

# Higher Activity Radioactive Waste in Scotland

## Summary of 2022/23 Near-Surface Disposal Research Findings

### Background

Scotland has a legacy of nuclear sites. Managing radioactive waste and cleaning up these sites responsibly and safely is a critical part of dealing with this legacy. It is our aim to achieve a high level of safety in radioactive waste management that protects individuals and the environment and doesn't place an unnecessary burden on future generations.

Radioactive waste is a devolved issue and so to ensure it is properly managed, in line with international conventions such as [The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management](#), we are required to maintain and progress national policies, strategies and plans.

[Our policy](#) is that the long-term management of higher-activity radioactive waste (HAW) should be in near-surface facilities located as near as possible to the site where the waste was produced. Developers<sup>1</sup> must demonstrate how the facilities will be monitored and how waste packages or waste could be retrieved.

This policy is supported by an [implementation strategy](#). Together these set a framework for the management of HAW in Scotland. The implementation strategy contains a series of commitments for us and our partners.

One of our key partners is the Nuclear Decommissioning Authority (NDA), a non-departmental public body tasked with leading the clean-up and decommissioning work at its sites on behalf of the UK Government and Devolved Administrations. The NDA is responsible for implementing our HAW policy and is accountable to Scottish Ministers for aspects of its work in Scotland.

In line with commitments made in the implementation strategy, we have been working with the NDA, with input from its site operating companies and regulators, to conduct research into near-surface disposal (NSD) in Scotland. The findings from this research will be used to guide delivery of our HAW work programme within the phased approach set out by the implementation strategy, summarised below (with indicative timeframes):

- **Phase 1 (2016-2030)** will include a review of the HAW that is expected to arise in Scotland. The suitability of disposal as a waste management option for these wastes under current technologies will be reviewed.

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<sup>1</sup> The term "developers" is used throughout this document to maintain consistency with the policy. Under current arrangements this term refers to the NDA.



- **Phase 2 (2030-2070)** we will work with the NDA, radioactive waste producers and regulators to help develop NSD concepts. Plans for the design, siting and construction of NSD facilities and second-generation storage facilities will also be developed.
- **Phase 3 (2070 onwards)** we anticipate that replacement storage facilities will be constructed. Disposal technologies will be further developed and NSD facilities will be constructed and operated. In total this phase may last in the region of 300 years.

**This research makes no recommendations or decisions regarding NSD in Scotland, including locations or designs. It is an early step in the very long-term plan outlined above.**

The nature of this research and its findings are now being communicated as we want to be as open and transparent as possible about managing the Scottish nuclear legacy.



## 2022/23 Near-Surface Disposal Research Summary

Radioactive waste has arisen during the operation of Scotland's nuclear sites, and more will unavoidably arise as these sites are decommissioned. Managing radioactive waste and cleaning up these sites responsibly and safely is a critical part of dealing with this legacy.

The most hazardous waste to deal with in Scotland, from a radiological perspective, is higher activity radioactive waste (HAW). It is our policy that the long-term management of HAW should be in near-surface facilities located as near as possible to the site where the waste was produced. Developers must demonstrate how the facilities will be monitored and how waste packages<sup>2</sup> or waste could be retrieved.

During 2022 and 2023 the Nuclear Decommissioning Authority (NDA), working with us, led a research project to consider the feasibility of constructing and operating engineered facilities in which Scotland's HAW would be disposed: Near-Surface Disposal (NSD) facilities.

The following sections give a brief overview of how this research was conducted and what the key findings were.

### Methodology

This research project drew from international experience in implementing NSD and the various design types used or planned to date. This research project considered the relationships between different designs, site characteristics and the waste requiring disposal, amongst other factors.

To enable this, it was necessary to make assumptions. As the technical feasibility of NSD depends on site-specific characteristics, such as geology, the main assumption made for this research project was regarding location.

For the purposes of this project **only**, it was decided that research should be focussed on an area within a 2km radius of Scotland's civil nuclear sites, to enable the development of practical scenarios. This is also consistent with the policy

#### *Explainer:*

The term HAW includes all Intermediate Level Waste (ILW) and any Low Level Waste (LLW) which is not suitable for disposal in existing facilities.

Disposal is the final stage of the waste management lifecycle and is the emplacement of waste into an appropriate facility with no intention to retrieve it.

The term HAW also includes High Level Waste (HLW), however there is no HLW to manage in Scotland.

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<sup>2</sup> A waste package comprises the waste, which has been conditioned for long-term performance (for example, by encapsulating it in a cementitious grout), and the container in which this is held.

requirement for facilities to be located as near as possible to the site where the waste was produced. These sites are<sup>3</sup>:

- Dounreay, near Caithness
- Hunterston A & B sites, in North Ayrshire
- Chapelcross, in Dumfries and Galloway
- Torness, in East Lothian

It is stressed that this research project makes no recommendations or decisions about where future facilities should be sited; it identifies relevant technical factors which would need to be addressed, along with other factors, in future decisions about siting. Further research is required, alongside a siting strategy and community and stakeholder engagement plan to support future decision making around siting.

To understand the type and quantities of HAW in Scotland, high-level data were taken from the [UK's radioactive waste inventory \(UKRWI\)](#). The UKRWI is maintained by the NDA to support the planning of radioactive waste management activities, as well as to fulfil international reporting requirements, and holds estimates of the volumes and characteristics of existing radioactive waste and forecasts for that which is yet to arise, in line with current plans for decommissioning each site.

As summarised in an [NDA NSD position paper](#), the two main concepts for NSD are those located at the surface<sup>4</sup> ('at surface') and those located up to tens of metres below the surface ('at depth'). Various design variations are possible within these broad concepts. This research project considered eight designs.

For each design the technical factors relevant to its implementation were appraised, including safety, security and environmental performance. Planning considerations were identified, along with associated needs for transport and storage. Alternative scenarios were then considered in a sensitivity analysis, and indicative cost estimates were derived for all scenarios.

This research project also considered how retrieval of waste packages or waste could be achieved as well as how the performance requirements of a NSD facility will change throughout its lifetime, as it moves from operation through to its closure, and how things might then evolve up to tens of thousands of years in the future.

## Findings

The main finding from this research project was that it appeared possible to implement NSD at any of the sites considered. This was based on a thorough appraisal of the relevant technical factors, for the assumed scenarios, and highlighted which technical factors are likely to be pertinent to future decisions about

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<sup>3</sup> The HAW Policy also identifies waste from the Ministry of Defence Rosyth site as being in scope, however the UKRWI now indicates that this will be managed as LLW, i.e. does not meet the definition for HAW, and so has not been considered as part of this study.

<sup>4</sup> Dounreay's existing low level waste disposal facility is an example of an 'at surface' NSD facility.



siting. However, no consideration was given to non-technical factors such as local views, and these may ultimately have a greater bearing on future siting decisions.

It was found that, for a given volume of waste requiring disposal, the key interactions between the site characteristics and the facility design include geology, groundwater conditions, coastal erosion depth, spatial factors and access requirements. More favourable conditions may mean greater radiological capacity<sup>5</sup> and less reliance on engineered features, such as barriers to limit interactions between the facility and the surrounding biosphere. It was also identified that some site and design combinations would not work.

The disposal of radioactive waste is regulated in Scotland by the Scottish Environment Protection Agency (SEPA). In conjunction with the UK's other environment agencies, SEPA has published [guidance on the requirements for authorisation of NSD facilities](#). Amongst other things, this guidance requires developers to assess how people could be exposed to radioactivity from the waste in the facility<sup>6</sup>. Although there are other factors to consider, these assessments indicate which wastes may be suitable for disposal in a particular facility.

Based on the application of this guidance, the findings from this research project indicate that roughly three quarters of HAW in Scotland may be suitable for NSD. This is a current estimate based on high-level data held for the waste in the UKRWI and the assumptions used for this research project. Further work will be required over several decades to further this understanding, as more becomes known about the waste to deal with at these nuclear sites.

It was found that a facility's design and location affect what waste it can accept, with 'at depth' facilities generally able to accept more waste than 'at surface'. As expected, however, there are certain wastes which appear unsuitable for NSD regardless of facility design or location, due to the nature of their long-lived radioactive properties<sup>7</sup>.

This research project included a scenario analysis in which the implications of having different combinations of sites and facilities were considered, including a scenario in which a single, national repository was assumed. This illustrated the interplay between disposal scenarios and other aspects of waste management, for example

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<sup>5</sup> Here the term radiological capacity is used to refer to the amount of radioactivity that a facility could accommodate. Different radioactive wastes have different levels of radioactivity, and this radioactivity can come from a variety of radionuclides with varying properties, most notably half-lives (the rate at which its radioactivity decays). In general, wastes that contain very long-lived radionuclides are unsuitable for NSD, but shorter-lived radionuclides are suitable because their radioactivity decays to safe levels before any dose might occur to people in the future.

<sup>6</sup> There are various ways in which this could happen, for example through groundwater or gaseous pathways, or inadvertent human intrusion to the facility in the future, and there are various evolutionary mechanisms which play into this, e.g. coastal erosion. The number of ways in which people could be exposed to radiation decrease with facility depth, which is why 'at depth' facilities generally have a greater radiological capacity than 'at surface' facilities.

<sup>7</sup> Credible options for managing waste which isn't currently viewed as being suitable for NSD will be developed according to the [Implementation Strategy](#) for our [HAW Policy](#).



storage and transport requirements. No technical factors, including ones such as nuclear safety or security, were identified as presenting insurmountable challenges for any of the considered scenarios.

This research project suggests it could cost between £1.5BN and £3BN to implement NSD in Scotland. This is a very early estimate. The cost would be spread over several decades and depends on several variables, most notably the number of facilities. This cost includes construction and operation of NSD facilities as well as related costs such as long-term storage costs for waste unsuitable for disposal. A relationship could also be seen between cost and radiological capacity, as 'at depth' facilities cost more than 'at surface' facilities however more waste would generally be suitable for disposal in them.

This research project has also considered the degree to which 'retrievability' can be designed for, in line with the policy requirement for facility developers to demonstrate how waste or waste packages could be retrieved. It was found that some facility designs could more easily facilitate retrieval than others, but retrieval from any facility will become more difficult with each phase of its operation, which agrees with the findings of other [known studies on reversibility and retrievability](#).

## Summary

To address Scotland's challenging nuclear legacy it is necessary to safely dispose of radioactive waste. This research project considered the feasibility of constructing and operating NSD facilities in which Scotland's HAW could be safely disposed.

This was achieved by identifying and appraising the technical factors involved in implementing NSD. Because many of these factors are site-specific it was necessary for this project to make assumptions about where NSD facilities may be located, although this project included no consideration of non-technical factors and makes no recommendations or decisions regarding siting.

This research project considered the relationships between different designs, site characteristics and the waste requiring disposal, amongst other factors. It represents an initial appraisal of the issues, as an early step in our very long-term plan for managing Scotland's HAW.

Its key findings were that:

- it appears technically possible to implement NSD at any of the sites considered,
- roughly three quarters of HAW in Scotland may be suitable for NSD, and
- it could cost between £1.5BN and £3BN to implement NSD in Scotland, when factoring associated costs.

These findings are heavily caveated at this stage, being based on numerous assumptions and uncertainties, but can be viewed as representing today's understanding. This understanding will be furthered over the coming decades in line with the [implementation strategy](#) for our [HAW Policy](#).

The consultation closes on 31<sup>st</sup> of March 2024 and can be found at;

[Scottish Government consultations - Citizen Space](#)

[Technical Investigations of the Near-Surface Disposal of HAW from Sites in Scotland  
- SSG Presentation](#)

The project to consider technical factors around the implementation of near surface disposal concepts in Scotland has now concluded. A presentation for SSG members on the outputs from the technical work conducted jointly between NDA and SG on Near Surface Disposal took place virtually on the 21<sup>st</sup> of February. This presentation was arranged to keep SSG members informed of the outputs of this work and to provide an opportunity for any questions, as part of our ongoing engagement.

**Diane Hamilton**

**Scottish Government**

## **SCOTTISH GOVERNMENT UPDATE TO DOUNREAY SITE STAKEHOLDER GROUP – 20TH MARCH 2024**

### **SCOTTISH GOVERNMENT RADIOACTIVE SUBSTANCES AND NUCLEAR DECOMMISSIONING POLICY TEAM**

#### Four Nations Policy Consultation on UK Radioactive Substances and Nuclear Decommissioning Policy Framework

Scottish Government are continuing to work with the UK Government and other devolved administrations on the publication of the revised framework document. The aim is for this to be published sometime in March. We will send out a link to published framework once it is available.

#### Public Attitudes to Radioactive Waste Management Survey

The 'Public Attitudes to Radioactive Waste Management' survey was conducted between the 8<sup>th</sup> and 11<sup>th</sup> of January 2024. 2160 responses were received. The results are due to be published in the Spring. We will advise the SSG when the results are available.

This wider public engagement work was undertaken to understand societal attitudes towards radioactive waste management, delivering on a research and development commitment made in the 2016 Implementation Strategy. This work complements specific engagement undertaken by the Scottish Government with stakeholders in the sector, including the communities around Scotland's nuclear sites and will inform implementation of the SG Higher Activity Radioactive Waste (HAW) Policy and any future review.

#### The Environmental Authorisation (Scotland) Regulations 2018 (EASR 2018) updates

The Environmental Authorisation (Scotland) Regulations 2018 (EASR 2018) are being amended to bring together all the permissioning arrangements for SEPA's four main regulatory regimes (Water, Waste, Radioactive Substances and Pollution Prevention and Control) into an integrated structure and under a single standardised procedure.

The Scottish Government is working with SEPA on proposed amendments to the Regulations. The public consultation for the amendments was released in December and it contains some minor amendments to the Rad Subs framework. Alongside bringing together the regulatory regimes, there are some clarifications to the Regulations in relation to radioactive substance activities but no significant changes.