

Geological Disposal

Further information on geology for West Cumbria MRWS Partnership

June 2011

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John Dalton,
Head of Communications,
Nuclear Decommissioning Authority, (Radioactive Waste Management Directorate),
Curie Avenue,
Harwell Oxford,
Didcot,
Oxon,
OX11 0RH, UK

Executive Summary

The note aims to provide information to the West Cumbria MRWS Partnership as to why the prospects of finding a site for a GDF in west Cumbria are sufficiently good to justify proceeding further (i.e. into Managing Radioactive Waste Safely Stage 4, desk-based studies).

It is helpful first to look back to the 1990s and consider why permission to build a rock characterisation facility near Sellafield was refused. The Secretary of State's reasons for refusal were the conventional environmental impacts of the RCF, such as its impact on visual amenity and protected species. He listed two other areas as areas of concern which would also have justified refusal of the appeal:

- Scientific uncertainties and technical deficiencies in the proposals presented by Nirex - the application was premature;
- The process of the selection of the site and the broader issue of scope and adequacy of the environmental statement – the process was not transparent.

We now have a completely different process for site selection and implementation of a geological disposal facility. The main changes are:

- The process is open and transparent and is based on voluntarism and partnership working;
- The wastes for disposal are different and the understanding of concepts for their disposal has advanced in the UK and overseas.
- The science and technology underpinning geological disposal – including requirements and techniques for site characterisation – have developed significantly in light of real progress on overseas programmes, e.g. in Sweden and Finland.

Geological information will be an important input to each stage of the implementation process, as more information becomes available through the stages of desk-based studies, surface based and underground investigations.

Some parts of west Cumbria have already been ruled out as unsuitable for the underground facility. For those areas that remain, the amount and level of geological information currently available is highly variable. In general, insufficient information exists on which to make an informed decision about a site's suitability at the current time. Even areas where considerable information exists will need to be evaluated further if such areas move forward in the process.

Work carried out in the development of the Disposal System Safety Case indicates that it is possible to safely develop geological disposal facilities in a range of geological settings including those found in west Cumbria. Significant advances in the interpretation of geological data allow more confidence in the interpretation of geological information than was available in the 1990s. Geological disposal is also being implemented in a number of overseas countries.

We do consider that there is sufficient area remaining to justify continuing in the MRWS process and working in partnership in developing technical understanding and community support. At this early stage, it is important to recognise that success is not guaranteed. Much more information will be needed on the geology of a site in order to develop a safety case. Geological disposal will only be implemented if the NDA can show that the site is safe, the community is supportive and the regulators give approval.

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1 Introduction

1.1 This technical note has been prepared in response to an e-mail request from Richard Harris, 3KQ on behalf of the West Cumbria MRWS Partnership, to Alun Ellis, NDA-RWMD on 26th January 2011. The request is given below:

1.2 *'As you will be aware, there is continuing concern, expressed locally and nationally, that the conclusions reached following Nirex's investigations in the 1990s suggest that the prospects of finding a safe site for a GDF^{*} in west Cumbria may be poor and may make renewed investigations unwise. The Partnership welcomes the NDA's Draft Briefing Note on these issues, circulated following the Partnership's Geology Seminar in November 2010 (Annex 1), but believes further input is required.*

The Partnership now asks the NDA to provide a more detailed explanatory report to show why it believes the prospects of finding a site for a GDF in west Cumbria are sufficiently good to justify proceeding further, commenting on the inherent uncertainties and how they will be managed. The Partnership asks that the report is fully referenced, especially regarding any significant assertions and/or assumptions being made.

We are aware that some of the questions that have arisen will have to be answered, in detail, later in the process (Stage 4 onwards), assuming there is continuing participation. However, we ask the NDA to (i) identify and provide early comment on such areas, as far as it is possible to do so and (ii) to set out the expected future research needs, especially as a result of key assumptions being made at this current stage'.

1.3 The request contains three main questions to which this note aims to provide a response:

- Why are the prospects of finding a site for a GDF in west Cumbria sufficiently good to justify proceeding further (i.e. into Managing Radioactive Waste Safely (MRWS) Stage 4, desk-based studies)?
- What are the inherent uncertainties and how will these uncertainties be managed?
- What are the future research needs?

A draft response was issued to the MRWS Partnership for their comment on 11th April 2011 and a meeting held on 19th May 2011. The note has been updated to take account of feedback received on the draft and the discussion at the meeting..

1.4 In order to answer these questions it is useful to set some context, first to set out the history of the Nirex investigations (particularly focussing on the reasons for the rejection of the planning appeal in the 1990s) (Section 2) to provide some additional background on international safety standards, guidelines and experience relevant to geological disposal of radioactive wastes (Section 3) and to outline the way in which geological disposal would be considered in the MRWS process (Section 4).

* Geological Disposal Facility

2 The Nirex investigations and the RCF Public Inquiry

2.1 Nirex commenced its surface-based investigation programme in the Sellafield area of west Cumbria in 1989. The purpose was to evaluate the geology of the area to enable a decision on the suitability of the “Longlands Farm Site” to host a geological repository for intermediate- and low-level radioactive waste. An application was made in July 1994 to develop an underground Rock Characterisation Facility (RCF) as a continuation of the investigations at Longlands Farm. The planning application was rejected by Cumbria County Council in December 1994. Following an appeal by Nirex, a 66 day local planning inquiry was held between September 1995 and February 1996. The Planning Inspector, Mr Chris Macdonald submitted his report to Government late in 1996 and recommended that the appeal be dismissed. On 17 March 1997, the Secretary of State announced that he had dismissed Nirex’s appeal and refused planning permission for the RCF. This result was conveyed to Nirex in a letter to David Brown (Director) from the Government Office for the North West. This letter presents the definitive conclusions of the appeal process and is appended to this note as Annex 1.

2.2 In the letter of 17th March 1997, the Secretary of State cited the conventional environmental impacts of the RCF, such as its impact on visual amenity and protected species, as being the reasons for his dismissal of the appeal (Section 9 of the letter to Nirex from the Government Office for the North West). He listed two other areas as areas of concern which would also have justified refusal of the appeal:

- Scientific uncertainties and technical deficiencies in the proposals presented by Nirex;
- The process of the selection of the site and the broader issue of scope and adequacy of the environmental statement.

2.3 In respect of the scientific issues, the Secretary of State noted the Inspector’s considerable concern and agreed with his conclusion that more scientific and technical work was required before the development of an RCF. With respect to the siting process, the Secretary of State agreed with the conclusions of the Inspector that the process for site selection was not transparent and lacked technical and scientific rigour.

2.4 The Government’s MRWS process for site selection and GDF implementation is different to the old Nirex-led process in many respects:

- The process is open and transparent and is based on voluntarism and partnership working;
- The wastes for disposal are different and the understanding of concepts for their disposal has advanced in the UK and overseas.
- The science and technology underpinning geological disposal – including requirements and techniques for site characterisation – have developed significantly in light of real progress on overseas programmes, e.g. in Sweden and Finland.

3 International guidance

3.1 While safety is a national responsibility, international standards and approaches to safety promote consistency; help to provide assurance that nuclear and radiation-related technologies are used safely. In considering the development of a GDF, relevant international standards and guidance are produced jointly by the

International Atomic Energy Authority (IAEA) and the Nuclear Energy Agency of the OECD and published by the IAEA.

The IAEA issues a number of different types of document. The ones relevant to the current discussion are;

- Safety Standards – basic requirements which must be satisfied to ensure safety for particular activities or applications areas
- Safety Guides – recommendations, on the basis of international experience, relating to the fulfilment of basic requirements. :

- 3.2 Safety Requirements relating to the geological disposal of radioactive wastes are contained in IAEA report WS-R-4, published in 2006[†], which can be downloaded from the IAEA website [1]. Paragraphs 3.25 to 3.39 lay out the safety requirements for geological disposal. These focus on the need for a multi-barrier system in which the various engineered and natural barriers contribute to containing the radionuclides within the waste and isolating them from the biosphere. The safety requirements recognise the role of the geological environment in contributing to containment by protecting the engineered barriers and preventing water ingress and also in isolating the radionuclides for the long term, at least several thousand years, with account taken of both the natural evolution processes and events that could disturb the facility.
- 3.3 The IAEA has recently published a report setting out specific safety requirements for geological disposal [2] This document again focuses on the use of a combination of engineered and natural barriers to provide safety (Paragraph 3.27). It also recognises that understanding of the performance of the disposal system will evolve as more data are accumulated and scientific knowledge is developed (See paragraph 3.27 to 3.30 of [2]).
- 3.4 The role of the geosphere as one barrier within a multiple barrier system was also described in detail in our recently-published DSSC, which states that ‘ In order to assure that these objectives of isolation and containment are delivered over the long timescales of interest, geological disposal facilities are designed as multiple barrier systems. This involves designing engineered barriers that will work together and in combination with the natural barrier afforded by the geosphere to prevent radionuclides being released to the surface environment in amounts that could cause harm to life and the environment [3].
- 3.5 As noted above, the multiple barrier concept of disposal addresses two principal objectives with respect to providing safety - the isolation of the wastes and the containment of the radionuclides associated with the wastes:
- By isolation we mean removing the waste from people and the surface environment. Geological disposal at depth in a suitable environment provides isolation by reducing the likelihood of inadvertent and unauthorised human interference. Disposal in a geological environment that is suitably deep and stable over long periods also provides isolation of the disposal facility from the impacts of climatic and other natural environmental events, and shielding of the natural environment from direct radiation from the waste.

[†] These international safety standards replace Report IAEA 99, which was the appropriate standard at the time of the Public Inquiry.

- By containment we mean retaining radionuclides within various parts of the multi-barrier system for as long as required by our safety concepts. Radioactive decay will progressively reduce the quantities of radionuclides present in the system. For many radionuclides, disposal concepts can provide total containment until the radionuclides and their daughters decay to insignificant levels of radioactivity within the engineered barrier system (EBS). However, the engineered barriers in a disposal facility will degrade progressively over time and gradually lose their ability to provide containment. Further containment is provided by the geological barrier, which acts to delay the movement of any small amounts of long-lived radionuclides that are released from the EBS. Locating the GDF in a suitably deep and stable environment protects the engineered barriers, helping them to preserve their containment function for longer times.’[3]

3.6 The requirement for a multi-barrier concept for radioactive waste disposal recognises that safety has to be assured for very long times. The safety Paragraph 4.1 of the IAEA Safety standard recognises that ‘safety of waste disposal does not rest on one single component or barrier but rather on the combined performance of several barriers. If a barrier fails to perform as designed, then the overall system should be sufficient to meet the safety objectives.

‘The total systems approach incorporates the idea that in the final analysis it is only the performance and safety of the disposal system as a whole at any given time in the future that has to be assured rather than the performance of all the individual components. This approach offers greater flexibility to the designers of a disposal system because weaknesses in one barrier may be compensated for by the containment capability of other barriers. The overall approach makes it possible to adapt the geological disposal concept to a variety of high level waste forms and packages and to a variety of geological formations which are often very different from country to country.

It is nevertheless recognised that the geological barrier plays the major role in assuring long-term safety. Its function may be inferred from natural evidences of the long-term containment provided by many types of geological formation’.

3.7 A safety guide on geological disposal was published in 1994 (Report 111 G4) [4]. This safety guide is currently being updated. An updated draft was issued to member states for comment in 2007 [5] but has not yet been published. However, the recommendations it contains are very close to the 1994 version. Section 4 of the report is devoted to site selection guidelines and states (paragraph 402) that ‘Guidelines can be helpful in the overall decision making process but they are not intended to be strict preconditions. To assess whether a disposal system meets its performance goals, the system of natural and engineered barriers has to be considered as a whole. Flexibility in the disposal system is important and the possibility to compensate for uncertainties in the performance of one component by placing more reliance on another should be retained’.

3.8 The guide then gives examples of different siting factors to be considered in a siting process. The guideline on geological setting is that:

‘The geological setting of a repository should be amenable to overall characterisation and have geometrical, physical and chemical characteristics that combine to inhibit the movement of radionuclides from the repository to the environment during the time periods of concern’;

and that on geology is that:

'the hydrogeological characteristics and setting of the geological environment should tend to restrict groundwater flow within the repository and should support safe waste isolation for the required times'.

- 3.9 The guidelines also indicate some examples of specific geological conditions which are preferred (e.g. 'uniform rock formations in comparatively simple geological settings' and 'mechanical properties of the host rock should be favourable for the safe construction, operation and closure of the disposal facility') and specific geological factors which should be considered (e.g. 'the thermal and thermodynamic properties of the host rock').
- 3.10 The IAEA safety guide states that the above guidelines 'are not meant to be a complete set of guidelines and their application will have to take into account the options available and the limitations within each country. Further, these guidelines should not be applied in isolation but will have to be used in an integrated fashion for an overall optimization of site selection' (Para 403ff). In the UK, where Government policy is for an approach to siting a GDF based on voluntarism and partnership, this means that the IAEA criteria will be applied to those parts of the UK where the local communities have volunteered to participate in the siting process. Potential sites identified through a voluntarism process may be comparatively complex and hence need more time, effort and cost to characterise in order to demonstrate their suitability for safe geological disposal. Although characterising and demonstrating safety is more challenging for a comparatively complex site than for a simpler site this does not prevent complex sites from being considered.
- 3.11 The British Geological Survey publication "Geology of the west Cumbria district" [6] and report for DECC "Managing Radioactive Waste Safely: Initial Geological Unsuitability Screening of West Cumbria"[7] provide a good summary of the range of rock types and geological settings in west Cumbria. It can be seen from these documents that there are a number of rock types present in the west Cumbria area which have generic geological characteristics consistent with the guidelines at depths suitable for the location of a geological disposal facility. Therefore it is considered that there is sufficient potential to consider the remaining area further in Stage 4 of the MRWS site selection process as discussed in the next section.

If the fractured rock in the basement rocks in west Cumbria were to be considered as a potential host rock for a geological disposal facility, it would be necessary to select a volume where the frequency of large geological deformation zones in the region with properties which indicate that they might represent preferential groundwater flow paths was sufficiently low that a disposal facility could be located so as to avoid this potential problem. This is standard practice in other national programmes that use strong, fractured host rocks, such as the Swedish and Finnish programmes described in Section 5 of this document.

4 How geological information would be taken into account under the current site selection process

- 4.1 The MRWS site selection process recognises international experience that to be successful site selection should be based on an approach of voluntarism and partnership between the developers and communities that choose to participate in the site selection process.
- 4.2 During preparation of the MRWS White Paper, Government obtained scientific advice on the high level criteria that could be used to rule out any 'Expression of Interest' areas of the UK which, because of obvious sub-surface characteristics,

would not be suitable and therefore should be excluded at an early stage. (see Annex B of the MRWS White Paper [8]). These criteria are suitable for immediate application, based on existing knowledge, anywhere in the country where a community might make an expression of interest, including those areas for which geological information might be limited. Two independent groups of scientists were asked to consider the issue and they submitted a joint report to Government in April 2007. Recommendations were subject to wider public and stakeholder comments as part of the consultation document 'A framework for implementing geological disposal'. Following closure of the consultation the Chairs of both committees reviewed the criteria in the light of responses received and provided guidance to government. On the basis of this review Government is satisfied that the exclusion criteria to be used at an early stage of the site selection process are robust, appropriate and fit for purpose (Para B5 in White Paper).

- 4.3 These high level criteria have now been applied to west Cumbria by the British Geological Survey, an independent expert body. As a result, some areas of west Cumbria have been excluded from hosting the underground workings of a geological disposal facility on the grounds of their subsurface characteristics [7]. However significant areas remain that have not been screened out and are considered potentially suitable for more detailed investigation if local communities decide to participate.
- 4.4 If the Decision Making Bodies in west Cumbria make a decision to participate in the site selection process, Stage 4 of the MRWS process would involve desk-based studies for the identification and assessment of potential candidate sites [8,9]. The approach to be used for identifying and assessing potential candidate sites during Stage 4 of the MRWS site selection process will be subject to a formal consultation later in 2011.
- 4.5 The current proposal for the identification of potential candidate sites is for a criteria-based approach to enable a wide range of issues to be considered. The proposed criteria are:
- a. the criteria set out in the White Paper;
 - b. local criteria determined by the local communities.
- The proposed criteria can be divided into those that relate to the surface, those that relate to the host rock or both. Government proposes that both groups of criteria would be considered in parallel to identify potential surface and sub-surface areas that could then be combined together.
- 4.6 It is proposed that the consideration of the geoscientific information at this stage would involve looking at the areas not excluded by the Sub-Surface Unsuitability test carried out by the British Geological Survey, to understand the likely presence, depth and thickness of potential host rocks in the 200 to 1000 metre depth range. At this stage the potential for a given rock formation to be a host rock would be based on the generic characteristics of the rock type rather than on the specific characteristics of the rock volume under consideration.
- 4.7 Safety is an essential requirement that runs throughout the site selection process. It is proposed that early in Stage 4, an initial consideration of the safety implications of implementing a geological disposal facility at specific sites would be undertaken. This would be a high level review of any safety issues that could focus the assessment on those potential candidate sites that show the most potential. The NDA would conduct a review of the geoscientific information available at this point to identify any early implications for the development of a safety case and

engineering design. This review would consider issues such as the possible depth and geometry of the host rock formation and could result in some Potential Candidate Sites being considered as more likely to be unsuitable. These considerations will take account of international guidance from the IAEA [4] and regulatory guidance, e.g. [10].

4.8 It is proposed that an approach based on multi criteria decision analysis (MCDA) should be used to assess potential candidate sites. The proposed criteria for assessment of the geological setting of a disposal facility are largely derived from the Environment Agency's response to the MRWS Consultation Document [11] and are as follows:

- the size of the potentially suitable volume of host rock;
- the level of technical challenges from construction and engineering conditions and the availability of knowledge and technology by which they can be overcome;
- the level of difficulty to ultimately characterise the potential candidate site;
- a qualitative assessment of the feasibility of developing a robust safety case, based on available geoscientific information (including known geological, hydrogeological and hydrological characteristics)

The final three bullets take into account the impact of the complexity of the geology on the safety case, engineering design and site characterisation as this is an important factor identified in the IAEA guidance [4].

Following the consultation later this year, Government will consider responses and in light of these further develop or refine the criteria as appropriate. The criteria will then be published ready for use during desk based studies.

4.9 For those locations identified as potential candidate sites, provided the community decided to continue its participation, the surface-based site investigation activities during MRWS Stage 5 would provide information to support the assessment of the suitability of the sites being investigated to host a GDF. This assessment would be supported by the development of site-specific disposal system safety cases, which would assess the total system performance of the engineered and natural barriers in providing the necessary isolation and containment of the inventory of wastes. These safety cases would be subject to scrutiny by regulators and by Government's independent advisors.

5 Why the prospects of finding a site for a GDF in west Cumbria are sufficiently good to justify proceeding further

5.1 The MRWS site selection process recognises the need to select a technically suitable site in an area which has community support. The process is fundamentally different to that used in the 1980s and 1990s and allows assessments of technical suitability and community support to be progressed in parallel through a clearly staged process.

5.2 International standards and guidance are discussed in Section 3 above. The guidance on siting does not preclude any geological setting in principle. The overall requirement is to be able to make a safety case demonstrating that international and national requirements are met. The international experience summarised below provides examples of implementation of geological disposal in a range of geological settings. Our recently-published generic Disposal System Safety Case)

shows how these requirements could be met for a range of geological settings [12]. In particular, the generic Environmental Safety Case presents post-closure safety assessment results for the disposal of the Baseline Inventory under a wide range of hydrogeological conditions such as might be found in the UK [13]. It used standard hydrogeological text-book properties for various rock-types and standard analytical treatments of controls on groundwater flow, such as topography, to derive the necessary parameters, viz: flow rate through the disposal facility; times for transport of water from the facility to the surface; and the degree of mixing with other groundwater in geological formations along the transport path. The range of conditions included the type of hydrogeological setting represented in west Cumbria; these conditions were found to have the potential to support the development of a safety case for a suitably designed and located disposal facility based on existing disposal concepts.

5.3 The MRWS site selection process ensures that all relevant geological factors will be considered as data become available. Geological setting is one of the criteria proposed for the assessment of potential candidate sites during MRWS Stage 4 [14,9]. Further, the geological suitability of sites would be examined in detail during MRWS Stage 5. The MRWS process includes an early screening out of areas which are obviously unsuitable on the basis of their sub-surface characteristics (White Paper, paragraph 7.4). Some areas in west Cumbria have been considered unsuitable for the underground workings of a GDF at this early stage. However, significant areas remain to make the prospects of finding a site for a GDF sufficiently good to justify proceeding to further investigations, provided there is community support. Whilst success can not be guaranteed the range of geological settings considered in the generic DSSC provides support to this view.

5.4 The amount and level of geological information currently available across that part of west Cumbria not excluded by the BGS site-screening report is highly variable. For most of the region, insufficient geological information is available to make an informed decision on whether any sub-area is suitable to host a GDF. More work would be needed to assess existing geological and related information in order to assess potential suitability of different sub-areas. Even areas for which considerable geological information is already available would need to be evaluated further using consistent and robust methodologies.

5.5 There have been a number of important advances in techniques for measuring and interpreting geological information since the 1990s. Some of these advances were discussed at a presentation to the MRWS Partnership in November 2010 and have been summarised in a briefing note to the Partnership which is appended to this document as Annex B. The most relevant advances are:

- Improved 3-D seismic surveying;
- Advances in 3-D computer modelling;
- Improved understanding of the role of geology in containing radionuclides.

These developments would allow a more reliable understanding of the potential for transport of any radionuclides released from the engineered barriers of any disposal facility. Coupled with 3-D information about a site, modern 3-D groundwater flow models can be used to analyse both the present day flow system and the effects of possible future changes in driving forces on important aspects of that system, such as flow rates and the locations of discharges at the surface.

5.6 Geological disposal of higher activity radioactive wastes is being planned or implemented in a number of different geological settings around the world. Three

main host rock types are currently under consideration, higher strength rocks (for example in Sweden and Finland), lower strength sedimentary rocks (for example in France and Switzerland), and evaporites (for example in Germany and the USA). The geological disposal concepts for the various host rocks differ because of the differences in the rock properties and therefore they meet the safety requirement of multi-barrier containment in different ways. RWMD has commissioned reviews of the range of concepts currently being considered worldwide for disposal of high level waste/spent fuel [15] and intermediate level wastes [16]. An important conclusion from this work is that a range of generic repository concepts is available that can provide safe and secure geological disposal options suitable for UK geological environments in a number of different host rocks [15].

- 5.7 Sweden and Finland are both planning to dispose of spent fuel in a geological setting of higher strength rock. Implementation in these two countries is well-advanced with first waste emplacement currently scheduled for approximately 2025. In Sweden, site investigations resulted in the selection of Forsmark in Östhammar municipality in 2009 as the disposal site and in March 2011 the Swedish implementer SKB submitted applications to the Swedish Radiation Safety Authority (SSM) and to the Environmental Court to build a repository for spent fuel in Forsmark. In Finland, Olkiluoto has been chosen as the final disposal site and excavation of an underground rock characterisation facility, ONKALO is well advanced. ONKALO will aid in collecting the further data needed for the application for the construction licence that will be submitted in 2012. Both these countries have very good websites describing their plans [17, 18].
- 5.8 France and Switzerland are both considering lower-strength sedimentary rocks for the disposal of spent fuel, high level waste and long-lived intermediate level waste. France is researching disposal in a lower-strength sedimentary rock in north-eastern France, also with first waste emplacement currently scheduled for 2025. The French implementer, Andra, is currently carrying out site characterisation using geological surveys, boreholes and seismic campaigns to identify a zone of interest of some 30km² to site underground installations for the geological repository with options for the surface sites. The Swiss programme is at an earlier stage of implementation. The site selection process, which is divided into three stages, is being led by the Swiss federal authorities. A geological screening exercise has identified a number of areas with potentially suitable geology and the next step will involve a stepwise process to select a site. The public, the Cantons, interested organisations and neighbouring countries all have the opportunity to express their views on the siting proposals and the results reports as part of the process. Again, the websites of the implementing organisations provide a clear description of the plans and progress [19, 20].
- 5.9 With respect to disposal in evaporites, the Waste Isolation Pilot Plant, or WIPP, in New Mexico, USA has been operating in New Mexico since 1999 for the disposal of the USA's defence-related transuranic radioactive waste in thick beds of salt which formed during the evaporation of an ancient ocean. At the depth of the WIPP repository, the salt will slowly encapsulate the buried waste. Germany is also considering disposal in salt formations but implementation is still at an early stage [21].
- 5.10 We have collated a range of concepts (worked-up from extensive R&D and safety assessment programmes in other countries) that relate to the different geological and hydrogeological properties of potentially suitable host rocks. This shows in particular the respective safety functions of the engineered barriers and the natural, geological barrier under a wide range of conditions. Certain concepts for the

disposal of ILW and of spent fuel and HLW were assessed under the range of hydrogeological conditions considered in the generic ESC, and these assessments showed that the analysed, existing concepts have the potential to deliver long-term safety of disposal.

6 Management of uncertainties

- 6.1 The two broad areas of uncertainty are associated with the two fundamental requirements for a successful geological disposal project;
- community support;
 - the presence of a geological setting with the required characteristics to ensure the long-term safety of the GDF.
- 6.2 Uncertainties associated with community support will be progressively addressed as the MRWS site selection process is followed. Government and NDA/RWMD are committed to working in partnership with local communities to implement the process.
- 6.3 Uncertainties associated with the technical suitability of potential sites will be progressively addressed as site identification, site assessment and surface based investigations are carried out. This will be achieved through the development of safety cases at various stages of implementation which will be subject to scrutiny by the independent regulators. If at any stage it becomes apparent that safety can not be demonstrated for a particular site then that site would not progress through the siting process.
- 6.4 The Site Characterisation Status [29] report describes the current understanding of the data acquisition and interpretation cycles to be used to characterise a site.
- 6.5 Details of the regulatory requirements are given in the Environment Agency's publication 'Geological Disposal Facilities on Land for Solid radioactive Wastes, Guidance for Requirements for Authorisation [22], often abbreviated to GRA. The main submissions will be:
- Initial Site evaluation – before intrusive site investigations begins;
 - Preliminary environmental safety evaluation in order to proceed with underground operations (construction);
 - Pre-operational safety case at the final hold point before waste is placed in the facility.
- 6.6 The GRA states 'We would expect the pre-operational environmental safety case to provide a sound scientific and technical basis for a decision to grant a revised authorisation to allow solid radioactive waste to be placed in the facility. We would also expect the developer to set out a programme of work to provide information and data to inform decisions on further development of underground facilities that might be required to meet operational needs'.
- 6.7 The GRA also provides information about the ongoing regulation of the facility, during its operational period. 'After any environmental permit for disposal has been granted, a geological disposal facility will be subject to the same regulatory process that applies to other nuclear facilities. This will require periodic reviews of the authorisation over the lifetime of the facility and submission by the operator of an updated environmental safety case at agreed intervals. The regulatory process

would continue beyond closure of the facility and would only end when we accept surrender of the environmental permit. This decision would be based on regulatory review of a final environmental safety case submitted by the operator after closure of the facility (see Section 5.6).

- 6.8 RWMD's approach to developing its work programme to meet its objectives is described in the Technical Strategy [23] while the Research and Development programme to implement the R&D Strategy[24] and address the uncertainties discussed in the Status Reports is set out in the R&D Programme [25] as described in section 7.

7 Future R&D needs

- 7.1 The future R&D needs are set out in the R&D Programme document [25] which was published earlier this year. This document sets the context for our needs-driven R&D programme, explaining the high-level drivers for the programme. It explains how the programme is structured into topics and identifies the R&D needs in each area within the topics. It also explains how we prioritise the R&D, using a series of structured questions to consider, for each area, what is needed to be known by when, the impact, the knowledge gap, what needs to be done to fill the knowledge gap and the urgency. The report then describes how these questions help identification and prioritisation of the R&D needs for each topic.
- 7.2 There are many ways in which we could have structured the programme into topics and the approach we have selected is not a unique solution. At this early stage in our programme our remit is very broad. We have not made decisions about preferred concepts or designs. However, all the concepts currently under consideration by ourselves and our sister agencies overseas are designed to meet two high-level safety objectives of geological disposal of radioactive waste, namely to isolate the waste from the biosphere and to contain the radionuclides associated with the waste. In order to assure that these objectives of isolation and containment are delivered over the long timescales of interest, GDFs are designed as multiple barrier systems. This involves designing engineered barriers that will work together and in combination with the natural barrier afforded by the geosphere to prevent radionuclides being released to the surface environment in amounts that could cause harm to life and the environment.

We took this multi-barrier concept as our starting point for considering our R&D programme and established five initial topics:

- Wasteform evolution, considering the different types of waste which would be disposed of in a GDF and the way in which they would gradually change over very long timescales;
- Container evolution, particularly focussing on the corrosion of metal containers during the period when the GDF would be operational and also in the period after closure;
- Near-field evolution, considering the buffer or backfill which would be placed around the waste containers to protect them;
- Geosphere, considering the natural geological barrier around a GDF and the way in which it would evolve;
- Biosphere, describing what we think a future biosphere may look like and how radionuclide uptake might be expected to take place.

- 7.3 We then considered the two main pathways by which radioactive material might be released from the GDF and eventually migrate through the surrounding rock and back to the earth's surface:
- Radionuclide behaviour in the groundwater pathway (including any effects of non-aqueous liquids);
 - Release by the gas pathway.
- 7.4 It is important to ensure that we can maintain safety even under accident or unexpected conditions. Our R&D topics in this area are:
- Waste package accident performance;
 - Managing for criticality safety.
- 7.5 The topics identified so far might be thought of as the scientific basis for the programme. Our current understanding of the science underpinning geological disposal is published in a series of eight research status reports:
- reports on package evolution [26], near-field evolution [27], and on the geosphere [28], describing the understanding of the role and evolution of the barriers;
 - reports on gas generation and migration [29] and on radionuclide behaviour [30], describing the release and movement of materials through the multi-barrier system;
 - reports on criticality safety [31] and on waste package accident performance [32] addressing the control of low probability events and their outcome; and
 - a report on biosphere describing what we think a future biosphere may look like and how radionuclide uptake might be expected to take place [33].
- 7.6 Other areas of the programme also require R&D to develop them to an appropriate level.
- Safety case methodology, to make developments to our methodology as we progress towards implementation to reflect advances in the state of the art and to address specific features at the site(s) under consideration;
 - Site characterisation, covering our approach to surface-based investigations and where available techniques may need development for the GDF project;
 - Design development, to complement the extensive work already undertaken by overseas waste management organisations (WMOs), and building on technologies developed by other industries (e.g. mining);
 - Strategic environmental assessments, to develop the standard techniques for assessment of the potential social, economic and environmental impacts for application to a GDF;
 - Public and stakeholder engagement, to help develop our approach to stakeholder engagement and communications and to research the potential social and ethical impacts of implementing geological disposal;
 - Site Assessment Methodology, to ensure that state-of-the-art decision-making techniques are available to be used in local and national decisions about which sites should proceed to subsequent stages in the MRWS site selection process.

- 7.7 Our R&D Programme overview describes the work we are doing now, the rest of the work planned during this preparatory studies phase (up until the end of MRWS Stage 4) , and, where appropriate, an outline of the work we expect to do during the surface-based site investigation phase.
- 7.8 We will have to satisfy the independent regulators of the safety and security of all aspects in the development of a geological disposal facility before they issue the appropriate licences. This includes safety during construction, operation and in the long term after the facility has been closed. The regulators' licensing process for a GDF will include their close examination of detailed safety cases produced by us covering all aspects of the disposal system.

8 Concluding remarks

- 8.1 This note has set out the background information to address the request for further information on geological issues from the west Cumbria MRWS Partnership and has attempted to address the specific questions asked by the Partnership as far as it is possible to do so at present. At this early stage in the voluntarism process, before desk-based studies, site investigation or even site identification we cannot single out particular areas of west Cumbria and make strong claims for their suitability. To attempt to do so now would pre-empt the voluntarism and partnership aspects of site selection and would not recognise the degrees of technical uncertainty that must remain until further detailed work has been undertaken on specific sites.

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GOVERNMENT OFFICE
FOR THE NORTH WEST

*From the Director
Infrastructure & Planning*

David Brown Esq
Director (Cumbria)
United Kingdom Nirex Ltd
Allerdale Court
Greengarth Hall
Holmrook
Cumbria CA19 1UL

Our ref: APP/H0900/A/94/247019
Your ref: DB.CD.8.51

17 March 1997

Dear Sir,

**TOWN AND COUNTRY PLANNING ACT 1990
APPEAL BY UNITED KINGDOM NIREX LIMITED
PROPOSED ROCK CHARACTERISATION FACILITY ON LAND AT AND
ADJOINING LONGLANDS FARM, GOSFORTH, CUMBRIA
(LOCAL AUTHORITY APPLICATION NUMBER 4/94/9011)**

1. I am directed by the Secretary of State for the Environment to say that consideration has been given to the report of the Inspector, Mr C S McDonald MA DMA LMRTPI concerning the above appeal. Between 5 September 1995 and 1 February 1996 Mr McDonald, assisted by Mr C Jarvis LLB and by an assessor, Mr C V Knipe BSc CEng CGeol MIMinE MIMM FGS, held a public local inquiry into the appeal, which was made by your company, United Kingdom Nirex Limited ("Nirex"), under Section 78 of the Town and Country Planning Act 1990, ("the 1990 Act") against the decision of Cumbria County Council to refuse planning permission for a Rock Characterisation Facility (RCF) on land at and adjoining Longlands Farm, Gosforth, Cumbria.

ISSUES SET OUT IN THE SECRETARY OF STATE'S "RULE 6" STATEMENT

2. On 27 February 1995 the Secretary of State issued a statement under the provisions of Rule 6 of the Town and Country Planning (Inquiries Procedure) Rules 1992 of the issues on which he particularly wished to be informed for the purpose of determining the appeal. The issues set out in that statement, which are also set out in paragraph 1.5 of the Inspector's report, are:

Infrastructure and Planning Group
Sunley Tower
Piccadilly Plaza
Manchester M1 4BE
Direct Dial: 0161 952
Switchboard: 0161 952 4000
GTN: 4301
Facsimile: 0161 952 4220

- (1). **The relationship of the RCF proposal to the policies and proposals in the existing development plan for the area.**

The existing development plan for the area comprises:

the Cumbria and Lake District Joint Structure Plan First Alteration, approved on 16 December 1987, and
the Mid Copeland Local Plan, adopted on 23 March 1990.

- (2). **The relationship of the RCF proposal to the policies and proposals in emerging development plans for the area.**

The emerging development plans are:

the Cumbria and Lake District Joint Replacement Structure Plan, and
the Copeland Borough Plan.

- (3). **In determining the appeal, the weight that should be attached to emerging plans, having regard to the advice set out in Planning Policy Guidance note PPG1.**
- (4). **The environmental impact of the RCF proposal.**
- (5). **The impact of the RCF proposal on the local highway network and the works, if any, required directly to accommodate additional traffic arising.**
- (6). **The results available so far from studies and surveys of the geology and hydrogeology of the area; the additional information that might become available only from the RCF, if developed; and the benefits to be gained from obtaining that additional information, if any, weighed against the possible impact the RCF might have on the site and the surrounding area.**
- (7). **The question of whether any planning permission which may be granted should be subject to any conditions and, if so, the form they should take.**
- (8). **Any other issues which the Inspector considers relevant to the determination of the appeal.**

3. At the inquiry the description of the development was amended by agreement and is now as described by the Inspector in paragraph 1.2 of his report, namely:

Construction of 2 shafts (5m diameter, not exceeding 1020m depth), galleries (none exceeding 5 m height & width and 975m length), exploratory drilling from underground; construction of engineered platforms and associated buildings and works for the purpose of carrying out searches and tests of the Borrowdale Volcanic Group (BVG) and overlying geological strata, including use for carrying out scientific investigations, measurements & experiments in and from the said shafts & galleries; storage of topsoil & subsoil, deposit of underground spoil, internal access road, services, landscaping & restoration.

4. It is also noted that, in his description of the site and of the proposals at Chapter 2B of his report, the Inspector has recorded, at paragraph 2B.16, that a decision to proceed with the deep waste repository (DWR) could be taken by Nirex at the earliest about halfway through Phase 1 of the RCF programme.

5. INSPECTOR'S RECOMMENDATION

5.1 A copy of the Inspector's and of the Assessor's report is enclosed. A copy of the Inspector's conclusions is appended to this letter, at Annex 1. The Inspector recommended that, in view of the considerations expressed in paragraphs 8.1 to 8.61 of his report, the appeal be dismissed.

6. MATTERS RAISED BY THE INSPECTOR IN HIS REPORT

(i) Planning Inquiry Commission

At paragraph 1.18 of his report the Inspector draws the attention of the Secretary of State to the request by The National Trust that, on receipt of the report, he reconsider the establishment of a Planning Inquiry Commission into the appeal. The Secretary of State remains of the view that a normal planning inquiry is the correct mechanism. It provides adequate opportunity for interested parties to make their views known and for relevant issues to be fully explored and carefully appraised before a decision is reached.

(ii) National Policy

The Secretary of State agrees with the Inspector's summary of national policy as set out in paragraphs 2A.6 to 2A.10 of his report. That current policy, which is set out in White Paper Cm 2919 ("Review of Radioactive Waste Management Policy, Final Conclusions") is to find a suitable site for a DWR for intermediate level radioactive waste and that once such a site is found a DWR should be constructed as soon as reasonably practicable. However, the onus is on Nirex to identify a site and prepare proposals which are consistent with that broad policy and which comply with all the regulatory requirements and which succeed in obtaining any necessary permissions/authorisations, including planning permission.

(iii) Role of the Nuclear Installations Inspectorate

It is agreed that, as noted by the Inspector at paragraph 2A.17 of his report, the Nuclear Installations Inspectorate of HSE does not so far have any statutory role in the proposals as regulations have yet to be made to specify that a DWR requires a licence under the provisions of the Nuclear Installations Act 1965.

(iv) The Development Plan

Section 54A of the 1990 Act requires the Secretary of State to determine this appeal in accordance with the development plan unless material considerations indicate otherwise. The Secretary of State agrees with the Inspector that, in this case, the statutory development plan applicable to the appeal site is the Cumbria and Lake District Joint Structure Plan 1991 - 2006, which was adopted in July 1995, and such parts of the Mid Copeland Local Plan, adopted in 1990, as are in general conformity with the structure plan (IR 2C.1, 8.11 and

8.17). It is also agreed that it is necessary to take into account policies contained in the previously approved structure plan which are saved pending the adoption of relevant local plans (IR 2C.2 and 8.18).

The Copeland Local Plan is also of relevance (IR 2C.26 to 2C.41 and 8.19 to 8.25). It is now at a very advanced stage following the consideration of objections at a public inquiry and the publication of proposed modifications, the drafts of which were presented to the appeal inquiry. The Secretary of State has directed that policy IMP1 in that plan should be modified to bring that policy into line with Government policy on planning obligations as set out in Department of the Environment Circular 16/91 and since updated in circular 1/97. The Council has not yet adopted the plan and so Section 54A of the 1990 Act does not apply to it, but it should to be taken into account as a material consideration, bearing in mind the advice in paragraph 48 of PPG1 (Revised) February 1997.

It is noted that, since the close of the appeal inquiry, Cumbria County Council has placed on deposit the proposed Minerals and Waste Disposal Local Plan for those parts of the County outside the National Parks. However, as an inquiry has not yet been held into that plan little weight can be accorded to it in the determination of this appeal.

(v) The Lake District National Park Management Plan

Notwithstanding that this plan is not a statutory development plan, it is considered that the Inspector was right to consider what it says, given that the appeal site lies right alongside the National Park boundary, and the fact that the proposals could affect the National Park and its purposes (IR 2C.42 and 8.26).

(vi) Nature of the project and relevance of the repository, alternative sites and the need for and availability of further information (IR Chapter 3A)

The Inspector has provided, at Chapter 3A of his report, a summary of the arguments put to him about the relationship between the RCF and any DWR proposed for the site; the Inspector's opinions on this set of issues are at IR 3A.17 to 3A.24 and 8.4 to 8.10).

The Secretary of State does not accept in their entirety the Inspector's views on this issue. In the Secretary of State's view the RCF can be regarded as a separate project, but he accepts that there is a relationship between the RCF and a DWR, although it may not easily be defined. The Secretary of State has considered whether or not, given that relationship, he should require Nirex to provide further information on that relationship together with such further information as the company may have on the available alternatives to and the alternative locations/sites for a RCF/DWR and the suitability or otherwise of those sites for the development of an RCF and, subsequently, a DWR, including such information as can be compiled now on the potential environmental impacts of alternative sites considered for such uses. However, he has concluded that, for the reasons set out below, the provision of such further information would not influence his determination of this particular appeal. But in any future application for a RCF (or any other major development proposal that represents a milestone towards the design and construction of the repository itself) the Secretary of State would expect the Environmental Statement to address the question of alternatives and to explain and justify why a particular location had been chosen in preference to others.

(vii) Marine discharges (IR Chapter 3C)

The Secretary of State notes and agrees with the Inspector's conclusions (IR 3C.18 to 3C.23) regarding the concerns of the Irish Government and other parties and agrees that the people of Ireland have a legitimate interest in any proposal for a repository for radioactive waste near the Irish sea coast. He is acutely aware of the Government's obligations to other states which are set out in various international obligations in respect of the sea and the environment more generally.

(viii) Conformity with the statutory development plan (IR Chapter 4A)

The Secretary of State notes the Inspector's thorough appraisal of the RCF proposal in relation to the statutory development plan for the area. He agrees that the conformity of the basic DWR concept with sustainability principles has been settled nationally in the White Paper Cm 2919 ("Review of Radioactive Waste Management Policy, Final Conclusions") (IR 4A.43). He agrees that as the RCF is a large development proposed for a site immediately adjacent to the National Park boundary. He considers that, having regard to the provisions Section 11A(2) of the National Parks and Access to the Countryside Act 1949 (as amended), its impact on the appearance and character of the Park are material to the determination of the appeal. He considers that the qualities of the Lake District National Park are nationally important, and its much celebrated natural beauty, wildlife and cultural heritage can be regarded as being of international interest. He also agrees most strongly that the transitional or temporary nature of the development proposed cannot excuse an unnecessarily poor standard of design (IR 4A.57).

(ix) Conformity with retained and emerging development plan policies (IR Chapter 4B)

The Secretary of State agrees with the Inspector's conclusion that the transitional development plan policies retained from the 1980 Structure Plan do not differ significantly from policies in the emerging local plans and their approach to any interest of acknowledged importance (IR 4B.23 and 8.18).

(x) Visual impact (IR Chapter 5A)

The Secretary of State agrees with the Inspector that the Potential Repository Zone, within which the appeal site lies, is located in an area of relatively uncluttered open countryside adjacent to the National Park, and that there is a continuum in the relatively open landscape across the A595(T) (IR 5A.60); that the site contains topographical features which are attractive in their own right, notably the woodland and the small and secluded valley (IR 5A.61); and as regards its place in the broader perspective, in the sweep of the view downward from the fells, across the fairly narrow coastal strip and out to sea (IR 5A.62). He agrees with the Inspector that the development is not trivial in comparison with the Sellafield Works (IR 5A.62), that the development would be noticeable and, indeed, intrusive when viewed from the adjacent countryside, highways and vantage points (IR 5A.63 to 65). He further agrees that the development proposed would certainly cause harm to its immediate setting, and that the buildings would look palpably out of place (IR 5A.67). He shares the Inspector's reservations about the visual impact of the proposed spoil heaps (IR 5A.69). He agrees that the RCF development and activities would fail to remain subordinate to the existing landscape (IR 5A.69), and would harm the appearance of the National Park (IR

5A.76). The Secretary of State also agrees that in respect of its design the RCF proposal does not conform with Structure Plan Policy 25.

The Secretary of State notes the Inspector's concern regarding the longer term evolution of the Sellafield Works in relation to the DWR site and its potential impacts (IR 5A.87). However, he attaches no great weight to that concern in the determination of this appeal.

(xi) Socio-economic impact (IR Chapter 5B)

The Secretary of State notes that the development promises modest employment and related benefit (IR. 5B.97). The nuclear industry is a considerable industry in the West Cumbrian economy, but the Secretary of State does not agree that its economy is "over dependent" on that one industry (IR 5B.86).

The Secretary of State notes the Inspector's conclusions that the development of the RCF would involve social detriment in that the amenity of a significant number of local residents would be injured by genuine apprehensions about the project, mainly relating to health and safety; that in economic terms there could be noteworthy effects on tourism, fisheries and inward investment in business, plus possibly agriculture (IR 5B.97 and 98); and that Nirex could acknowledge and mitigate such effects. The Secretary of State respects these concerns. He considers that there could be socio-economic benefits as well as some socio-economic detriment which are capable of being mitigated in part. Nirex, however, has not done enough to acknowledge and mitigate those effects. He readily acknowledges that such a sensitive application needs to be convincing to all parties, especially to people living in the locality, and all those with a legitimate interest in the development and its actual and potential impacts. There would also, in the Secretary of State's view, be benefits to be gained for the nation from identifying and confirming a suitable site for long term, safe, reposition of intermediate level radioactive waste.

(xii) Traffic impact (IR Chapter 5C)

The Secretary of State agrees with the Inspector's conclusion that in the absence of a detailed assessment of a road link between the Sellafield Works and the PRZ it is not possible to conclude that a surface rail link would not be feasible (IR 5C.36). Consequently, he agrees with the Inspector that, on the face of it, there is a national policy objection to retaining an access from the PRZ onto the A595(T) (IR 5C.37). The Secretary of State agrees with the Inspector that the unavoidable local community use and the safety record of this stretch of all-purpose trunk road militate against the retention, contrary to national policy, of the direct access to the road notwithstanding its apparent physical capacity to accommodate more local and freight vehicular trips (IR 5C.42). He agrees with the Inspector that the proposal fails to accord with several policies in the development plan; that there is no planned provision for cyclists and pedestrians (IR 5C.42 and 43); and that criticism of the excessive provision of car parking on the site has not been answered (IR 5C.43).

(xiii) Noise and vibration effects (IR Chapter 5D)

The Secretary of State agrees with the Inspector's conclusions on issues relating to noise and vibration (IR 5D.25 to 33)

(xiv) Other environmental effects (IR Chapter 5E)

The Inspector reviews the Environmental Statement and notes that the Environmental Statement provides no assessment of the effects from the DWR on the marine environment or elsewhere (IR 5E.1).

The Secretary of State agrees with the Inspector that there is a link between the RCF and the DWR. The Secretary of State concludes that the RCF should not be considered without reference to the effects of the DWR. The Secretary of State agrees with the Inspector that the presence of a protected species is a material consideration if the development would be likely to cause harm to the species or its habitat (IR 5E.26). In this case it is clear that the proposed spoil disposal operations would harm the habitat of the Lingbank badger clan, for the operations would take place over most of the clan's principal feeding ground, which raises further doubts about the conformity of the development proposed with the development plan (IR 5E.26). He agrees that it is particularly important to sustain this clan since it seems to be the only one in the locality to have survived human persecution. The Secretary of State considers that development planning and site planning alike can and should strive to respect protected species and habitats and to maintain bio-diversity. His policy on those matters is clearly set out in Planning Policy Guidance Note PPG.9. The Secretary of State agrees with the Inspector that the best solution would be to identify another spoil disposal area altogether (IR 5E.27). He has considered whether this might be achieved by way of planning conditions but has concluded that this would not be satisfactory given the likely impact on the landscape of the locality and the National Park.

(xv) Basic repository locational criteria (IR Chapter 6A)

The Secretary of State agrees with the Inspector that your company has failed to appreciate that it is for the local planning authority and not the regulators to review the choice of location, and that the local planning authority is entitled to reach its own view about the acceptability of risk so long as it does not substitute its own detailed risk assessment for that of the regulators (IR 6A.67).

(xvi) Site selection process (IR Chapter 6B)

The Secretary of State notes with some concern that your company's site selection process for the potential repository zone ("PRZ") has singularly failed to impress the Inspector in terms of its transparency and the rigour of its technical and scientific logic (IR 6B.85 to 105).

(xvii) Science and technical programmes (IR Chapter 6C)

The Secretary of State also notes the concerns expressed by the Inspector that your company failed to present reasoned projections on the potential disturbance from RCF construction to the PRZ.

(xviii) Model development (IR Chapter 6D)

The Secretary of State notes the depth and extent of the Inspector's concerns about the model development associated with the RCF proposal. He agrees with the Inspector that your company should not contemplate RCF shaft sinking, risking long-term perturbation of the

centre of the hydrogeological system, until the modelling issues identified by the Inspector have been at least addressed and, where necessary, resolved (IR 6D.71).

(xix) Radiological protection and safety assessment (IR Chapter 6E)

In Chapter 6C of his report the Inspector considers the topic of radiological protection and safety assessment in relation to conditions after closure, or withdrawal of control from, the disposal facility. He makes the point that, as the Assessor comments, with the multi barrier concept there are opportunities to feed back lessons from the preliminary assessments into the design of the waste packaging and emplacement and the detailed engineering and layout of a repository, as well as into more basic decisions on its location. This in turn can have implications for the detailed design of the RCF and the nature and choice of investigations and experiments within it. The Inspector also notes that the Assessor is firmly of the opinion that, whilst the timing of the detailed modelling and other work on the requisite back-filling and sealing of excavations would be late, it would confirm that appropriate materials and techniques are already available (IR 6E.72). The Inspector concludes that the RCF proposal is premature (IR 6E.87). The Secretary of State agrees with that conclusion.

(xx) Role of the RCF and promise of the PRZ (IR Chapter 6F)

The Secretary of State notes that the radiological performance of the site could be affected by the RCF (IR 6F.40).

The Inspector acknowledges the general quality and innovation of Nirex's scientific and technical work to date, but concludes that it is too optimistic about the situation it has reached. (IR 6F.50). He concludes that your company does not understand the regional hydrogeological system well enough and it is not planning to give the remainder of its investigatory programme sufficient scope to remedy the discrepancy. Also it does not fully comprehend the extreme complexity of the PRZ and over-estimates its own knowledge and understanding in critical respects, and it is much too hopeful about the speed and confidence with which it could reliably process information and make firm decisions in constructing and operating the RCF (IR 6F.52). He concludes, therefore, that Nirex should not be allowed to proceed with the RCF in its current state of inadequate knowledge, for that would cause needless damage to the PRZ. Also, that it would make it very difficult for anyone to predict the consequences of Nirex's actions and result in a confusing outcome (IR 6F.53 and 8.56).

Secondly, he concludes that it is difficult to credit that Nirex has optimised the location of the RCF, because it has not equipped itself with the knowledge to do this. The Inspector suspects that the RCF could not, except by coincidence, be the confirmation of the suitability of the most stable, understandable and impermeable volume of rock for a DWR (IR 6F.53). He notes that the Assessor advises that the RCF would be unable to provide information on about half of the principal hydrogeological units which make up the current regional transport model (IR 6F.54). The Inspector and the Assessor are sceptical of Nirex's ability to make a decision halfway through Phase 1 to proceed with a DWR application since they would not be far enough into the rock and would not have enough additional information for such a decision point to be realistic (IR 6F.55). He also considers that Nirex remains unduly optimistic about its model development and validation programme, and warns that there is a serious risk of basing successive predictions on inadequately refined models, in turn

producing output of insufficient reliability (IR 6F.55). He concludes that to go ahead now with the RCF would be seriously premature (IR 6F.59).

The Secretary of State notes the Inspector's considerable concern on these points and agrees with his conclusion that more scientific and technical work is required before the development of an RCF. He considers that it is a matter of overriding national interest that a PRZ, however it is selected, should not be damaged by exploration based on anything other than a fully sound and convincing technical and scientific case.

(xxi) Mitigation of environmental effects (IR Chapter 7A)

The Secretary of State agrees with the Inspector's conclusions on the mitigation of environmental effects as set out at IR 7A.7 to 7A.12.

(xxii) Ensuring scientific and technical benefits (IR Chapter 7B)

The Secretary of State notes that the Inspector considers it is necessary to secure the scientific and technical benefits of the RCF. The Inspector suggests that, in order to achieve adequate control of the scientific and technical aspects of the development, there should be a binding agreement between Nirex and the Environment Agency (IR 7B.9). Should planning permission be granted for the development of the RCF in the absence of such an agreement then, he considers, Cumbria County Council, as local planning authority, must regulate all aspects of the RCF (IR 7B.10).

It is a matter of some concern to the Secretary of State that there is lack of certainty about how scientific and technical benefits are to be achieved, since the lack of controls to ensure this could increase the risk of uncalled for harm to a potential DWR location. He considers that Nirex could have submitted an agreement setting out the full arrangements for providing information to the full range of interested parties and statutory bodies, and firm commitment to, and clear arrangements for, independent peer review. He has considered whether or not to require that now, but has concluded that it would not affect the outcome of his determination of this particular appeal.

(xxiii) Inspector's final conclusions (IR Chapter 8)

The Inspector rehearses his opinions on the connection between the RCF and the DWR and the need to look at alternative sites for a RCF/DWR. The Secretary of State's view on this is set out at paragraph 6(vi) above.

The Secretary of State notes the Inspector's conclusion that the Environmental Statement contains no information about the possible environmental effects of abnormal incidents at the RCF. However, he has concluded that, for the reasons set out below, the provision of such further information would not influence his determination of this particular appeal.

The Secretary of State agrees with the Inspector's appraisal, at IR 8.11 to 8.27, of the RCF proposal against policies contained in the statutory development plan for the area and in emerging local plans as they were at the close of the inquiry and with his appraisal, at IR 8.28 to 8.41, of the degree of adverse environmental effects and the extent of conflict with policies. Since then Copeland Borough Council have refined and published the modifications

which the Council proposes to make to the emerging Copeland Local Plan and, further, the Secretary of State has directed that one of those policies, IMP1, should be further modified. He considers, however, that the main thrust of the plan insofar as it applies to sites such as the appeal site remain largely unaltered since it was discussed at the inquiry and that the Inspector's conclusions remain valid. Since the close of the inquiry the emerging Cumbria Minerals and Waste Local Plan has been amended and placed on deposit. However, as an inquiry has not yet been held into that plan it is considered that relatively little weight should be accorded to it in the determination of this appeal.

On the question of the suitability of the site, the Secretary of State agrees with the Inspector's conclusion (IR 8.47) that your company does not appear to have selected this site in an objective and methodical manner and, further, does not appear to have fully appreciated the limitations of its understanding of the site (ie groundwater conditions in and around the site and the extent and variability of faulting in the rock). He also notes, with some concern, that your company appears to be unduly optimistic in that it does not appear to plan to take all the steps which appear to be necessary to put right those deficiencies (IR 8.50). He notes, with concern, the Inspector's conclusion that the indications are that this site is not suitable for the proposed repository and that investigations should now be moved to a more promising site elsewhere. The Secretary of State has considered whether or not these concerns are themselves sufficient grounds for reopening the inquiry to address these matters in greater detail, but he has reached the view that the deficiencies of this application are so numerous and extensive that reopening of the inquiry would not be an appropriate step before proceeding to determine the appeal.

The Secretary of State considers that exploratory investigations to inform choice and design of a satisfactory repository is potentially of great environmental benefit to the nation. However, such potential benefits may be put at risk by ill-considered exploratory development within a promising site. And the prospect of considerable potential benefit to the nation from such development cannot of itself justify overriding or sweeping aside all other planning considerations. In this case, the Secretary of State agrees with the Inspector's conclusions that, on balance of benefits and adverse effects, your company should not be allowed to proceed with the development of the RCF.

7. THE TECHNICAL ASSESSOR'S REPORT

The Secretary of State has also considered most carefully the Technical Assessor's report which concludes, at paragraph G.52, that

"The voluminous technical evidence submitted to the inquiry within my field of interest has led me to conclude that the setting of the Sellafeld site is geologically and hydrogeologically much less simple and more complex than would be expected of a choice based principally on scientific and technical grounds, and does not match any of the theoretically favoured types. It therefore suffers from the disadvantages which led to its not being generically chosen in the first place. As a consequence it and the surrounding district are proving difficult to explore and characterise. In particular the actual basement rock chosen is exceptionally difficult to characterise due to the nature of its eruptive volcanic origins. This and the frequency of significant faulting means that potential repository sites within this area will be severely constrained and may require compromise on layout and orientation. The geosphere uncertainties have increased the importance of engineered barriers so that there is high reliance on an

artificial containment concept which is itself complex and untried. The preliminary safety case is certainly not a patent failure, but nor is it so clearly within targets as to command any substantial degree of confidence. Because of all the foregoing factors, the eventual achievement of a satisfactory standard of proof for this locality is especially problematic and uncertain. Nirex acknowledges there are likely to be radiologically better sites available around the UK, and in my view some probably have simpler geology and hydrogeology and therefore would be more readily investigable and characterisable."

8. MATTERS RAISED SINCE THE CLOSE OF THE INQUIRY

Following the close of the inquiry the Secretary of State has received a large number of representations from interested third parties in relation to the appeal. For ease of reference these are recorded in the schedule attached to this letter at Annex 2 which excludes, however, letters of a purely procedural nature.

On 5 February 1997 an internal Nirex memorandum, dated 10 December 1996, and certain papers concerning that memorandum, were copied to the parties for comment. At the same time the inquiry parties were given an opportunity to comment on a report, entitled "Economic assessment of the timing of the Nirex deep repository", by Mike Sadnicki and Gordon MacKerron, which had been submitted by Friends of the Earth.

The responses received from the inquiry parties to that letter, and the representations received from other parties opposed to the development, indicate their belief that the memorandum supports their view, expressed at the inquiry, that the site is difficult to characterise and may not be a safe place in which to consider constructing a deep repository for radio active waste. They suggest that the appeal should be dismissed or at least held in abeyance until more information is made available by your company, particularly report "Nirex 97" which it has been suggested will be published later in the year. Parties who support the development argue that the memorandum contains nothing new to suggest that the development should not be allowed to proceed. You argue that the Sadnicki and MacKerron report is wrong in suggesting that sufficient information could be obtained from surface research to establish whether the site might be suitable for a repository and that the report's conclusion that it might be better and cheaper to wait and research rather than proceed now with the RCF is not based on sound methodology.

In addition to the Sadnicki and MacKerron report mentioned above some of those who have written mention particularly other reports and letters which are listed at Annex 3 to this letter. The Haszeldine/Smythe report draws together into one document only reports which were presented to and debated at the inquiry and contains nothing new. The two HMIP reports were published before the inquiry and, indeed, extracts from them were submitted to the inquiry. The view is taken that they too contain no new information. The two Nirex science reports which were published in December 1996 have been considered and the view is taken that they do not provide any new information which requires that inquiry parties should be provided with an opportunity to comment on them before the appeal is determined. The RWMAC report sets out the Committee's views on the ways by which Nirex publish information and seek peer review of their ongoing work and contains no new information which has a bearing on the determination of the appeal. The letter from Sir John Knill has been considered alongside the other representations received since the close of the inquiry.

The majority of other representations received before and since the letter of 5 February was issued express general concerns about the nuclear industry generally and about further expansion of the industry in the Sellafield area; and suggest that waste should be stored at the place of origin and in a way in which it can be monitored rather than disposed of by deep underground disposal.

For those reasons it is considered that representations and reports submitted since the close of the inquiry do not raise any issue requiring reference back to the parties, either under the Town and Country Planning (Inquiries Procedure) Rules 1992 or otherwise in the interests of fairness, before a decision is issued on the appeal. Details about how any of the representations and reports recorded in Annex 2 to this letter may be inspected are set out at paragraph 11 below.

9. SECRETARY OF STATE'S CONCLUSIONS AND DECISION

The Secretary of State has considered the available evidence and material considerations and taken into account the possible advantages and disadvantages of the proposed development. He agrees with the Inspector's conclusions and reasons, except where indicated elsewhere in this letter. The proposed development does not accord with all the policies of the adopted development plans and the material considerations which exist (including the emerging draft development plan policies) do not indicate that planning permission should be granted on this appeal.

The Secretary of State is satisfied that the poor design, layout and arrangements for access and the adverse impact on visual amenity, a protected species and the natural beauty of the National Park caused by the surface elements of the proposed RCF are serious and in themselves warrant refusal of the application. The Secretary of State cannot conclude that wider considerations justify these planning matters being overridden in the present circumstances. **For those reasons the Secretary of State dismisses the appeal.**

Further, the Secretary of State also remains concerned about the scientific uncertainties and technical deficiencies in the proposals presented by Nirex, which would also justify refusal of this appeal.

He is also concerned about the process of the selection of the site and the broader issue of scope and adequacy of the environmental statement which again would justify refusal of this appeal. These matters are mentioned in section 6 of this letter.

10. RIGHT TO CHALLENGE THE DECISION

A separate note is attached setting out the circumstances in which the validity of the Secretary of State's decision may be challenged by making an application to the High Court within 6 weeks of the date of this letter.

11. INSPECTION OF INQUIRY DOCUMENTS AND POST INQUIRY REPRESENTATIONS

The same note also explains the arrangements for inspecting the documents listed in the Appendix to the Inspector's report and in Annex 2 to this letter.

12. DISTRIBUTION OF THIS LETTER

A copy of this letter has been sent to Cumbria County Council and other parties who appeared at the inquiry or asked to be advised of the decision.

Yours faithfully

A handwritten signature in black ink, appearing to read 'P.C. Stycbe', with a long horizontal flourish extending to the right.

P C STYCHE

Authorised by the Secretary of State for the Environment
to sign in that behalf

ANNEX 2 Briefing note on west Cumbrian geology



Nuclear
Decommissioning
Authority

NDA, Radioactive Waste Management Directorate
Building 587
Curie Avenue
Harwell
Nr Didcot OX11 0RH

West Cumbria MRWS Partnership

Dear Partnership Member

Geological Information Seminar, 15 November 2010

NDA Briefing Note

A draft of this note was produced in response to a request to brief the West Cumbria MRWS Partnership's Geological Information Seminar on the 15 November 2010. This briefing provided the basis for discussion on geological developments that have taken place since the mid-1990s in the five broad areas requested by the Partnership:

- a) Improved understanding of the role of geology in containing radionuclides (i.e. radioactive elements)
- b) Improved 3-D seismic surveying
- c) Advances in 3-D computer modelling
- d) Information relevant to the MRWS site selection process in West Cumbria
- e) How geological information will be taken into account under the current site selection process.

The intent of the note is to set out what has changed since the 1990s in terms of the science and to give some explanation as to why it is appropriate to consider hosting a geological disposal facility in West Cumbria. The note is not intended to provide a balanced assessment of all the geological issues that will need to be considered during the MRWS site selection process.

The note was originally presented as a draft at the Partnership seminar in November 2010 so that the NDA could learn from the seminar if there was further information that the local community would like to receive. This, updated, final version of the note includes some additional information.

a) Improved understanding of the role of geology in containing radionuclides

Geological disposal involves the use of what is termed a multiple barrier approach where engineered barriers and the natural barrier provided by the geology work together to contain the radionuclides associated with radioactive wastes. The main objective of this containment is to prevent or minimise the movement of radionuclides through the groundwater system back towards the surface environment. If radionuclides in the groundwater eventually move out of the engineered system, a number of physical and chemical processes could occur in the deep rock-water system to contain them.

In most of the types of rocks found at depth in West Cumbria radionuclides that escaped the engineered barriers would tend to move with the flow of groundwater in naturally-occurring fractures and joints in the rocks. Given the very long times taken for water to flow from depth back to the surface many radionuclides would completely decay to stable, that is non-radioactive, nuclides before reaching the surface environment even if they travelled at the same rate as the groundwater. However, this would not be true for very long-lived radionuclides and a number of processes that prevent or retard their movement in relation to groundwater flow are therefore important.

Work in this area over the last 15 years, in Sweden in particular, has given a great deal more confidence that two relevant processes can be characterised and applied in assessing the "transport resistance" of the geology.

- One important process involves the diffusion of radionuclides out of the water in the fracture carrying flow and into stagnant water in closed-ended pores in the rock adjoining the fracture, where the radionuclides essentially become trapped. Work in Sweden and elsewhere now allows scientists to combine experiments on rock samples taken from boreholes with measurements taken on the rock walls of boreholes to determine the extent to which this process will operate.
- A second important process is termed sorption and involves the transfer of radionuclides out of solution in groundwater onto the solid surface of minerals on the rock wall of a fracture or pore. There has been a major international effort over the past 15 years to improve the understanding of sorption such that many of the uncertainties about its effectiveness, that had to be taken into account previously, have been removed.

In addition, other processes such as the possible transport of radionuclides in the form of colloidal particles or as gas that are relevant to the safe disposal of radioactive wastes are better understood (and subject to ongoing research).

b) Improved 3-D seismic surveying

Seismic surveys involve studies of the velocity and deflection of man-made shock waves to investigate the deeper structure of the Earth. 3-D seismic surveying can give a detailed picture of the structure of rocks at depth, including the "discontinuities" in the rocks that could control groundwater movement. Since the former Nirex carried out a trial survey in the 1990s, other waste management organisations, notably Nagra in Switzerland, have successfully built on that,

and oil-industry experience, to use the technique to characterise the detailed structure of large volumes of rock having the potential to host a disposal facility.

c) Advances in 3-D computer modelling

3-D modelling of groundwater flow through the large volumes of rock relevant to geological disposal has been possible for some time, but until recently was unable to represent the detailed structure of the rock that would control the precise pathway taken by the water. Partly driven by radioactive waste management programmes in other countries such as Sweden, Finland and Canada, computer modelling techniques have now been developed that can calculate the tracks of particles of water flowing from depth to the surface environment through a volume of rock that has been adequately characterised. These computer models have been tested in international co-operative programmes such as the Äspö Hard Rock Laboratory (Sweden) Groundwater Modelling Task Force. Their use in safety assessments in Sweden continues to be scrutinised by their independent regulator and its scientific advisors. There are other areas (eg 3-D visualisation models) where there have been significant advances since the 1990s.

Why these developments are helpful

These developments, outlined under points a, b and c, allow a more reliable understanding of the potential for transport of any radionuclides released from the engineered barriers of any disposal facility. Coupled with 3-D information about a site, modern 3-D groundwater flow models can be used to analyse both the present day flow system and the effects of possible future changes in driving forces on important aspects of that system, such as flow rates and the locations of discharges at the surface.

Without such improved techniques there would be greater uncertainty about the performance of the geological barrier at the conclusion of surface-based site investigations. The resulting, possibly small chance that the geological barrier might have unfavourable characteristics could dominate the developing safety case, even if the site was in reality suitable. These scientific and technical developments would also be helpful in the case of a site that was unsuitable since they would allow this to be identified more readily than was possible previously, thereby saving time, trouble and pointless expenditure of public money.

d) Information relevant to the MRWS site selection process in West Cumbria

It is clearly important to take account of what was learned about the geology and hydrogeology of West Cumbria from the investigations carried out by and for the former Nirex. Most of the detailed work was focused on the Longlands Farm site. Roughly speaking, the information that Nirex presented to the Rock Characterisation Facility (RCF) Local Planning Inquiry in 1995 was based on less than 25% (in cost terms) of the geological information that it had acquired by the time investigations were halted. The information available in 1995 did not enable an adequate understanding of the controls on groundwater flow or of some of the field observations, as was acknowledged in Nirex's reports on its modelling work and reflected in the RCF Planning Appeal inspector's report..

When the full suite of information was available later, groundwater flow models were developed on behalf of Nirex by many of the UK's recognised hydrogeology experts and, following independent peer review, were published in December 1997 in "Nirex 97" as a means of documenting the outcome of the work programme. These models took account of all the features and processes that could control the flow of groundwater, including:

- the topography and rainfall of West Cumbria,
- the various types of water found at depth,
- the fracture zones in the deep rocks, and
- the hydrogeological properties of the rocks and their fractures, joints and pores.

The models, which were tested against field observations not used in their development ("independent test data"), showed groundwater flows and flow paths which Nirex concluded did not exclude the possibility of safe disposal of long-lived radioactive wastes (the UK intermediate-level waste inventory) at the Longlands Farm Site, as described in "Nirex 97". The British Geological Survey integrated information from the Nirex studies into its Memoir "Geology of the West Cumbria District", also published in 1997.

The current MRWS process is a completely new process and therefore the area covered by expressions of interest in West Cumbria is being considered in the same way as any other area in the UK which made an expression of interest. However, if local communities choose to participate in the site selection process and historical information gathered by Nirex were relevant to the evaluation of potential candidate sites there would clearly have to be a due process of review and scrutiny in the light of current understanding and all relevant information as outlined in the next section.

e) How geological information will be taken into account under the current site selection process

The MRWS site selection process recognises international experience that to be successful it should be based on an approach of voluntarism and partnership. Candidate sites that are identified by a local community engaged in the process and agreed by Government will be subject to evaluation for suitability against key criteria including the site's geological and hydrogeological characteristics as well as other relevant site assessment criteria.

At various stages of the site selection process, the independent environmental regulator requires that safety assessments will be presented to show, amongst other things, how the site's geological and hydrogeological characteristics are consistent with meeting safety requirements. Before a GDF can be developed a full safety case must be presented for scrutiny and agreement by the regulators.

The potential for earthquakes to affect the safety of a disposal facility provides a specific example of one area where geological information would be assessed in increasing detail at successive stages of the site selection process. In deep rocks the effects would be relatively localised so earthquakes and faults were not included in the sub-surface screening criteria to be used in relation to areas in Stage 2 of the MRWS site selection process. However, as noted in the MRWS

White Paper, account should be taken of earthquakes and faults once the stage of assessing candidate sites has been reached.

Initially this is likely to involve assessing whether there is evidence of seismically active geological faults or fractures that might obviously rule out a siting option. If a site were carried forward to the surface-based investigation stage, more detailed information would become available to assess the potential size and consequences of movements that might occur in the deep rocks in the future. SKB (Sweden) has published details both of the type of site information that is required and of the methods they used to carry out the necessary assessments of potential effects of earthquakes.

I have attached a list of technical reports that I hope will provide useful more detailed information on the various topics touched on in this note. Most of the UK reports are available via the NDA/RWMD web based bibliography and the SKB reports from their website. If you need any assistance with obtaining copies please let me know.

I hope that this note addresses the main questions, comments and observations raised before and at the seminar.

Yours faithfully



Alun Ellis

Repository Project Director
2 February 2011

Further reading list

Radionuclide transport properties

Knight, L., Black, J. and Watson, S., *NDA-RWMD Geosphere Characterisation Project: Data Acquisition Report: Measurement of rock properties relevant to radionuclide migration*. Report QRS-1421A-R3, Version 2, prepared by Quintessa Limited, April 2008.

3-D seismic surveying

Nirex, *Sellafield Geological and Hydrogeological Investigations: Spatial heterogeneity of the rock mass within the potential repository zone*. Nirex Science Report No. S/97/005, August 1997.

Emsley, S., *Geosphere Characterisation Project: Data Acquisition Report: Surface-based Geophysical Techniques*. Report No. 07154270359.501/A.0 prepared by Golder Associates (UK) Limited. August 2008.

3-D computer modelling of groundwater flow

Follin S, Hartley L, Jackson P, Roberts D, Marsic N, *Conceptual model development and numerical modelling using CONNECTFLOW. Forsmark modelling stage 2.3*. SKB Report R-08-23, 2008.

Scientific outcome of Nirex investigations

Nirex, *Nirex 97: An assessment of the post-closure performance of a deep waste repository at Sellafield*. Nirex Science Report S/97/012 (4 volumes), 1997.

Norris S, *Nirex 97: An assessment of the post-closure performance of a deep waste repository at Sellafield. Summary Report*. Nirex Science Report S/98/015. 1998.

Norris S, Chapman N, Maul P, *Nirex 97: An assessment of the post-closure performance of a deep waste repository at Sellafield*. Report on peer review by QuantiSci Ltd. Nirex Science Report S/98/014, 1998.

Earthquakes and faults

Fälth B, Hökmark H, *Seismically induced slip on rock fractures. Results from dynamic discrete fracture modelling*. SKB Report R-06-48, 2006.

Fälth B, Hökmark H, Munier R, *Effects of large earthquakes on a KBS-3 repository. Evaluation of modelling results and their implications for layout and design*. SKB Report TR-08-11, 2010.

Nirex, *Report on the Seismological Database (in 4 volumes)*, Nirex Report SA/95/003, 1995.



Certificate No 4002929



Certificate No 4002929

Nuclear Decommissioning Authority
Radioactive Waste Management Directorate
Building 587
Curie Avenue
Harwell Oxford
Didcot
Oxfordshire OX11 0RH

t +44 (0)1925 802820

f +44 (0)1925 802932

w www.nda.gov.uk

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