Public Health England

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Principles for assessing the radiological impact of land contaminated with radioactivity

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Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. It does this through world-class science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. PHE is an operationally autonomous executive agency of the Department of Health and Social Care.

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Principles for assessing the radiological impact of land contaminated with radioactivity

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Abstract

This report presents guiding principles which should form the basis of any assessment of the radiological impact from using land which is contaminated with radioactivity. The principles are intended to cover assessments undertaken in support of decisions being made in England and Wales within either the statutory regimes for the identification and remediation of land contaminated with radioactivity made under Part 2A of the Environmental Protection Act 1990 or the Town and Country planning regimes.

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1 Introduction

A review carried out by Public Health England (PHE) showed that, whilst local authorities in England and Wales have a duty to assess the risks associated with land contaminated with radioactivity, very few of their staff had suitable expertise or experience to undertake such work (Oatway and Ramwell, 2016). Consequently, whilst many local authorities stated that they would contract out such work, it was felt that additional guidance should be provided to help local authorities quantify the quality of assessments done on their behalf.

In response to the request made by local authorities, PHE presents in this report the key principles for undertaking and reporting a radiological impact assessment with respect to land contaminated with radioactivity. Although the intended audience for this guidance is local authorities in England and Wales, it is hoped that it may also be useful to other stakeholders involved in carrying out or reviewing risk assessments with respect to land contaminated with radioactivity.

2 Principles for assessing land contaminated with radioactivity

2.1 Undertaking the assessment

The Radioactive Contaminated Land Statutory Guidance specifies the conditions for which land may be determined to be radioactively contaminated land (BEIS, 2018). One of these conditions is that contamination present as a result of the after-effects of an emergency, a past practice or past work activity should cause, or have a significant possibility to cause, harm to humans. With respect to the radioactive contaminated land regime, harm is defined as an annual effective dose from exposure to radioactive contamination greater than 3 mSv or an annual equivalent dose to the lens of the eye or to the skin greater than 15 mSv or 50 mSv respectively. Where exposure to contamination is not certain to occur, the local authority should regard the possibility of harm as significant if, having regard to any uncertainties, the potential annual effective dose from any lasting exposure multiplied by the probability of the dose being received is greater than 3 mSv so long as the annual effective dose, assuming exposure did occur, was below 50 mSv.

Where a change in land use is planned, the minimum requirement for accepting the application is that the proposed use of the land should not result in an annual effective dose from exposure to remaining radioactive contamination above 0.3 mSv (Environment Agency, 2012; HPA, 2009). The regime that the land is being assessed under should be clearly stated since this affects the criterion against which an assessment is compared to. In all assessments, no dose from background radiation should be included.

Principle 1: It should be clear whether the assessment is intended to support the statutory regimes for the identification and remediation of land contaminated with radioactivity made under Part 2A of the Environmental Protection Act 1990 or the Town and Country Planning regime.

Dose assessments are generally carried out using exposure scenarios to describe situations whereby a person could become exposed to radioactive material. Within each exposure scenario, exposure pathways describe the routes by which exposure to any radioactivity present could occur. Common exposure pathways in the context of land contaminated with radioactivity include ingestion of radioactivity within foodstuffs grown on the land, inadvertent ingestion of contaminated dust and soil, inhalation of suspended contaminated dusts, and irradiation of the body from radionuclides present in the ground or within dust present on the skin. If the land is contaminated with discrete radioactive objects rather than material distributed over an area, the selection of appropriate exposure pathways needs care as the physical size of the object can affect how it interacts with the body. For example, objects over about 100 µm in size cannot be inhaled although they could be inadvertently ingested.

The relevant exposure scenarios and pathways applicable to a site are used to define the conceptual site model (NIGLQ, 2012). As described in the Radioactive Contaminated Land Statutory Guidance (BEIS, 2018), a radiological assessment must consider how the land is currently being used and also how it could be used in any reasonably foreseeable situation. For practical purposes, reasonably foreseeable land uses should be those the land can be put to without requiring a new or amended grant of planning permission. Where a change of land use is planned, such that a new or amended grant of planning permission is required, then the assessment should consider all reasonably foreseeable uses that could be made of the land in its planned state.

Where appropriate, uses of land that may disturb buried contamination should be identified and their effects accounted for in the assessment. For example, gardening in a residential setting may disturb buried contamination and bring it to the surface resulting in additional routes of exposure such as the inhalation of suspended dust. Informal recreational use of land, for example children playing within the boundaries of an area where construction work is being undertaken, may also need to be considered although regard should be paid to the effectiveness of any measures put in place to prevent such activities.

It is important that site specific considerations are included as far as practical within any radiological impact assessment. However, the level of detail included in the assessment should be commensurate with the potential radiological risk. Consequently it is recommended that a tiered approach is adopted when undertaking an assessment so that best use is made of available resources (SNIFFER, 2007); (NIGLQ, 2012).

An initial qualitative assessment (tier 1) should be undertaken to determine whether a source-pathway-receptor link is likely to be present. All information relating to the site should be reviewed to identify whether there are any realistic routes by which radioactive materials could be present in the ground and where that material could currently be located. Identification should be made of what the land is, or could realistically be used for and what receptors could be present (for example humans, terrestrial or aquatic biota). The final stage is to identify whether there are any pathways that could expose those receptors to any contamination present. If a tier 1 assessment demonstrates that a reasonable source-pathway-receptor link could be present then the process moves to more complex levels of assessment.

A generic assessment (tier 2) often uses relatively simple mathematical models together with parameter values that are often generic in nature that may not reflect the characteristics of the site precisely. The aim of a tier 2 assessment is to estimate the likely magnitude of the dose rather than its precise value. Although it is important that the estimated doses are not

underestimated due to the use of inappropriate assumptions, care should be taken to ensure that unrealistic values or assumptions are avoided. Common simplifications made for a generic assessment include the assumption that an individual spends all of their available time on the land or that all of a single type of food consumed by an individual was produced within that area of land. As a tier 2 assessment includes a significant level of caution, if the estimated dose is below the statutory criteria then there is little possibility that the criteria will be exceeded and appropriate conclusions can be drawn.

If a tier 2 assessment estimates a dose which is close to or exceeds the statutory criteria then the assessment should be refined. A detailed assessment (tier 3) is intended to reduce uncertainty in the estimated dose by decreasing the assessments reliance on generic quantities and assumptions. This is often achieved by collecting additional data on the habits of any receptors or on the activity concentration of any contamination present, including how it varies both across the site as well as with depth. It may also involve the use of more detailed models although the complexity of any model used should reflect the available information. A tier 3 assessment may therefore require considerable resources to undertake.

Principle 2: A tiered approach should be used when assessing the radiological impact from using an area of land that may be contaminated with radioactivity. The level of detail in the assessment should be proportionate with the potential radiological risk.

For radiological protection, the International Commission on Radiological Protection (ICRP)* recommend that the risks to a population be assessed by estimating the effective dose to representative individuals of different ages, usually consisting of 1 year old infants, 10 year old children and 20 years old adults (ICRP, 2006). In some rare situations, the dose to the foetus may also need to be considered (HPA, 2008). The use of different age groups allows consideration of the effect of age-specific habits and differences with age in doses per exposure. The habits of the representative person may be based on individuals observed to be using the land or on a hypothetical person who could reasonably be expected to be present given how the land is or could be used.

Principle 3: The dose to the representative person should be assessed for comparison against the dose criteria. The habits used in the assessment should represent those of a 1 year old, a 10 year old or an adult and be appropriate for the area of land being assessed.

Mathematical models, such as the one described in NRPB-W36 (Oatway and Mobbs, 2003) or the RCLEA tool (Environment Agency, 2011), can be used to estimate the radiological impact to the representative person using an area of land for each exposure scenario and pathway given in the conceptual site model. Regardless of the model used, it is important that the

* The ICRP is the primary international body providing advice and recommendations on protection against the risks associated with ionising radiation.

assessment is performed by a suitably qualified and experienced individual and that the model and data used are suitable for the site in question.

Principle 4: All actual and reasonably foreseeable uses of the land, and all associated exposure scenarios and pathways, should be included in the assessment. Any models and parameter values used to assess the dose should be suitable for the site in question.

The area that could be potentially contaminated with radioactivity may vary from a few to many hundreds or even thousands of square metres. Contamination may also be present on the surface or at depth. The distribution and variation in the level of activity in the ground depends on what caused the contamination and what may have happened to that land since that time. For example, contamination caused by a leaking pipe may be limited to the area around the pipe but contamination caused by a spill may cover a larger area. The level of radioactivity present in different media will also depend on processes such as radioactive decay, uptake of radioactivity by plants and other biota, and migration with groundwater. All of these factors can influence the risk to health posed by the contamination and hence it is important that both the physical extent and the composition of any contamination are accounted for in an assessment.

It is important that the activity concentrations used in the assessment are representative of the level of radioactivity to which a person is exposed to when they are present on that land. However, it is recognised that this activity concentration may not be easily determined as monitoring may not encompass all areas of a site and often produces results that are highly variable. In addition, it is also often difficult to tie measurements made in relation to how much radioactivity is present with where individuals may spend their time. A practical approach in a tier 2 assessment is therefore to assume that any contamination is present with an activity concentration equal to the maximum measured and that any individuals using that land are only exposed to that level of contamination. For a tier 3 assessment, more effort should be made to estimate the average level of radioactivity that someone may be exposed to. This could be achieved, for example, by dividing the site into sub-areas each of which possess a more homogeneous level of contamination or where someone may use the land for a specific activity.

In some situations, especially where contamination is by small radioactive objects, exposure may not be certain to occur. In these cases, a specific estimate of the probability of an exposure occurring should be made in addition to an estimate of the dose assuming an exposure did occur (BEIS, 2018). An example of estimating the probability of encounter with a radioactive object is given in report PHE-CRCE-056 (Oatway et al, 2020).

Principle 5: The radionuclides present, their activity concentrations, their distribution across a site and the physical form of the contamination should be accounted for in an assessment. Where the probability of exposure occurring is substantially below unity an estimate of that probability should be made.

2.2 Interpretation of the results of an assessment

Based on assumptions made within the assessment with regards to exposure scenarios, pathways and parameter values, and uncertainties associated with those assumptions, the outcome of an assessment may be limited in its ability to inform decision makers. It is important that any such limitations, and possible ways in which the situation could be improved, are highlighted. For example, an assessment may have had to estimate, using very limited information, the extent of any buried contamination. It should therefore be highlighted that even simple maintenance work on the land may result in conditions that exceed those assumed in the assessment and could result in higher than estimated doses being received. Where this situation may arise, it is important that suitable precautions are employed until the risks are better defined, including the distribution of relevant information to all appropriate persons. It should also be highlighted that if work on the land is undertaken in the future, then the opportunity should be used to conduct further measurements to reduce the uncertainty in the assessment.

Principle 6: Any limitations on the application of the assessment to inform decisions being made with respect to the land, including those associated with uncertainties in the assessment, should be clearly stated and discussed.

3 Conclusions

This report presents key principles which should form the basis of any assessment of the radiological impact from using land which is contaminated with radioactivity. The principles are intended to cover assessments undertaken in support of decisions being made within the statutory regimes for the identification and remediation of land contaminated with radioactivity made under Part 2A of the Environmental Protection Act 1990 or the Town and Country planning regimes in England or Wales. These principles are designed to ensure radiological impact assessments are consistent, transparent and easy to judge with respect to their suitability to support decisions being made with regards to the land in question.

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