered analogous to the intervention concept for radioactively contaminated land. It is anticipated that most land affected by contamination will be dealt with when sites are redeveloped. When local planning authorities are considering granting planning permission for a development they need to be satisfied that any contamination is properly investigated and remediated to make the site fit for its proposed use. The planning regime uses the concept of "land affected by contamination" – a looser concept that would include "contaminated land" under Part IIA, but is also likely to include some land that would not be considered "contaminated land". The planning regime may be considered analogous to the practice concept for radioactively contaminated land.

Part IIA may not be applicable where authorisations are in place under other legislation, such as Integrated Pollution Control (Part I EPA), the Waste Management Licensing regime (Part II EPA), or where other legislation such as that to prevent pollution of controlled waters is relevant. Remedial activities themselves may require planning permission, and/or a licence under the Waste Management Licensing Regulations 1994, or other environmental protection permits such as discharge consents, Groundwater Regulations authorisations or a PPC permit. Any permit requirements for the remediation must be complied with.

UK policy also recognises that land development and redevelopment provide the best means of tackling much past contamination, and contaminated land has been and will continue to be, dealt with through planning legislation, ie the Town and Country Planning Act. The planning and development control process involves taking account of both the actual and intended uses of land, and of the risks which may arise from contamination, when a new use or development is proposed. Model procedures for the management of contaminated land have been set out by DEFRA and the EA in Contaminated Land Report 11 (DEFRA/EA, 2004).

Box 3.2 *Statutory definition of ‘"contaminated land"*

Part IIA provides a statutory definition of contaminated land:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:

(a) Significant harm is being caused or there is a significant possibility of such harm being caused.

(b) Pollution of controlled waters is being, or is likely to be, caused."

The other terms relevant to Part IIA regime, for example "significant", "harm" and "pollution of controlled waters", are defined in the legislation and the statutory guidance. Because of this definition, not all land affected by contamination is "contaminated land". Land is only defined as "contaminated land" if there is a "significant pollutant linkage" present. There must be evidence of a "contaminant-pathway-receptor" relationship. This means there should be a contaminant present, a receptor that could be harmed by the contaminant, for example humans, and a pathway linking the two.

Contaminant → **Pathway** → **Receptor**

Box 3.3 *Land required to be designated as a special site*

2 (1) Contaminated land of the following descriptions is prescribed for the purposes of section 78C(8) as land required to be designated as a special site:

(a) Land to which Regulation 3 applies.

(b) Land which is contaminated land by reason of waste acid tars in, on or under the land.

(c) Land on which any of the following activities have been carried on at any time;

(c.i) The purification (including refining) of crude petroleum or of oil extracted from petroleum, shale or any other bituminous substance except coal, or

(c.ii) The manufacture or processing of explosives.

(d) Land on which a prescribed process designated for central control has been or is being carried on under an authorisation where the process does not comprise solely things being done which are required by way of remediation.

(e) Land within a nuclear site.

(f) Land owned or occupied by or on behalf of;

(f.i) The Secretary of State for Defence

(f.ii) The Defence Council

(f.iii) An international headquarters or defence organisation

(f.iv) The service authority of a visiting force, being land used for naval, military or air force purposes.

(g) Land on which the manufacture, production or disposal of;

(g.i) Chemical weapons

(g.ii) Any biological agent or toxin which falls within section 1(1)(a) of the Biological Weapons Act 1974 (restriction on development of biological agents and toxins), or

(g.iii) Any weapon, equipment or means of delivery which falls within section 1(1)(b) of that Act (restriction on development of biological weapons), has been carried on at any time.

(h) Land comprising premises which are or were designated by the Secretary of State by an order made under section 1(1) of the Atomic Weapons Establishment Act 1991 (arrangements for development etc of nuclear devices);

(h.i) Land to which section 30 of the Armed Forces Act 1996 (land held for the benefit of Greenwich Hospital) applies.

(j) Land which;

(j.i) Is adjoining or adjacent to land of a description specified in sub-paragraphs (b) to (i) above, and

(j.ii) Is contaminated land by virtue of substances which appear to have escaped from land of such a description.

3.3.2 Radioactively contaminated land

Radioactively contaminated land on a nuclear licensed site is regulated by the HSE/NII under the Nuclear Installations Act 1965. Guidance for NII inspectors on the management of radioactive materials and radioactive waste on nuclear licensed sites (HSE, 2001) indicates that radioactively contaminated land is to be regarded as an accumulation of radioactive waste on the site and regulated accordingly. This effectively means that its management is treated as part of the practice being carried out on the site. Noting that management options include interim end-points, it is noted that increasing use is being made of Contaminated Land Safety Cases under nuclear site licence condition 32, to demonstrate how the licensee is controlling accumulations of radioactive waste.

The issue of delicensing a site is also addressed through the Nuclear Installations Act. In 2004, the HSE consulted upon a proposal to publish a policy statement setting out its criteria for delicensing parts of, or entire sites licensed under the NIA'65. To delicense part of, or a whole site, HSE must be satisfied that there has ceased to be any danger from ionising radiations from anything on the site or part therefore. Of particular interest in this consultation is the interpretation of "no danger". If a site has been subject to radioactive contamination, this term can be difficult to define, particularly in view of the usual regulatory assumption that there is no threshold below which small doses are harmless. However this argument will not be used to assume that HSE will never delicense a site (or part thereof). Box 3.4 below summarises the HSE's proposed criteria for no danger as detailed in the April 2004 consultation document.

Box 3.4 *HSE criteria for no danger (HSE, 2004)*

In HSE's view, requiring a licensee to demonstrate "no danger" cannot mean asking the licensee to demonstrate that the site is "completely safe". Such absolute certainty could never be delivered, no matter how comprehensively a site is cleaned up and monitored. To us, it suggests that after termination of licensable activities on a site, and following rigorous decontamination and clean up, it may be acceptable for there to remain a small but finite radiological hazard, whose further detection and reduction would necessitate a disproportionate effort and cost. HSE would, however, require the licensee to show that any residual radiological hazard will not pose a significant ongoing risk to any person, regardless of the future uses to which the site, or anything left on the site, may be put.

Taking account of existing published guidance, HSE believes that the possibility of a fatality of 1 in a million per year (1 in 10^6/y) might be regarded by society as a "broadly acceptable" level of risk to a member of the public going about their normal business. For practical purposes, therefore, HSE proposes using this criterion as the minimum requirement of what is regarded as "no danger" for the purposes of sections 3(6)(b) and 5(3)(a) of NIA'65. In addition, when interpreting 'no danger', HSE considers that this criterion should be supplemented by the ALARP[3] principle. This means that, in making an application for delicensing all or part of a site, the applicant should demonstrate that he has taken all reasonable practicable actions to reduce the residual risk below 1 in a million per year. The application of the "no danger" risk criterion and ALARP is consistent with the approach outlined in HSE's "Tolerability of Risk" and "Reducing Risks, Protecting People" publications.

HSE considers that equating "no danger" with these criteria is a pragmatic approach to satisfying the absolute and practically unachievable requirements of the Nuclear Installations Act. To place the residual risks we are considering here into a broader context, it should be noted that the average risk of death in the UK from naturally occurring radioactivity is estimated to be around 1 in 10,000 per year (1 in 10^4/y).

A formal response to the 2004 consultation has not yet been published. In the mean time, for practical purposes of planning for any unrestricted end-use, the standards outlined for non-nuclear sites in Environment Agency guidance (see below) are often used.

Any delicensing would be handled in consultation with the relevant environment agency, and therefore their acceptability criteria would also be relevant. However, it is unlikely that such criteria would be more stringent than those proposed by HSE.

A control regime for radioactively contaminated land is currently being established by DEFRA and the devolved administrations with the powers provided by Part IIA of the Environmental Protection Act 1990. Although the provisions of Part IIA were not developed to deal specifically with radioactively contaminated land the Act does give powers to the Secretary of State to apply any modifications necessary through

3 ALARP (As Low As Reasonably Practicable) is the legal term used in the UK in place of ALARA

regulations made under section 78YC of the 1990 Environmental Protection Act. A consultation paper was issued in 1998 on control and remediation of radioactively contaminated land (DETR, 1998). Taking account of the results of the consultation, DEFRA is currently preparing the elements of a comprehensive regime for radioactively contaminated land. They aim to conduct further consultation in 2005 with a view to issuing guidance in 2006.

This regime would apply to situations analogous to those already considered under Part IIA, ie where the contamination is the result of past activities and is considered to represent a significant hazard under current conditions, in particular, with current land use. In radiation protection terms, these would be the 'intervention' type cases. The regime would only apply to sites that are radioactively contaminated through industrial (not natural) processes including non-nuclear radioactively contaminated sites. The UK Environment Agencies would be the lead enforcement agency. It is expected that guidance on risk assessment and when a site can be considered suitable for use will be prepared. It would not apply to contaminated land on nuclear licensed sites.

Pending the establishment of such a regime, the Environment Agency has produced guidance for its inspectors on the regulation of remediation of radioactively contaminated land under current legislation. (The Environment Agency is separately developing guidance on requirements for revocation of RSA 93 authorisations.)

This guidance takes account of ICRP Recommendations and NRPB advice (NRPB, 1998) and recognises the distinction made between practices and interventions. However, the distinction is not always obvious in terms of contaminated land. If remedial action is taken on land that is currently accessible to the public, it might constitute an *intervention*. If land is not publicly accessible, but the site is redeveloped in such a way that would allow public access, then this would introduce new exposures from the activity remaining after remedial action. Therefore the exposures would be subject to similar criteria as those applied to *practices*.

Two main categories of situation are identified in the guidance, as follows.

1. A change of land use is proposed that is expected to increase public access and exposure. The system of control for practices should be applied, even though the practice that led to the contamination is no longer taking place.
2. Contamination is discovered on land to which the public have access, but for which no change of use is proposed. This situation should be considered as an intervention.

Recognising that some situations will not clearly fit one category or the other, the guidance states that such situations "should be handled in terms of the principles and criteria for practices unless there are clear reasons to suppose that this could do more harm than good." This is essentially the same view as that taken by NRPB in its advice (NRPB, 1998).

The EA guidance addresses primarily practice situations, because EA inspectors most commonly become involved in decisions concerning radioactively contaminated land at the point of redevelopment of land. For these situations, the guidance notes that, in order to apply radiological protection principles to remediation of radioactively contaminated land, an assessment of the potential radiological exposures is required and that a constraint applies to optimisation of the remediation strategy. In order to ensure that doses and risks to the public will not be unacceptable, the excess risk to a representative member of the most highly exposed group, attributable to the residual contamination, should not exceed a maximum risk of 10^{-5} y^{-1}. For year on year exposures over a lifetime, this corresponds to the risk associated with an effective dose rate of about 0.3 mSv y^{-1}. The figure of 10^{-5} y^{-1} represents a maximum value. In some circumstances, a lower risk constraint might be appropriate.

Any action will have to be optimised, to ensure that worker and public dose are ALARP. Optimisation will (often) require consideration of management options from "do nothing", through to complete decontamination, however that is defined. When considering the options, the future use of the site will be important and will determine the likely future exposures and costs of remedial work. Tools exist to support quantitative decision making of optimisation studies. For contaminated land where public perception will play an important role, multi-attribute or multi-criteria decision making methods rather than simple cost benefit analysis, may help operators/ land owners determine the most appropriate end-point.

The EA guidance notes that some remediation options would result in doses significantly less than 0.3 mSv/y, and that such options should be considered. However, the guidance concludes that significant expenditure to reduce the risk to future site occupants below about 10^{-6} y^{-1} is unlikely to be warranted on radiological protection grounds. If there are simple and inexpensive measures that could reduce risk further, they should be taken, but a detailed analysis of options would not be expected if the risks were already so low.

The EA guidance also discusses some practical reference points that may be used in addressing radioactively contaminated land, even if they were not designed for that purpose. Activities per unit mass in Schedule I of RSA 93 and the Substances of Low Activity Exemption Order (SoLA) Exemption Order (EO) were derived in the late 1950s and early 1960s largely on pragmatic grounds. These provide that material with activity concentrations of man-made radionuclides below 0.4 Bq/g (higher values for some isotopes of lead, thorium and uranium) need not be subject to regulatory control. This is not to say that the definitions are not or cannot be related to risk. They have recently been reviewed to investigate whether they are consistent with modern radiological protection principles. The review showed that, for waste soil deposited on or very near the land surface, the Schedule I and SoLA EO numbers correspond to a risk of less than 10^{-6} y^{-1}.

For situations involving radioactively contaminated land considered to be intervention situations, the EA guidance reproduces NRPB's advice. This largely requires situations to be addressed on a case-by-case basis, using the justification and optimisation principles for intervention. However, it is suggested that intervention involving major resources or disruption are unlikely to be appropriate unless they would reduce the doses by at least several mSv in a year. Less costly or disruptive actions might be warranted on the basis of smaller dose reductions.

Other research that may be relevant in this context has been carried out by SNIFFER (Scotland and Northern Ireland Forum for Environmental Research), most notably the recently published report on a "Review of the application of 'Best Practicable Means' within a regulatory framework for managing radioactive wastes" (SNIFFER, 2005). While not exclusively dealing with contaminated land it is applicable when considering the potential radioactive wastes arising from any contaminated land remediation process.

Box 3.5 *The Decommissioning of the UK Nuclear Industry's Facilities (DTI, 2004)*

Sites of decommissioned nuclear facilities may represent a potentially valuable resource. The future use of the site, once decommissioning operations have been safely completed, could therefore be a significant factor in determining decommissioning operations. It may be possible in some cases to complete decommissioning operations to the point where unrestricted use is possible, although an overriding consideration will be whether it represents the Best Practicable Environmental Option (BPEO) for the site. Experience to date suggests that potential uses will range from industrial and commercial use to unrestricted use. The objective should be to get the best solution overall taking into account the needs of the environment and the safety of workers and the local community. The range of facilities and circumstances to which the proposed policy will apply mean that the specific use (or uses) of each site cannot sensibly be determined many years in advance of decommissioning operations. To do otherwise risks foreclosing options currently not envisaged or imposing uses which turn out to be unsuitable. The Government expects operators to address the future use of sites in good time and to take decisions which take into account local factors and the wishes of the local community. Operators will therefore need to discuss potential uses with the Local Planning Authority, the regulators and local public and stakeholder groups (eg the NDA's Site Stakeholder Groups, and the National Stakeholder Group). In the case of sites for which the NDA is to become responsible, the NDA's strategy will include an objective as to the condition to which the site is restored, which will be subject to Ministerial approval.

4 The NDA, end-points and the SAFEGROUNDS principles

From 1 April 2005, the Nuclear Decommissioning Authority (NDA) assumed responsibility for 20 sites around the UK, which collectively represent the UK's civil public sector nuclear legacy. UK nuclear decommissioning policy (DTI, 2004) (see Box 5 above) and the Energy Act 2004 make it clear that it will be for the NDA to establish end-points for each of these sites, taking into account the results of consulting stakeholders and overall government policy. The NDA has indicated that the views of the communities local to the sites will be a major factor in establishing end-points.

It is therefore not entirely appropriate for SAFEGROUNDS to produce specific guidance on this topic. However, given the central role in remediation decision making of future site use, some discussion, with reference to the SAFEGROUNDS Principles, may be helpful, to assist the NDA and other relevant agencies in demonstrating adherence to wide stakeholder involvement and industry best practice in their activities.

The objective should be to get the best solution overall taking into account the needs of the environment and the safety of workers and the local community, both during remediation activities and in the longer term. In doing so the management solution should, at a minimum, demonstrate compliance with SAFEGROUNDS Principle 1:

> **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.**

However, the range of facilities and circumstances to which the principle will apply means that the specific use (or uses) of each site cannot sensibly be determined many years in advance of decommissioning operations. To do so may foreclose options currently not envisaged or impose uses on a site which are unsuitable. The Government expects operators to address the future use of sites in good time and to take decisions which take into account local factors and the views of local stakeholders. Potential use of a site will have to be agreed between the local planning authority, regulators, the public and other stakeholder groups. Sites that are the responsibility of the NDA will include an objective as to the condition to which the site is restored, which itself will be subject to Ministerial approval. Depending on final remediation activities, other communities, adjacent to remote waste processing or disposal facilities, if relevant, may also need to be consulted, as will those along potential transport corridors.

Notwithstanding this limitation, the NDA will be expected by all parties to act within the spirit of SAFEGROUNDS Principle 2:

> **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.**

The NDA has developed a comprehensive, all inclusive stakeholder involvement Framework.

SAFEGROUNDS Principle 3 is of particular relevance to the issue of end-points, emphasising as it does the need not only to merely involve a wide range of stakeholders in decision making (Principle 2) but also the importance of assessing all possible options (and therefore end-points) as early in the process as possible:

> 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.

This clearly recognises that the choice of **end-use** and therefore the **end-point** for nuclear sites will be influenced by a variety of factors. Government policy, at both national and local level, is likely to be the most important of these and this varies from country to country depending on future energy options and plans for site re-use (see Box 3.1). In the UK, at national level, the policies relating to long-term management of radioactive waste and to the role of nuclear power in future energy production are likely to the be most influential. At local level in the UK, the policies of Government and regulators in regard to duties under the Environment Act 1995 and other legislation are also likely to have an appreciable effect.

In 2003, the IAEA referred to site remediation activities, saying that "*the goal of remediation activities is the timely and progressive reduction of hazard and eventually, if possible, the removal without restrictions of regulatory control from the area. In each specific situation, remedial measures shall be based on reference levels established as part of the decision making process*."

SAFEGROUNDS Principle 4 is therefore relevant here, referring as it does to the need to conduct activities in a timely fashion:

> 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.

It is also essential that the selected **end-point** meets other societal criteria. It should be one that is *"sensible in technical, social and financial terms, that properly protects workers, the public and the environment and, in summary, complies with the basic principles of sustainable development" … "It is generally presumed that the eventual* ***end-point*** *of these activities is return of the site to a condition in which it can be released for unrestricted use"* (NEA, 2002).

In all cases there is an overarching need to maintain full and comprehensive records of all activities concerned with remediation of the land in question, including a clear audit trail of how specific decisions were taken. This is enshrined in SAFEGROUNDS Principle 5:

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.

Indeed, IAEA (2003) suggests that "*a remediation plan showing that remediation can be accomplished safely should be prepared for each contamination area, this plan should be approved by the regulator and should include the goal for remediation, reference levels for remediation, the nature, scale and duration of the remedial measures, the waste disposal or storage requirements, post-remediation restrictions, monitoring and surveillance programmes and institutional control requirements. If the approved goals are not met, further decisions will be required to determine whether further remediation measures are necessary*".

It may be necessary to apply specific restrictions for the removal of radioactive material from contaminated areas, control access to specific areas, and institute limits on the future use, including for the production of foodstuffs and water use. These restrictions would apply to the end-point of the site. However, if no restrictions or controls are placed on the land following remediation, the land "*shall be considered to constitute the background conditions for new practices or for habitation of the land*" (IAEA, 2003).

As discussed in Chapters 2 and 3, the UK framework for radiological protection is based on ICRP recommendations and therefore adopts the concepts of optimisation of practices and interventions. For contaminated land in the UK it can be difficult to determine whether the situation is a practice or intervention. Where it is unclear, the principles and criteria for practices should be used unless there is a reason that to do so could potentially cause more harm than good (NRPB, 1998; EA, 2002).

It is worth considering how far the SAFEGROUNDS Principle 1 (Protection of People and the Environment) meets the ALARP principle, that any future exposures to occupants of the site and exposure of workers during remedial actions are As Low As Reasonably Achievable, economic and social factors being taken into account. By applying Principles 2 (*Stakeholder Involvement*) and 3 (*Identifying the Preferred Land Management Option*), a range of options for the site should be considered, taking account of the need to immobilise or isolate the radioactive material on-site or removal off-site and acting in accord with Principle 4 (*Immediate Action*) as regards timescales.

The NRPB (NRPB, 1998) has recommended that the excess risk to the critical group as a result of residual contamination and future use of the site should not exceed a risk constraint of 10^{-5} y^{-1}. This is equal to the recommended risk constraint for future exposures arising from land based disposal of solid waste and the HSE benchmark level of risk for new nuclear power stations. However, it is not easy to define the assumptions concerning the critical or other exposure groups, whose radiation exposure (to dose and/or risk) is to be assessed against constraints.

There may be situations whereby the optimisation requirement can be relaxed, ie a level below which it is not necessary to consider the application of significant resources to achieve further reductions (NRPB, 1998). However, in some cases, the operator may decide that further risk reductions can be achieved with little extra cost, for example Defence Estates (see Box 6.5).

The level of remediation required on an industrial or commercial site to achieve a satisfactory end-point may be less than the level required for development of a site for housing. It is unlikely however, that significant expenditure to reduce excess risk to an average member of the most highly exposed group of future site occupants to below about 10^{-6} y^{-1} would be warranted on radiological protection grounds. This is the target now widely accepted for radioactive waste disposal (EA *et al*, 1997) and it corresponds to an annual dose below about 20°µSv (Oatway and Mobbs, 2003). If there are simple and inexpensive measures that could reduce risk below 10^{-6} y^{-1}, these should be taken.

It is for licensees to identify and evaluate the possible remediation options, and to obtain HSE permission for their chosen course of action. HSE enforcement powers in this area derive from the conditions attached to nuclear site licences, particularly the conditions that require adequate arrangements for storage of nuclear matter (condition 4(2)), adequate records (Condition 6), safety cases (Condition 23), wastes to be minimised (Condition 32) and wastes to be contained (Condition 34). The environment agencies have powers relating to disposal of radioactive waste and these would be used in the event of movement of radioactive contamination off-site.

5 The relationship between interim land management and site end-points

The need for remediation and the judgement about permissible residual contamination levels are often driven by site owners' or society's wishes to bring a site back into use. Depending on the envisaged land use and foreseeable exposure pathways, permissible residual contaminations may be different. Land to be sealed and earmarked for industrial use might be left with a higher residual contamination than land for residential, recreational or agricultural uses, for example (IAEA, 2002). However, the legislative and regulatory framework will decisively influence the decision making process in environmental remediation, both with respect to the way it is progressing and with respect to end-points to be achieved.

Remediation objectives and the technologies used to achieve those objectives have to be evaluated in terms of their potential impact on future land use. As the IAEA stated in TecDoc 1279, "*one of the overarching objectives is that the remediation not only improves the radiological situation, but that it also does not result in undue detriments to other properties of the site*". However, the corollary is also true, namely that "*the choice of remediation technique and strategy may put restrictions on possible future land use. For instance, certain land use types may interfere with containment or in situ fixation techniques*" (IAEA, 2002).

In some cases, it is the very fact that a site has been "off limits" to the public for a considerable length of time that can sometimes cause complications when it comes to deciding on post-remediation uses. In many cases in the US, sites that have been unavailable to the public for almost 50 years have now become valuable ecological reserves, and there is debate about whether they should be disturbed at all. As Greenberg *et al* (2003) has questioned whether it is better to physically remove all contaminated soil on a site to allow unrestricted use, including housing, or whether it is actually more sensible to simply change the future use designation to prohibit housing and not disturb the material at all, but cover it and allow industrial use only, or even leave it as a wilderness area?

As US DOE have identified (US DOE, 2001), the selection of the site cleanup remedy and its implementation process essentially determines how any residual hazards at a site will be managed for the long-term and therefore establishes implicit or explicit long-term stewardship needs; "*for example, a remedy that incorporates an assumption about anticipated future land use establishes the long-term stewardship need to ensure that actual land uses remain consistent with this assumption*".

In some situations, however, there may be no established consensus as to the future end-use for the site, or particular portion of the site, despite the fact that decisions are required regarding remediation strategies. As the IAEA point out (IAEA 2002), potential future land use can actually itself become a variable in the decision making process, which can allow for optimisation within certain constraints. We discuss stakeholder involvement in this issue further in Chapter 6. A major problem arises of course if there is no agreed end-use, in that there is thus no end-point for site stewardship; it could in theory continue in perpetuity. This can make calculation of realistic life-cycle costs for a remediation project "not meaningful" (DOE 2001).

In the United States, long term stewardship is defined broadly as "*all activities required to maintain an adequate level of protection to human health and the environment from the hazards posed by nuclear and/or chemical materials, waste, and residual contamination remaining after cleanup is completed. Some of these stewardship activities are prescribed by regulation, compliance agreements, or DOE orders, while others have not yet been defined*" (US DOE, 2001).

Relevant activities can range from varying degrees of surveillance, monitoring, and maintenance at sites with residual contamination to access restrictions at sites with hazards of greater concern. Stewardship activities may include safeguarding nuclear materials, monitoring the migration of contamination and the effectiveness of remedies, inspecting disposal cells, enforcing physical access restrictions, implementing permits and other legal or institutional controls, maintaining relevant information, and generally providing responsible long-term care of the sites. For example, clay caps built over landfills will require occasional repair due to damage caused by weather and erosion. Additionally, rigorous record keeping will be required to preserve information on the location and longevity of residual contamination to ensure future generations do not inadvertently disturb contaminated areas. Institutional controls may deliver an acceptable interim land management option until such time where an appropriate strategy to meet an agreed end-use can be implemented.

Stewardship is taken so seriously in the United States that there now is a dedicated Office of Legacy Management, which took over all related activities from the Office of Environmental Management in October 2003.

At UKAEA Dounreay, the contaminated land safety case is linked to the progression of the strategy for the site end-state, although as mentioned below in Section 6, that decision itself is not necessarily agreed by all parties at the present time. This issue has assumed increased importance now that UKAEA is proposing to accelerate the site decommissioning (NII, 2004).

6 Stakeholder perception and local community aspirations for sites

Failure to consider the local situation can derail the remediation process in a variety of ways. For example, even a well structured remediation plan may not be accepted by the local community. Particularly when institutional measures are part of the overall remediation strategy, solutions may fail when local behaviours are not considered adequately. Decisions may be considered inappropriate when they interfere with local practices and customs (IAEA op cit). It is important for operators and land owners to obtain stakeholder buy-in and demonstrate good practice both in terms of communication and remediation techniques, for a strategy and final end-point to be accepted.

Bardos *et al* (1999) pointed out that while selection of remediation methods should always be done in as open and transparent a way as possible, and without disadvantaging any individual stakeholder, for some stakeholders, the end conditions of the site are of more importance than the process used to arrive at that condition.

Box 6.1 *The Maralinga Rehabilitation Project, Australia – an example of non-standard end-points*

The $108 million Maralinga Rehabilitation Project to clean up the former British atomic test site in South Australia, the largest remediation of this type, was completed in 2000. The rehabilitation was agreed by the Commonwealth and South Australian Governments and the Maralinga Tjarujta traditional owners, following methods identified by technical experts.

The clean-up has largely been directed at remediating plutonium contamination caused by minor trials. The clean-up involved two components, the removal of surface soil from the more contaminated areas, and the treatment of contaminated debris pits.

In 1967, the British Government carried out Operation Brumby, which was intended as a "final" clean-up of the Maralinga site, before returning it to Australian Government control. The clean-up was predicated on the assumption of no significant future human habitation of the site. The project involved the burial of the most highly contaminated materials in shallow pits, with the ploughing of various areas, to depths of 15–25 cm, in order to dilute the surface activity levels by mixing with the clean lower soil. The clean-up failed to significantly reduce the hazard at the site.

In 1985, the Royal Commission into British nuclear tests in Australia recommended that the test sites be cleaned up to be fit for unrestricted habitation by the Aboriginal owners. The semi-traditional lifestyle of the Maralinga Tjarutja people was taken into account when the various options for the clean-up were put together and were based on assessment of the level at which risks for the traditional owners became unacceptable, considering social, economic, and scientific factors. Several parallel end-points for different parts of the site were determined by consultation between the authorities and the Tjarutja people and covered activities ranging from semi-permanent habitation to hunting and travel across the region.

The cleanup standard was determined such that the annual committed dose, for any scenario involving permanent occupancy by the Tjarutja would be less than 5 mSv. This standard and its associated risk of fatal disease of approximately 10^{-4} per year at age 50 were accepted by them as a reasonable limit. A non-residential area, in which transitory activities such as hunting and travel are acceptable, was established comprising those areas following remediation in which the annual dose by inhalation for 100 per cent occupancy was anticipated to exceed 5 mSv per year (Williams unpublished).

Box 6.1 *The Maralinga Rehabilitation Project, Australia – an example of non-standard end-points (contd)*

Despite acceptance of the cleanup by ARPANSA, the Australian regulator in 2000, some observers still feel that more work is required, to enable the Aboriginal owners complete and unrestricted access to the complete site area. However, they have been advised that as much as 450 km^2 remains unsuitable for habitation and is fenced off to restrict access (Parkinson 2002). Lifestyle changes could also markedly affect dose estimates. If in time the Maralinga Tjarutja were to move towards a more European lifestyle, with extensive areas being covered by concrete, tarmac, buildings and lawns, and living in western-style houses in suburban settings, then the dust levels and hence doses are expected to be much lower (ARPANSA 2004).

The issue of unusual behaviours arose in Australia (see Box 6.1 above) and the United States, at Hanford, where input from the local Nez Perce Native Americans persuaded DOE to change its conservative assumptions for post remediation behaviour to include their consumption of elk, deer and fish, as well as increased exposure to soil due to their particular lifestyle.

The US DOE Long Term Stewardship Study, published in 2001, already referred to, described community involvement in early determination of desired site end-points as "crucial" to local buy-in and acceptance of any proposed remediation plan. IAEA (2003) suggests that the *"decision making process shall provide for the involvement of a wide range of interested parties in the definition, implementation and verification of remediation programmes and for regular public information exchange on the implementation of these programmes*".

Comprehensive stakeholder consultation is essential for all aspects of decommissioning and remediation decision making, and the determination of acceptable remediation end-points and site end-uses are no different. As demonstrated clearly in the SAFEGROUNDS Guidance on Community Stakeholder Involvement (in preparation 2004), application of best practice whenever possible is however important in improving transparency, building trust and above all making better decisions based on overseas experience, it is clear that if this is carried out with due reference to the 2002 Principles, there is a greater chance of community buy-in and support. Given the timescales envisaged for remediation of most sites in the UK and overseas, such support is a prerequisite for success.

The Draft ICRP 2005 Recommendations also discuss the benefits of stakeholder involvement in terms of input to optimisation: "*While the extent of stakeholder involvement will vary from one situation to another in the decision-making process, it is a proven means to achieve the incorporation of values into decisions, the improvement of the substantive quality of decisions, the resolution of conflicts among competing interests, the building of trust in institutions as well as the education and information the workers and the public. Furthermore, involving all parties affected by the decision reinforces the safety culture and introduces the necessary flexibility in the management of the radiological risk that is needed to achieve more effective and sustainable decisions*" (ICRP, 2004).

Examples of improvements in remediation planning and increased local acceptance are becoming more common from around the world, and in particular from the United States where community involvement is now well-established and where oversight groups and panels are mandated in the regulations. In several cases local participation has resulted in increased local involvement far beyond that originally envisaged (see Box 6.2 below).

Box 6.2 *Development of Soil Action Levels at the Rocky Flats Environmental Technology Site, USA (taken from Till and Meyer 2001 and Earle 2004)*

Initially, a working group consisting of the Department of Energy, Environmental Protection Agency, the Colorado Department for Public Health and Environment and Kaiser-Hill (the site contractor) was formed to develop a consensus proposal for the appropriate cleanup standards and action levels that should apply at the Rocky Flats site, where components for nuclear weapons were made from 1952 until 1989.

This resulted in adoption of interim radionuclide soil action levels (RSALs). For plutonium, the RSAL was about 4,300 Bq kg^{-1} – assuming a dose limit of 0.15mSv y^{-1}. The RSALs, which determine post-cleanup limits for radionuclides in Rocky Flats soil, were incorporated into the Rocky Flats Cleanup Agreement (RFCA) between DOE the regulatory agencies (EPA and the Colorado Department of Public Health and Environment). However, there was considerable concern about these from people in the communities surrounding the site, who at that stage had had no input into the process. Concern developed over the fact that the RSALs for Rocky Flats seemed to be higher than at other remediation sites. This public concern led to calls for an independent assessment of the RSALs and the process used to establish them.

In October 1997 DOE agreed to support an independent re-evaluation of the soil action levels, to be overseen by a citizens' panel. The Radionuclide Soil Action Level Oversight Panel was created in January 1998 and this appointed a contractor in September 1998.

The Panel consisted of 16 people who represented a cross section of the local community, including those with technical and non-technical backgrounds, as well as members of public interest groups and local elected representatives. DOE, EPA and the Colorado Department of Public Health and Environment each had one ex-officio member. The Panel, which served in an advisory role only, met on a monthly basis until March 2000, with all meetings open to the public. Other information meetings were held when required, and each monthly meeting included a technical session for questions. The Panel operated through the process of consensus, which allowed disagreement to take place. An independent facilitator chaired each meeting, although the process has been described as long and tedious. The Panel was given the responsibility of recommending an acceptable soil action level value to the responsible agencies. The result was a more technically defensible and publicly supported soil action level.

The successes of this project; the establishment of trust, the open discussion of highly technical issues, the development of a methodology to calculate RSALs, all depended significantly on the narrowness of the context in which the project took place.

That narrow context is also the source of the project's failures, namely the failure (because it was excluded from the mandate) to consider RSALs in conjunction with economic and socio-political factors. Another failure was a failure to plan and provide for the implementation of the results of the project.

A number of conclusions can be drawn from this example:

- don't assume that local people have no contribution to make in technical discussions on site remediation levels or future uses
- allowing local people access to technical expertise and support can actually assist them in recognising the validity of a proposed remedy
- it is essential to demonstrate how decisions reached by consensus can be fed into the management process in a clear and transparent way.

At Oak Ridge, also in the US, a Specific End User Working Group was established to focus specifically on consideration of the community's values and how these could be incorporated in long term planning. Amongst many recommendations was one that DOE should strive wherever possible to use brownfield sites for additional facilities and that end-use decisions should be continuously re-evaluated, as better technologies become available. The West Cumbria Sites Stakeholder Group in the UK has recently set up a Life Cycle Baseline Sub-Committee to develop community and stakeholder engagement approaches to begin exploring the implications of LCBLs for Sellafield, Windscale, Calder Hall and Drigg, and to begin to explore site re-use and end-states.

In the UK, The NDA is proposing to carry out extensive research in this area according to its first Annual Plan (NDA, 2005), recognising that determination of suitable end-points can have significant impact on its activities and costs. It is expected to involve local and national stakeholders in these deliberations, and has developed a comprehensive stakeholder involvement Framework for use post-April 2005. (It is however important to realise that there remains uncertainty at many sites as to the process by which the initial Near Term Work Plans have been derived.) Even at those sites where consultation has gone beyond the involvement of statutory stakeholders (local councils, regulatory agencies etc), even basic issues such as determination of end-points or future site use are areas where improvements are still possible. One of the recommendations of the Business Futures Working Group (BFWG) of the now-terminated BNFL Stakeholder Dialogue, published in December 2004, was that *"On its formation, the NDA should give urgent consideration as to how stakeholders may best be engaged in decisions about site end-points on a case by case basis"* (Environment Council, 2004). Site stakeholder groups are adopting constitutions in line with the Stakeholder Framework, to include broader stakeholder representation.

Clearly it is important to fully involve local stakeholders in these discussions. It is however also essential that all those taking part do so from a common level of understanding. For example, in a review of the consultation process (see also Box 6.3) for the Dounreay Site Restoration Programme BPEO, it was pointed out that *"some of our interviewees said it was particularly disappointing that there was no consultation on the future of the site. One argument was that, though the UKAEA and some other parties might see a greenfield as the desired end-point, what was really required was a plan that combined decommissioning of the nuclear facilities with industrial redevelopment"* (Faulkland Associates, 2004).

Box 6.3 *The Dounreay site restoration plan (DSRP) end-point and public perception*

It is certainly clear from a reading of the proceedings of a 2003 stakeholder workshop on the LLW management BPEO at Dounreay that differing views were held amongst local people as to the supposed end-point for the site.

For example, as reported by White and Kemp (2003):

One Panel member expressed concern regarding the end-point of the DSRP. From recent meetings with DTI the Panel member understood that the outcome of the DSRP would be a green-field site. The Panel member concluded that this meant that storage would only be a short-term solution and that a final solution would require total removal of everything from the site. Another Panel member agreed that the DTI had given the impression that the end-point of the DSRP would be a greenfield site.

(A UKAEA spokesman) explained that the site end-point had not been finalised and that it was not pre-determined that the end-point would be a green-field site. (Another spokesman) added that if the site were used for waste disposal, then it would be landscaped to resemble a green-field site and that it would be safe for other uses.

One Panel member considered that it was necessary to know the end-point before making decisions regarding solid LLW management. Several other Panel members commented on public perception and the DSRP end-point. One Panel member said that the public would not want a nuclear dump.

Another Panel member thought that the public perception of the DSRP end-point was a golf-ball (the DFR sphere) and a green-field site. Another Panel member felt that the end-point was described as a "final solution" and that the public perception of this was a green-field site. Another Panel member had been given an impression of the site containing picnic benches following restoration.

Clearly there are indications here that confusion amongst stakeholders as to final site end-uses is real. Given that UKAEA admitted that final decisions had yet to be taken, it is unclear as to how choices amongst different remediation measures can be made without continuing stakeholder involvement. The advent of the NDA in April 2005 is obviously an important factor in maintaining public support.

Even in cases where there is now reasonable support for the remediation activities, there is clear evidence that several of the basic SAFEGROUNDS Principles were not initially applied, especially those concerned with early and comprehensive stakeholder involvement. It is far easier to gain support from early involvement than to have to struggle for it after key decisions have been made. BNFL have recognised this and in their contributions to the Stakeholder Dialogue have demonstrated clearly, through completion of various draft 'Generic Test Frameworks for Cleanup Projects', developed by the BFWG, that there is considerable scope for stakeholder input on issues such as derivation of final end-states for the Sellafield Site (Environment Council op cit). (It is expected that the NDA will support this view and will encourage similar approaches to stakeholder review of its activities, especially development of site specific Near-term Work Plans and Lifecycle Base Line studies.)

Other examples exist abroad. In France, ANDRA was unable to gain any real public confidence in its initial plans for the closure and remediation of the Centre de la Manche LLW disposal site. These had been developed without any meaningful local community input, and resulted in a series of time consuming inquiries. Only then, after changes were mandated, did acceptance gradually develop.

Similar lack of local involvement took place in Belgium around the Olen radium factory, although there was actually little opposition to what was proposed as the main aim was to reduce exposure levels in an existing residential area.

Finally, at Wismut in Germany (see Box 6.4), once the actual decision on remediation methodology had been taken, there was extensive involvement of the likely end-use stakeholders, such as farmers and industrialists, with close co-operation with local government bodies, covering all matters from traffic disruption to final choices of post remedial land use.

Box 6.4 *Wismut, Germany*

One of the important factors in the Wismut remediation plan is the political commitment made by the Federal Government. A stepwise process of planning and remediation was called for, including interim end-points, because of the scale of the problem. In accordance with ICRP recommendations, Wismut GmbH has carried out a series of multi-attribute utility analyses (MAUA) to evaluate alternative remediation options for tailings ponds and waste rock dumps around Ronnenburg. Important decision factors used in the analyses included:

(i) Costs; these related to impairment of natural resources, eg potential lack of access to safe water supply, which would have to be replaced from other sources.

(ii) Health risks; expressed and quantified in terms of "Loss of Life Expectancy" (LLE).

(iii) Public issues; these included environmental issues, public acceptance and socio-economic factors such as land availability and investment stimulation.

Set against these were a number of 'trade-off' issues, generally quantified in terms of costs. For example, one year of LLE was costed at DM 200,000, whilst trade-off costs of DM 10-100,000 per hectare were applied to remediated land.

Public acceptance and environmental issues were not costed but weighted in a value-laden system, from 1-100. The general public is not involved in the decision-making process but is informed of the conceptual plans for remediation of sites. The controlling factor on acceptability was actually regulatory approval.

However, once a decision on remediation methodology was made, discussions did take place with likely end-use stakeholders, such as farmers or industrial users. There is close co-operation on this issue with local government bodies, covering all matters from traffic disruption during work programmes to choices of post-remedial land use.

It is claimed that public attitudes have changed during the remediation period. From original mistrust and hostility, there is now more general acceptance of the need for the work and an understanding of the issues involved. (Pelz *et al* in IAEA, 2002)

These situations are not unique. Although there is often a loose presumption of unrestricted greenfield status as the eventual end-point for many decommissioning programmes, most plans involve substantial elements of deferred dismantling and institutional control or "long-term stewardship", for periods between 30 and 300 years, but lack detail as regards final objectives. There is clearly a requirement for early involvement of all interested stakeholders, not only those with statutory responsibilities. This is directly in keeping with Principle 2. The degree of involvement and the kinds of groups to involve are detailed in the SAFEGROUNDS Guidance on Community Stakeholder Involvement (2004 in preparation) and should be followed wherever possible.

Recently in the United States concerns have been expressed by several Site-specific Advisory Boards (legally mandated to be involved in review of cleanup activities) that their role is rapidly changing from one of involvement in major substantive decisions to one of "window dressing" to confirm decisions that have already been taken. More and more examples are being seen of where they are given merely a "review and comment" role. This risks destroying the hard-won credibility that has been built up over the last 8–10 years (Bradbury *et al*, 2003).

Examples do exist, however, of well organised, successful application of the stakeholder involvement Principles. The remediation of the AWE site in Cardiff, Wales, involved extensive stakeholder and public dialogue. Defence Estates inherited a successful relationship with the Local Liaison Committee which facilitated the remediation process. Further details are in Box 6.5.

Box 6.5 *AWE Cardiff site remediation: Stakeholder consultations*

In June 2003 Defence Estates completed the remediation of the former Ministry of Defence site operated by the Atomic Weapons Establishment in Cardiff prior to the sale of the land for redevelopment. The AWE Cardiff site was originally established as a Royal Ordnance factory during the Second World War. Its role changed in 1960, with production moving to the manufacture of components for the nuclear weapons programme and thus became one of a number of sites that formed Britain's Atomic Weapons Establishment. Activities on site generally comprised those that could be expected in a traditional engineering works, however some processes utilised depleted uranium (DU) and beryllium.

Site investigations identified areas of limited soil and groundwater contamination that would require remediation to facilitate any redevelopment of the site. Amongst other areas of 'conventional' contamination, localised DU contamination of shallow soil was found to be associated with one of the production facilities.

Defence Estates and their remediation consultants held discussions with the Environment Agency Wales (EA) prior to formulation of the remediation and procurement strategy. The EA expressed the view that the MOD should remediate all radiological contamination prior to any sale of the site to maintain public confidence in the process that had been established by AWE plc.

The remedial scheme for the site was designed to incorporate the removal of the DU contamination to remedial targets set to allow the unrestricted use of this area of the site. Previous investigation had determined the background a activity for natural soils in the north Cardiff area to be 1Bq/g and as such remedial targets were set to reflect this limit, allowing for no excess risk over background activity. In fact, following stakeholder consultation, DE decided to go beyond risk based criteria to lower levels for only small extra cost. Taking account of the low cost and the intangible benefits (such as goodwill), this extra work was considered to be beneficial.

The radiological remedial process comprised the excavation of contaminated soils with the streaming of waste for appropriate disposal. Waste with activity in excess of 11.1Bq/g was categorised as Low Level Waste (LLW) and was disposed of to the British Nuclear Fuels (BNFL) facility at Drigg in Cumbria, UK. Waste with activity in excess of the remedial target of 1Bq/g a but less than 11.1Bq/g was disposed of to local landfill under a "special precautions burial" authorisation. Waste segregation was undertaken using calibrated direct probe readings confirmed with on site analysis.

Box 6.5 *AWE Cardiff site remediation: Stakeholder consultations (contd)*

The excavation of DU contaminated soil was carried out within a tented secondary containment with forced air ventilation via High Efficiency Particulate Air (HEPA) filters with a 99.99 per cent efficiency, with discharge through a 4 m high stack.

An RSA93 Authorisation was obtained prior to the commencement of the remedial works to accumulate and dispose of soils contaminated with DU as Low Level Waste. The Authorisation also allowed for the limited discharge of gaseous and aqueous waste. Continual air monitoring was in place within the secondary containment during excavation works to demonstrate that no airborne activity was generated prior to filtration and discharge thus optimising risk to ALARP and in any case not exceeding 20 mSv over the works period. No aqueous waste was generated.

On completion of excavation works the area was subject to both an instrument survey and a rigorous programme of sampling and analysis, as agreed with the EA, to demonstrate the achievement of remedial targets. In total, approximately 40 tonnes of DU contaminated soil categorised as LLW was disposed of to BNFL Drigg and approximately 630 tonnes of waste categorised as VLLW was disposed of to landfill.

The remainder of the remedial works at the site were undertaken with precautionary health physics monitoring to ensure that any previously unidentified radiologically–contaminated material was appropriately streamed for disposal. The final outcome of the works was that the site at Cardiff was successfully and safely remediated. The process proved a very useful exercise for DE, highlighting practical and regulatory challenges.

Given the sensitive location of the site and the relatively wide knowledge of contamination conditions in the local community it was crucial that public perception of the project was understood and addressed during stakeholder consultations. Whilst the risks posed by contamination on the site were well quantified and understood by the various professionals associated with the project, there was a need to recognise that the perception of risk in the local community may be somewhat different. It is unwise of practitioners in contaminated land remediation to dismiss the perceived position as unfounded.

An apparently very successful programme of stakeholder consultation had been started by AWE plc during the decommissioning and DE undertook to continue this process throughout the remediation. DE inherited a very useful forum for consultation from AWE. The Local Liaison Committee; which was formed by AWE, comprised local councillors and representatives from the local authority, Health and Safety Executive, Emergency Services and Environment Agency. The attendance of local councillors ensured that a link with the local community was maintained. The results of the comprehensive environmental monitoring regime were presented at each Local Liaison committee meeting held periodically through the site work.

However, a view expressed quite forcibly was that the attendance of local councillors at meetings of the Local Liaison Committee was insufficient to guarantee a broad spectrum of support from local organisations. There was widespread suspicion and apprehension about the environmental monitoring regime, and this underlines the importance of independent verification of the results if the community is to accept the remediation of radioactively contaminated land.

7 Issues for further consideration

It is clear that a variety of factors are likely to modify future planning on site end-points and contaminated land management. The following issues are identified as requiring further consideration.

Depending on the requirements of the local community and other factors, the end-point of interest at a site may change over time as further information is obtained. Implementation of an option should only prejudice future actions to the extent that this is justified by protection objectives which apply today. At the same time, implementation of a potentially suitable option should not be delayed indefinitely, simply on the basis that circumstances may change. Policy and planning needs to allow for this while also providing a clear mechanism for action.

The uncertainties include the determination of practical derived standards which relate end-points for future site use to the levels of environmental and human health protection intended. There are technical issues associated with the risks associated with low level radiation exposure, and there are developing arguments concerning the appropriate assumptions for human behaviour at sites, and for other factors which define exposure group assumptions, in so far as they affect the assessment of radiation doses for comparison with regulatory and any other relevant protection objectives.

In addition, there are on-going developments in international recommendations, at the IAEA and within the ICRP, which may affect European law and add uncertainty to the appropriate management plan.

While the SAFEGROUNDS focus is upon radioactive contamination, there are some important issues to address related to other hazards, not only non-radioactive hazards of radioactive materials, but also non-radioactive contaminants and physical hazards. Such factors need to be taken into account in any framework for a coherent land use risk management strategy.

While regulatory requirements may differ, it may be difficult for external stakeholders to understand why any generic differences should arise between management of defence and nuclear sites.

Land owners should take care to account for the contribution that local stakeholders and the public can make to discussions and the decision-making process of site remediation for future land use. Progress can be significantly facilitated if the results of consultation are be fed into the management process in a clear and transparent way.

The NDA is currently developing a comprehensive stakeholder involvement framework that is currently available in a draft form on their website <www.nda.gov.uk>. This document provides a rationale for engagement, the key issues to be discussed and with whom, as well as how to run the engagement process. This document is to be used in conjunction with the draft Arrangements for Stakeholder Engagement, also available on the NDA web site. There is obviously a significant overlap between the NDA and SAFEGROUNDS on these issues.

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