

New LLW Facilities Project – Stage 2

Summary Position Paper on Climate Change and Coastal Erosion

Michael S. Tait (UKAEA)
Daniel A. Galson (Galson Sciences Limited)

Introduction

- 1 UKAEA has undertaken a transparent and consultative site selection process resulting in the decision to submit a planning application for new Low Level Waste (LLW) disposal facilities on a site adjacent to the eastern boundary of the existing Dounreay nuclear licensed site. The proposed facilities consist of a series of six below-ground concrete vaults, as shown in Figure 1, required to enable the decommissioning and restoration of the Dounreay site.
- 2 UKAEA has consulted widely on the proposals, both in the Best Practicable Environmental Option (BPEO) selection stage¹ and during the subsequent preparation of the planning application and its associated Environmental Statement².
- 3 This note specifically addresses how the New LLW Facilities Project has accounted for the long-term impacts of coastal erosion and sea-level rise.

Why is coastal erosion and sea-level rise an issue?

- 4 As part of the safety case to be presented to regulators, UKAEA has to address future risks from the proposed disposal facilities. In particular, UKAEA has to demonstrate that it has used Best Practicable Means (BPM) to control and contain the waste disposed of within the facilities. UKAEA therefore has to demonstrate that it has adequately considered the potential for future disruption of the facilities and has done all that is reasonably practicable to minimise potential risks from any disruption of the facilities.
- 5 Future sea-level rise and coastal erosion have the potential to disrupt the facilities. Disruption of the facilities has the potential to increase the risks associated with the facilities; therefore, the issue of sea-level rise and coastal erosion has to be addressed within the safety case.
- 6 It should be noted, however, that any near-surface disposal facilities in the North of Scotland will be disrupted eventually. The Earth undergoes cyclical warming and cooling periods over many tens of thousands of years. This cycle will lead to glaciation of most of northern Britain, which in turn will lead to disruption of any near-surface features.
- 7 Also, in the future, any facilities built in a location below 80 m above current sea level have the potential to be disrupted by sea-level rise. It has been estimated that if all the ice sheets in the world were to melt due to global warming, there would be a sea-level rise of around 80 m. These two issues are discussed further below.

¹GNGL(04)TR75 April 2004 - Dounreay LLW Strategy Development - Best Practicable Environmental Option Study - Final Report

²LLW(06)S2/61 March 2006 - New LLW Facilities Project – Stage 2 – Environmental Statement

How has this issue been addressed?

- 8 UKAEA's consultants have reviewed the potential for sea-level rise and the potential rates of coastal erosion at Dounreay³ and UKAEA has located the facilities with sufficient distance from, and elevation above, the sea to ensure safety. Placing the waste in a location where the facilities will never be disrupted is not practicable, nor is it necessary to ensure safety.
- 9 The radioactivity in the waste to be disposed of in the proposed facilities decays naturally with time. The average level of radioactivity in the facilities is illustrated in Figure 2 and shows that the radioactivity, and therefore the hazard, reduces sharply over the first few hundred years. Indeed, by 10,000 years the average activity in the waste is dominated by the alpha activity in the waste, and is below the natural alpha activity levels found currently in the soils in the Dounreay area. This is often termed as being "below background levels" and can be regarded as having radioactivity levels that are insignificant in terms of hazard.
- 10 An important consideration in demonstrating BPM is local siting of the facilities in a location where they are highly unlikely to be disrupted by natural processes for the next 10,000 years. By this time, the waste in the facilities will have no greater radiological impact than the natural rock and sediments in the Dounreay area.

Sea-level rise and coastal erosion

- 11 Galson Sciences Limited³ has reviewed information on predicted global climate changes and future sea-level changes from a number of recent open file sources, such as the 4th Assessment Report of the International Panel on Climate Change (IPCC).
- 12 The review noted that there is not a lot of information on current and historic coastal erosion rates in the Dounreay area. It also noted that climate change models are immature and that predictions of sea-level change carry large uncertainties on the size and timing of such changes. To cater for this, the review identifies best-estimate, i.e. reasonable, upper erosion rates and sea-level rises, recognising that the actual rates are likely to be lower than those identified.
- 13 It is believed that emissions into the atmosphere of greenhouse gases such as carbon dioxide, methane and nitrous oxide will have a profound combined long-term warming effect on global climate. Predictions of global temperature and sea-level rises depend heavily on assumptions that are made for future emission rates for greenhouse gases. Current global model studies indicate that a 1-4°C average temperature increase would lead to partial melting of the Greenland Ice Sheet and some loss of the West Antarctic Ice Sheet, leading to a sea level rise of 4-6 m or more.
- 14 Extreme predictions of global warming could result in complete melting of all ice sheets and this has been predicted to have the ability to raise sea levels by around 80 m above current levels.
- 15 The review concluded that a best upper estimate for the relative sea-level rise at Dounreay is 12 m above Ordnance Datum (AOD). This is based on a conservative assumption that both the Greenland and West Antarctic Ice Sheets will disappear entirely over several thousands of years.

³ LLW(07)S2/195 Issue 1, March 2008 – New LLW Facilities Project – Stage 2: Position Paper on Climate Change and its Impacts

- 16 The review³ also looked at potential future coastal erosion rates at Dounreay. The main energy source leading to coastal erosion is the erosive power of waves hitting the coast. The vulnerability of a coast to erosion is determined by the characteristics of that coast, such as relative sea level, type of rock present, the structure of the rock, topography and the orientation of the coast relative to the predominant wave direction. The uncertainty about future sea levels leads to uncertainty about future coastal erosion rates.
- 17 In estimating potential future erosion rates, the review pays particular attention to estimates of historic erosion rates over long periods. Most estimates of long-term erosion rates for rock cliffs in the Caithness area are below 10 mm per year. There are higher rates of erosion in areas where superficial deposits above the bedrock are being eroded but estimates of rock cliff erosion rates along the coast generally tie in with other worldwide studies of hard rock coastal erosion rates, and are less than 10 mm per year³.
- 18 Taking account of the lack of information and the general uncertainty in rates of erosion, the study concluded that the best upper estimate of the long-term average coastal erosion rate at Dounreay is 10 mm/year until the point where global cooling leads to a fall in sea level. As sea-level falls, coastal erosion will reduce or cease entirely as new land emerges from the sea.
- 19 Using these two upper estimates for sea-level rise and coastal erosion to estimate potential timescales to erosion of the facilities indicates that it would take over 20,000 years for the sea to breach the facilities. The review therefore concludes that the red line shown in Figure 1, used by UKAEA in its siting assessments, can be regarded as a robust siting constraint.
- 20 It should be noted that the Environmental Safety Case⁴ associated with the proposed facilities reviews the safety implications should the facilities be eroded in the very far future and looks at the potential implications should sea-level rise and coastal erosion rates exceed the predicted upper rates used for siting purposes. There are no significant safety implications, primarily due to the low activity levels of the waste, as discussed in paragraph 9.

Summary

- 21 There are significant uncertainties in sea-level rise predictions and coastal erosion rates in the long term but, taking those uncertainties into account, the siting constraint used by UKAEA in its siting assessment is appropriate and a facility located to the south of that line is unlikely to be eroded by the sea for the next 10,000 years.

⁴ LLW(07)S2/197 Issue 1, March 2008 – Dounreay New LLW Facilities RSA93 Environmental Safety Case 2008

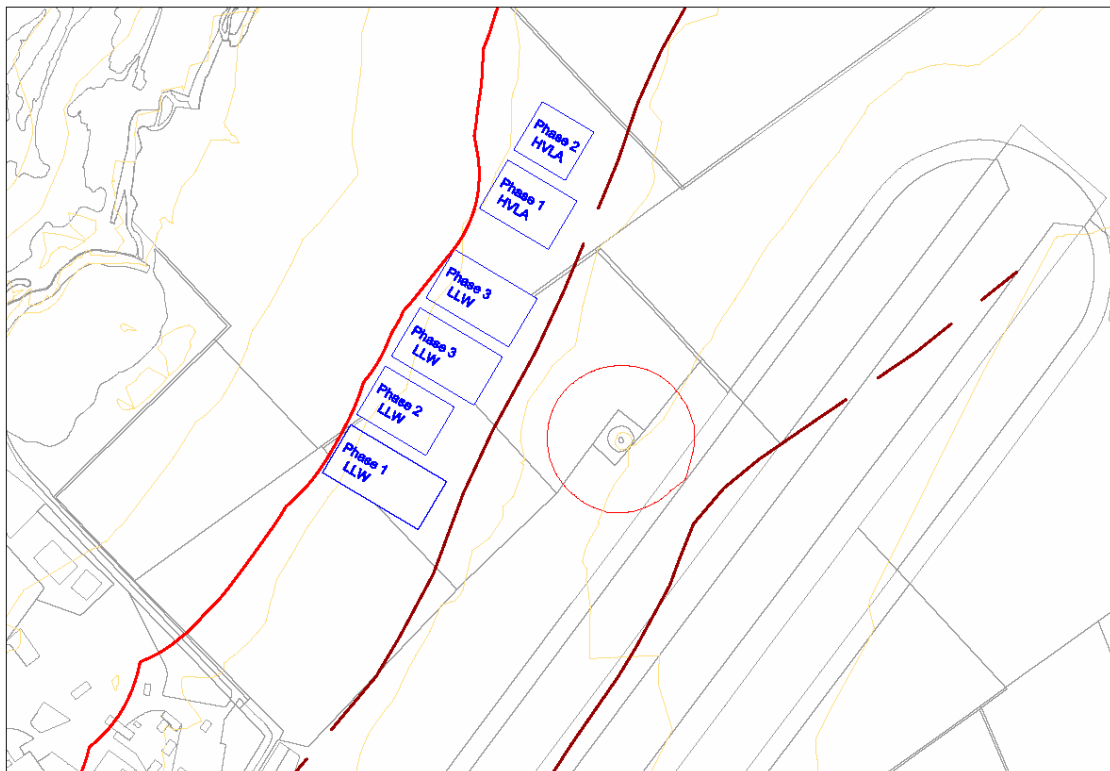


Figure 1. Layout of the proposed new facilities with respect to significant siting features. The Figure represents approximately 950 m (west-east) by 850 m (north-south). The red line represents 100 m inland of the 20 m AOD contour to allow for future sea-level rise and coastal erosion. The brown lines indicate the approximate north-western and south-eastern edges of the Geodh nam Fitheach Fault Zone. The red circle represents a 50-m exclusion area around a chambered cairn. The south-eastern corner of the existing licensed site is seen in the south-western part of the Figure.

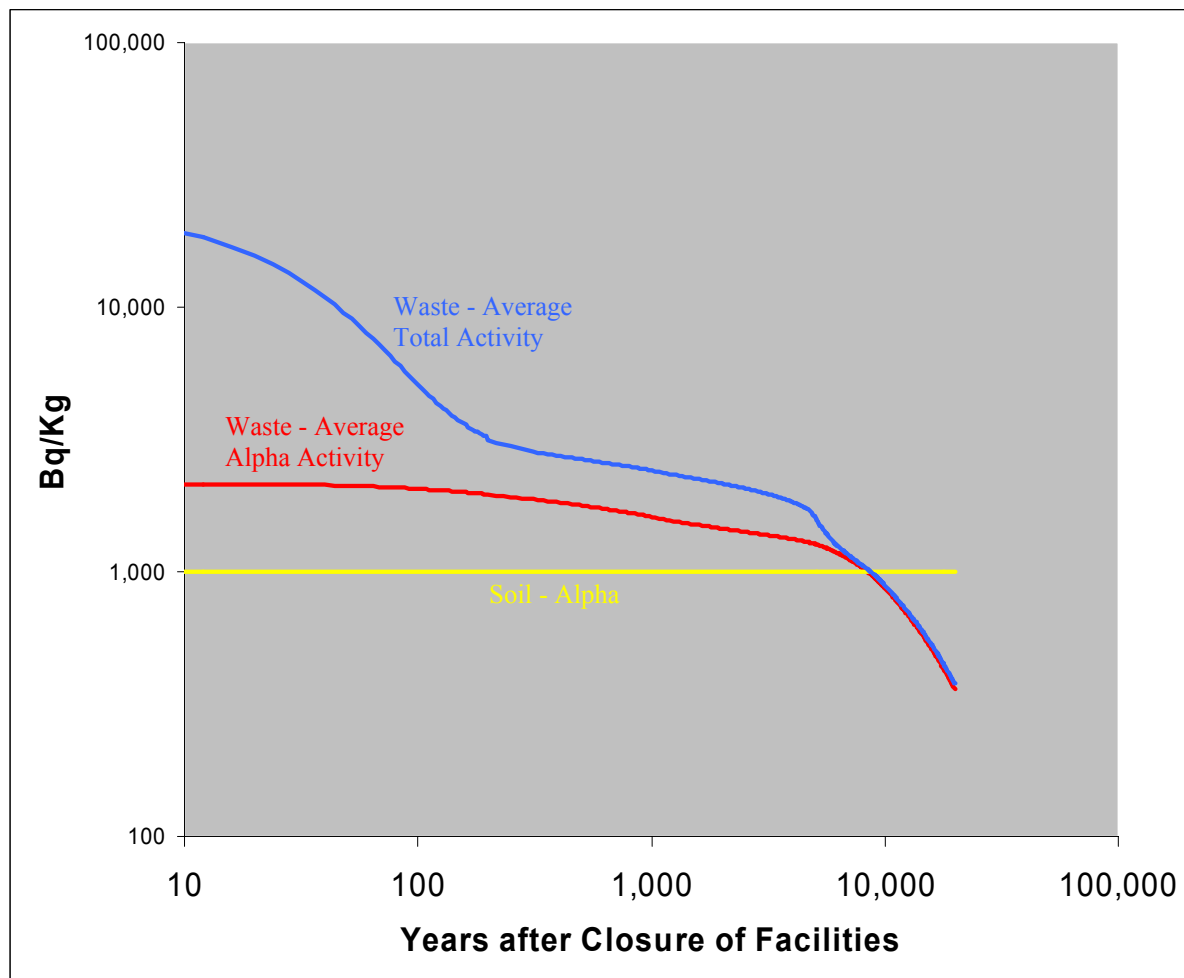


Figure 2: Average alpha and total radioactivity concentrations over time in the proposed New LLW Disposal Facilities (Bq/kg) in the waste form. Present-day average background alpha concentration in Dounreay soils (Bq/kg) is shown for comparison.