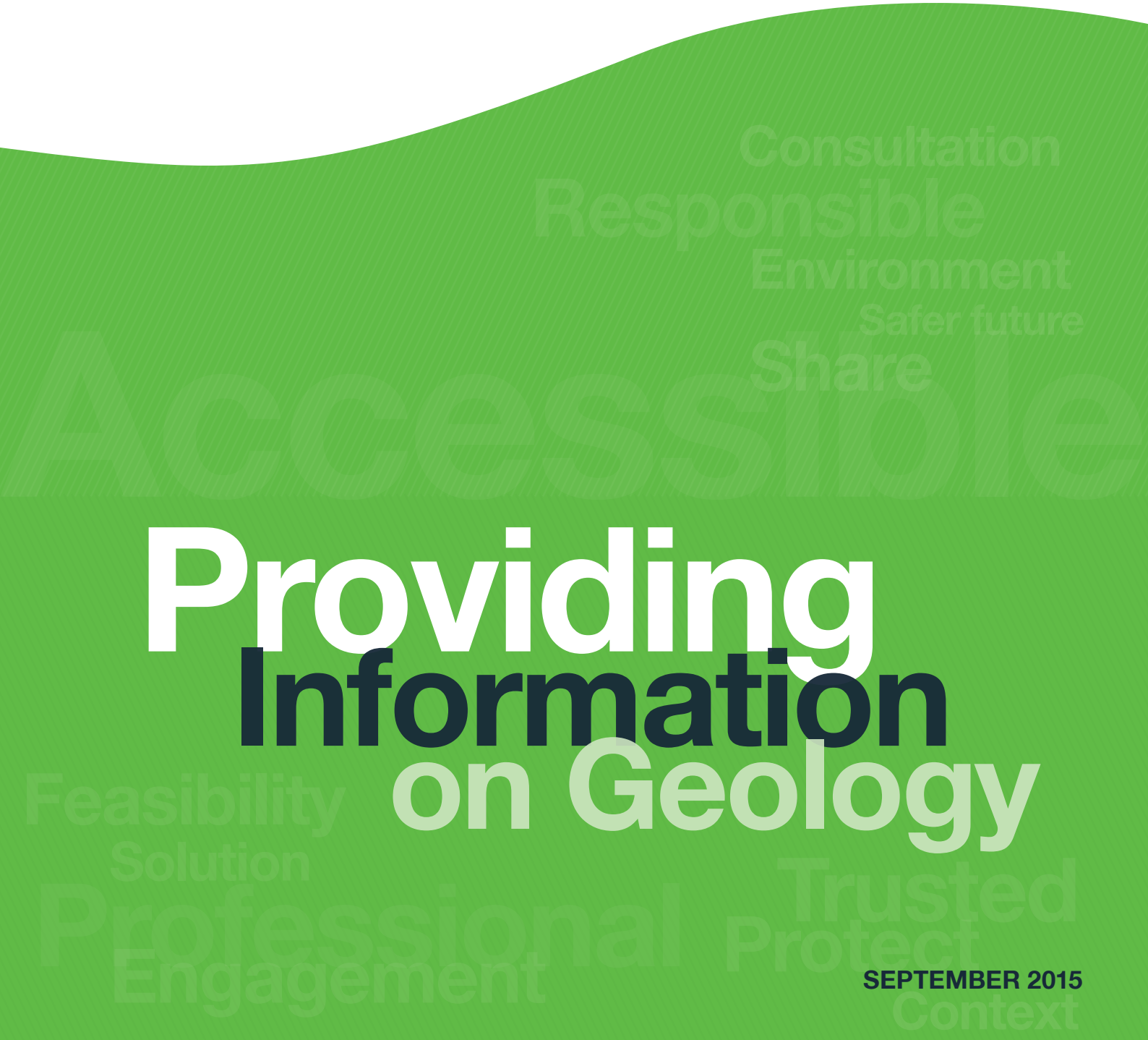
Radioactive Waste Management

A PUBLIC CONSULTATION

National Geological Screening Guidance



Providing Information on Geology

SEPTEMBER 2015

Contents

1

Introduction to the consultation

1.1

National geological screening is an exercise to bring together existing information about UK geology that is relevant to the long-term safety of a geological disposal facility (GDF) and make it available in an accessible form. It is not intended to be able to definitively rule all areas as either suitable or unsuitable.

1.2

Geological disposal involves isolating radioactive waste from the surface environment by placing it deep underground and containing the radioactivity so that it does not cause harm. This is achieved through the use of multiple engineered barriers which work together with the natural barrier provided by the geological environment. Some of the radioactive wastes will remain hazardous for hundreds of thousands of years and the geological barrier has an important role in providing safety in the very long term.

1.3

To demonstrate the safety of a GDF we need to assess how each barrier performs individually and how they work together as a system. The results of those assessments, alongside international guidance, enable us to establish how the geological barrier contributes to long-term safety. By providing existing, relevant information across the various regions of the UK we will have a national resource to help inform early discussions with communities about their potential suitability to host a GDF. Whilst no national exercise will be able to definitively rule all areas as either suitable or unsuitable, it is possible that screening may lead to some areas being identified as unsuitable for hosting a GDF.

1.4

The national geological screening exercise has two parts. The first part involves developing Guidance which sets out how the information will be assembled and presented. The second part involves applying the Guidance. During 2015 we have been working with geoscience specialists and potential users of this information to develop the proposed Guidance. This has been reviewed by an Independent Review Panel (IRP) of expert geologists and we are now presenting it for public consultation.

1.5

There are four specific topics we would like to hear views on:

- our proposed approach to national geological screening.
- the sources of information we plan to use.
- the form in which we plan to present information relevant to long-term safety so it is useful to a general audience.
- any other matters which you consider relevant to this exercise.

1.6

In Section 2 of this document we provide background information about geological disposal. The Guidance is presented in Section 3. We provided an earlier version of the Guidance to the IRP and have updated it to address their review comments. In Section 4 we list the consultation questions and tell you how you can get involved. A glossary of terms is provided on our website at **www.nda.gov.uk/rwm**

1.7

The consultation will be open until Friday 4 December 2015. During the consultation period, we will be organising a number of events around the country, for both specialist and wider audiences, to discuss the national geological screening Guidance. The details will be published on our website at **www.nda.gov.uk/rwm**

1.8

We will carefully consider all the responses to the consultation and update the Guidance accordingly. We have asked the IRP to review the final Guidance before publication, which is currently scheduled for early 2016.

1.9

We, as experts in the science and engineering of geological disposal, will work with the British Geological Survey (BGS), who hold much of the definitive existing information on British geology, to apply the Guidance and develop the outputs. The application of the Guidance will be reviewed by the IRP.

2
Context

THE WASTES

2.1

The UK has accumulated radioactive waste from a range of activities including nuclear power generation, medicine, research and defence-related nuclear programmes. Most of the waste can be disposed of safely in facilities on the surface but a long-term solution is still needed for the most radioactive waste (higher activity waste) some of which will remain hazardous for hundreds of thousands of years.

The UK's higher activity waste is made up of:

- high level waste, which arises initially as a liquid during the reprocessing of spent nuclear fuel and is converted to a solid glass form in a process called vitrification.
- intermediate level waste, from a range of nuclear activities including the operation maintenance and decommissioning of nuclear facilities and the reprocessing of spent nuclear fuel.
- a small amount of low-level waste, which is not suitable for disposal at the existing facilities.

2.2

For geological disposal we consider higher activity waste in two groups: high heat generating waste (high level waste) and low heat generating waste (intermediate and low level waste).

2.3

In planning for the long-term management of higher-activity wastes, we include some nuclear material that is not currently classified as waste but could become so in the future if it is deemed to have no further use. This nuclear material includes spent fuel from nuclear power stations, uranium and plutonium. We also make provision for the waste that would be generated from a new build programme.

GOVERNMENT POLICY

2.4

UK Government's policy is that higher activity waste should be managed through geological disposal.

2.5

There is a large range of potentially suitable geological environments for geological disposal the UK. To identify potential sites where a GDF could be located, the UK Government favours an approach based on working with communities that are willing to participate in the siting process.

2.6

The framework for implementing geological disposal is set out in a White Paper published in 2014[1]. The White Paper sets out a programme of work to be completed before formal discussions can begin. National geological screening is included in this programme.

2.7

Siting will begin when this programme of work is complete, which is expected to be in about two years' time. A high-level programme showing the stages in implementation, the activities at each stage and indicative timescales is given in Figure 1.

2.8

Radioactive waste management is a devolved policy issue. Therefore the Welsh Government, Northern Ireland Executive and Scottish Government each have responsibility for radioactive waste management in their areas. More information about these policies can be found in Appendix 1.

Figure 1 Geological disposal: making it happen

1 Implementing Geological Disposal. A Framework for the long-term management of higher activity radioactive waste, July 2014 http://bit.ly/1NtEcUi

GEOLOGICAL DISPOSAL

2.9

Geological disposal involves placing waste deep underground to ensure that the hazardous materials are isolated from the surface environment and contained for the time required for the radioactivity associated with them to naturally reduce. This ensures that no harmful quantities of radioactivity ever reach the surface environment. There is general agreement internationally that geological disposal provides the safest long-term management solution for higher-activity waste.

2.10

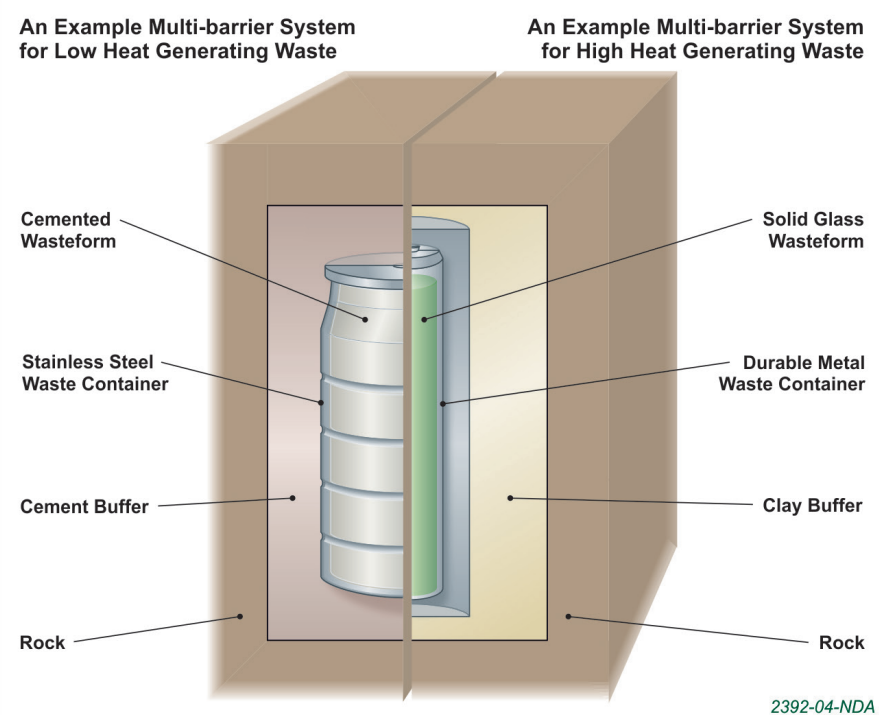
The multiple barriers that provide safety for geological waste disposal are a combination of:

- the form of the radioactive waste itself.
- the packaging of the waste, typically metal or concrete containers.
- buffer or backfill materials placed immediately around the waste containers to protect them.
- engineered features of the facility such as filled and sealed tunnels or vaults.
- the stable geological environment in which the facility is sited.

2.11

This is referred to as the multi-barrier system. The details of the barriers are tailored to the type of waste and the geological environment. Some examples are given in Figure 2.

Figure 2 Schematic showing some examples of multi-barrier systems



WHAT WILL A GEOLOGICAL DISPOSAL FACILITY LOOK LIKE?

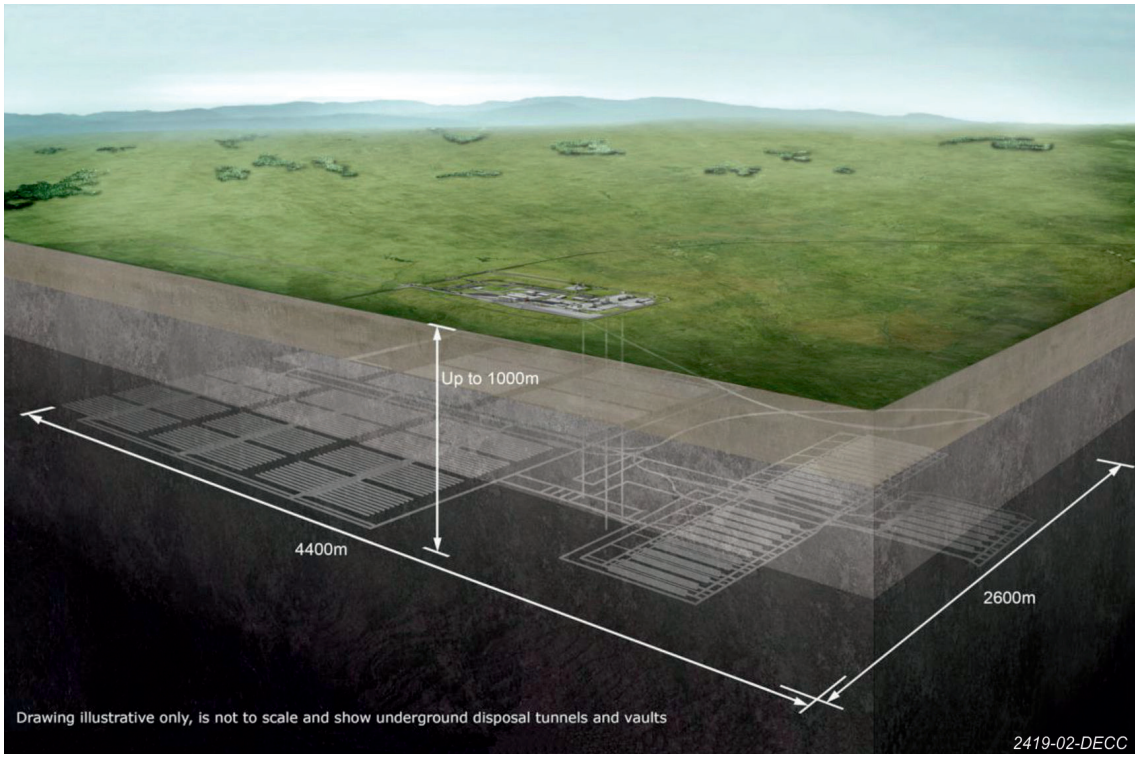
2.12

A GDF will have both surface and underground facilities, linked by shafts or inclined tunnels, as illustrated in Figure 3. The surface facilities will comprise a number of buildings for waste receipt and transfer, infrastructure for the underground environment such as ventilation and administration and other support buildings. In total, they will cover an area of approximately 1km^2 with the details of layout and appearance being tailored to the particular site.

2.13

The underground facilities will comprise a system of vaults and engineered tunnels for the disposal of waste. A GDF will be located at a depth between 200m and 1000m underground and will cover an area of approximately 10 to 20 km^2.

Figure 3 Artist's impression of a geological disposal facility



DEMONSTRATING SAFETY

2.14

The process for developing a GDF involves assessing its performance and demonstrating its compliance with all relevant safety requirements. The requirements cover construction of the GDF, all its operations and the long-term safety after the facility has been closed and sealed.

2.15

Geological screening is about long-term safety. The relevant requirements on the disposal system relating to long-term safety are set out in national and international standards and guidance[2,3,4]. These require that the multi-barrier system must provide:

- isolation of radioactive waste.
- containment of radioactive waste.
- confidence in long-term safety.
- low likelihood of future generations inadvertently intruding into a GDF.

2.16

We need to assess how each barrier performs individually and how they work together as a system. We consider all the pathways by which radioactivity could be released from a GDF and return to the surface environment, through:

- transport in groundwater that flows through the GDF.
- transport in gases generated by the waste.
- human intrusion into a GDF.

2.17

We present the evidence from our assessment in a set of documents called a safety case. We have developed a generic safety case[5], where we describe how safety could be achieved in a range of different geological environments.

2 Environment Agency. Geological disposal facilities on land for solid radioactive wastes: Guidance on requirements for authorisation. February 2009.
3 International Atomic Energy Agency (IAEA). Disposal of Radioactive Waste. Safety Standards Series No. SSR-5. 2011.
4 International Atomic Energy Agency (IAEA). Specific Safety Guide No.SSG-14 – Geological Disposal Facilities for Radioactive Waste. 2011.
5 NDA RWMD Geological Disposal: An Overview of the generic Disposal System Safety Case. NDA/RWMD/010. 2010.

APPROACH TO NATIONAL GEOLOGICAL SCREENING

2.18

We used the evidence and understanding from our safety case to define long-term safety requirements to which the geological environment must contribute. We then identified the geological attributes which are relevant. The safety requirements and geological attributes are listed in the Guidance in Section 3. Appendix 2 describes the geological attributes in more detail.

2.19

We developed the national geological screening Guidance in a collaborative way, drawing on the experience from the geoscience community, overseas waste management organisations and wider interested parties. We have held more than twenty meetings across the UK to share our work and help shape our approach.

2.20

We submitted the draft Guidance[6] to an IRP established by the Geological Society. The IRP is a group of seven expert geologists from the UK and overseas. They have been asked to assess whether the screening Guidance was technically sound; could be applied using existing geological information; and provided a basis for assessing the prospects for developing a long-term safety case in a range of geological settings to accommodate the UK inventory of higher activity waste.

2.21

The IRP provided us with written review comments and held a meeting with us in public in London to discuss their views[7]. The facilitators of the meeting prepared a report of the meeting[8]. We have revised the national geological screening Guidance in response to the IRP review and now present it for public consultation.

6 http://www.nda.gov.uk/publication/implementing-geological-disposal-draft-national-geological-screening-guidance-a-document-for-the-independent-review-panel/
7 https://www.youtube.com/channel/UCpFJyxnagWhTWURacGN42KQ
8 http://www.nda.gov.uk/publication/national-geological-screening-for-the-disposal-of-radioactive-waste-2/

3

National geological screening guidance

INTRODUCTION

3.1

National geological screening is an exercise to bring together existing information about aspects of geology that are relevant to the long-term safety of a GDF and make it available in an accessible form. It will provide authoritative information for England, Wales and Northern Ireland that can be used in early discussions with communities about their geological potential to host a GDF.

3.2

As required by the 2014 White Paper, the approach to national geological screening is based on geological attributes (characteristics of the geological environment relevant to the long-term safety of a GDF) and the requirements of the existing GDF safety cases.

3.3

The national geological screening guidance comprises:

- the safety requirements to which the geological environment contributes.
- geological attributes that are relevant to meeting these safety requirements.
- sources of existing geological information relevant to understanding these attributes.
- a description of the outputs that will be produced based on this existing geological information.

SAFETY REQUIREMENTS

3.4

The first consideration in developing national geological screening Guidance is the contribution to long-term safety required from the geological environment, as a component of a multi-barrier system.

3.5

To understand the contribution to long-term safety of the geological environment we considered national and international standards and guidance and our generic safety case. The long-term safety requirements are listed in Table 1.

Table 1 Long-term safety requirements

The geological environment contributes to the following long-term safety requirements:

1. The functions of the engineered barrier system will be maintained.
2. Radionuclides or toxic substances entering groundwater will not compromise safety.
3. Any gas generated in the GDF will not compromise safety.
4. Natural events and changes will not compromise safety.
5. The site can be characterised sufficiently to demonstrate safety.
6. The effect of long-term evolution on safety can be understood.
7. The potential consequences of human intrusion can be assessed.

GEOLOGICAL ATTRIBUTES

3.6

We identified geological attributes that are relevant to meeting the safety requirements under five geological topics: rock type, rock structure, groundwater, natural processes and resources. The geological attributes are listed in Table 2 and you can find information on why they were chosen in Appendix 2.

SCREENING APPROACH

3.7

National geological screening will be carried out for England, Wales and Northern Ireland but will not be applied to Scotland (which has a different higher activity waste management policy).

3.8

Our proposed approach aims to provide descriptions of geology at a regional scale and we will indicate the prospects for long-term safety. We are not setting firm values that need to be achieved as there is not enough certainty or consistency in the available geological information for this approach to be meaningful. In some areas, we expect to find that very little is known about the geological environment at the depths we are interested in. Numerical assessments will be important later in implementation when we consider the characteristics of specific sites and are developing site-specific designs.

Table 2 Geological attributes

Geological topic	Attribute
ROCK TYPE	– Distribution of suitable host rock types (higher strength rocks, lower strength sedimentary rocks, evaporite rocks) at the depths of a GDF. – Properties of rock formations that surround the host rocks.
ROCK STRUCTURE	– Locations of highly faulted and folded zones. – Locations of major faults.
GROUNDWATER	– Presence and properties of aquifers. – Presence of geological features and rock types which may indicate separation of shallow and deep groundwater systems. – Locations of features likely to permit rapid flow of deep groundwater to near-surface environments. – Groundwater age and chemical composition.
NATURAL PROCESSES	– Distribution and patterns of seismicity. – Extent of past glaciations.
RESOURCES	– Locations of existing deep mines. – Locations of intensely deep-drilled areas. – Potential for future exploration or exploitation of resources.

3.9

We will apply the Guidance working closely with the BGS and specialist contractors. We will develop detailed technical instructions, setting out specifically how to capture information about the attributes from the available datasets. These detailed technical instructions will be reviewed by the IRP.

3.10

The relevant geological information will be sourced from publicly available national datasets and compilations. We recognise that there is more detailed information available for particular areas and/or for particular geological attributes and where appropriate this information will be considered later in the siting process.

3.11

The depth of the underground facilities of a GDF is expected to be between 200m and 1000m. The surface facilities of a GDF will be located on land. However the design of a GDF could allow the underground facilities to extend offshore if accessed from onshore surface facilities. Therefore screening will consider the geological environment in England, Wales and Northern Ireland, including areas up to 20km offshore.

3.12

The proposed approach to assembling information about the geological attributes and the information sources to be used are presented in the following sub-sections for each geological topic.

ROCK TYPE

3.13

We propose to produce maps to show the distribution of potentially suitable host rocks across England, Wales and Northern Ireland in the depth range 200m to 1000m.

3.14

The surrounding geological environment and its expected contribution to safety will be discussed in a narrative.

3.15

Low groundwater flow is one of the main factors used in identifying potentially suitable host rocks[9]. Building on the approach described in the 2010 generic Disposal System Safety Case (see footnote 5), potentially suitable host rocks will be considered in three broad types, based on UK geology and environments that have been identified internationally as suitable for geological disposal. These types are classified as higher strength rocks, lower strength sedimentary rocks and evaporite rocks:

- Higher strength rocks, which may be igneous, metamorphic or older sedimentary rocks, have a low matrix porosity and low permeability, with the majority of any groundwater movement confined to fractures within the rock mass.

9 The ease with which fluid moves through a rock is measured in terms of the rock's permeability or hydraulic conductivity. Intrinsic permeability is a rock property independent of the type of fluid (used largely in the oil and gas sector where water, oil, gas and brine need to be considered) while hydraulic conductivity combines rock and fluid properties assuming the fluid is fresh water (used largely in the water resources sector). This document uses the term permeability rather than hydraulic conductivity because we believe that it is more readily understood and applicable.

- Lower strength sedimentary rocks are fine-grained, sedimentary rocks with a high content of clay minerals that provides their low permeability and are mechanically weak, so that open fractures cannot be sustained. They will be interlayered with other sedimentary rock types.
- Evaporite rocks have formed as ancient seas and lakes evaporated and often contain bodies of halite, for example, that provide a suitably dry environment. They are weak and creep easily so that open cracks cannot be sustained[10].

3.16

We propose to use geological columns for each region to identify which of the rock units shown on existing BGS geological maps are likely to contain each of the potential host rock types. This assignment will consider existing qualitative information such as the BGS Permeability Index and experience from exploitation of water and other resources in the same or similar geological formations in the UK and Europe. The reasons for allocating rock units to particular host types will be documented and uncertainties in rock properties that would need to be resolved by further investigations during the siting process will be discussed in the narratives.

3.17

The principal information sources will be the BGS maps, memoirs and stratigraphic summaries, together with the BGS GB3D model.

3.18

The UK Government has a strong preference to manage the inventory for disposal in one GDF and recognises that this would require a large enough volume of suitable rock (in an area willing to host a GDF) for the underground facilities to be constructed and for a safety case made. However as a single GDF is not a requirement volumes of rock that would be suitable for only a part of the inventory will also be included at screening. The minimum rock volume of interest as a potential host rock has an area of the order of one square kilometre and a thickness of some tens of metres. The volume of host rock at a particular location would be considered in more detail during the siting process.

10 These types were introduced in the 2010 generic Disposal System Safety Case (see footnote 5). The definitions have been updated to improve clarity.

3.19

Although the near-surface geology of the UK is well known, the uncertainty increases at greater depth, except in specific areas such as those that have been exploited or explored for deep geological resources. In particular, depth and thickness estimates may be subject to significant uncertainties at increasing distances from existing boreholes. Additionally, the nature of concealed rock units that are only imaged by geophysics may only be understood in general terms. In the depth range of interest, as a general guide, we can make the following points:

- For concealed higher strength rocks, it is likely that only their presence and approximate depth are known; the exact nature of the rocks present may be quite poorly defined.
- For layered sedimentary rocks, the exact depths and thicknesses of known layers may be uncertain. It may be known that specific layers are not persistent or that the mapped formations vary in composition, however, where these changes take place may not be well known.
- It is generally possible to identify the formations that include evaporite rocks, but it will not be possible to specify which evaporite rocks (such as halite) are present.

3.20

These uncertainties will be made clear in regional narrative descriptions.

ROCK STRUCTURE

3.21

We propose to produce maps to show:

- Major faults and fracture zones that would provide effective limits to any rock volume being considered for siting a GDF.
- The locations of areas in which geological structures would have an impact on the uniformity and predictability of rocks and groundwater at a scale appropriate for a GDF. Many such complex zones are well-known and are identified in the BGS regional guides and memoirs.

3.22

The principal sources of information will be the BGS 1:1,500,000 “Tectonic map of Britain, Ireland and adjacent areas” and the BGS 1:1,000,000 map and contour overlay “Pre-Permian geology of the United Kingdom (South)”. 1:50,000 BGS solid geology maps and supporting memoirs contain further information which may be useful in identifying which of these complex zones have characteristics which are of relevance to the safety requirements for a GDF.

GROUNDWATER

3.23

Consideration of groundwater in screening is limited by the lack of national information available about the movement and chemical composition of groundwater in the depth range of a GDF. There is very little information available from depths below those aquifers that are currently exploited for groundwater. Furthermore, groundwater movement and composition can vary significantly over short lateral and vertical distances. Developing an understanding of groundwater movement and chemistry and the implications for safety are major activities which will be carried out during the siting process and particularly during site characterisation.

3.24

Therefore we propose to produce maps showing locations of features which may indicate connectivity between deep and near-surface groundwater:

- deep-sourced springs.
- existing deep mine workings.
- arrays of deep exploration boreholes extending to depths in excess of 200m.

3.25

The following information will be discussed in regional narratives:

- Potable aquifers, identified from maps of the distribution of superficial and upper bedrock aquifers in England and Wales produced by the Environment Agency. Where deep salinity data are not available, a maximum depth of 400m for potable water will be assumed[11].
- The distribution of deeper confined aquifers, identified from the BGS GB3D model and the Environment Agency regional aquifer conceptual model reports.
- The flow regimes feeding deep-sourced springs, where known, and the potential presence of karst at depths greater than 200m.
- The presence of rock types and other geological features likely to result in separation of deep and shallow groundwater bodies, for example the presence of lower-strength sedimentary or evaporite rocks.
- The limited regional information about groundwater chemistry, salinity and age, sourced mainly from the existing BGS baseline chemistry and dominant geochemical processes reports[12]. This information can be useful for indicating the extent of groundwater movement.

NATURAL PROCESSES

3.26

We propose providing a qualitative explanation of the nature and distribution of natural processes that have the potential to affect safety. This will include a commentary on the UK's history of seismicity with an explanation of the amounts and depth of observed fault movements. We will also discuss the uncertainties in projections of future events from historical information. Many aspects of this topic were recently investigated and reported in BGS Commissioned Report, Potential Natural Changes and Implications for a UK GDF[13]. Therefore we plan to use this report as the principal information source for screening. The regional narratives will highlight the relevance of this information in the regional context.

3.27

Because of the scale on which natural processes operate, these outputs will be presented as national maps. It is proposed to produce a national map of the distribution of recent seismicity and a national map showing the extent of past glaciation.

11 Water Framework Directive UK TAG. Defining and reporting on groundwater bodies. http://www.wfduk.org/resources%20/defining-and-reporting-groundwater-bodies 2012.
12 Baseline chemistry and dominant geochemical processes – report series. http://www.gov.uk/government/publications/baseline-chemistry-and-dominant-geochemical-processes-report-series 2007.
13 British Geological Survey, National Nuclear Laboratory, University of Manchester Dalton Nuclear Institute. Potential Natural Changes and Implications for a UK GDF. Minerals and Waste Programme COMMISSIONED REPORT CR/12/127. 2013.

RESOURCES

3.28

We propose to produce maps of the locations of known resources of a range of metal ores, industrial minerals, coal and hydrocarbons below a depth of 100m that are exploited today or have been exploited in the past. Shallower resources that clearly have no deeper extension, such as sand, gravel or peat, will not be considered because they are above any possible GDF.

3.29

Future exploration often takes place at sites where shallower mining has taken place in the past, with a view to finding deeper reserves, and for this reason mining below 100m is considered relevant. Resources below 1000m are included because the GDF might be intersected by drilling or extraction.

3.30

We will discuss in the narrative the possible extent of remaining resources of materials beyond the limits of existing or planned workings (e.g. coal) and provide information on other potentially exploitable resources whose presence can reasonably be inferred. This will include the potential for coal-bed methane, shale gas and geothermal energy. Evaluating the likely potential for future deep exploration is subjective and uncertain because it will depend on market conditions as well as geological information.

3.31

The primary sources of information will be compilations of information about past mining operations in the UK, particularly the BGS maps "1:1500,000 Coal Resources (1999)" and "1:1500,000 Metallogenic Map (1996)" together with the BGS Economic Geology Memoir series. Information about current operations will be taken from the BGS Directory of Mines and Quarries, along with the BGS BRITPITS dataset. The BGS GeoIndex includes a large database of onshore boreholes that can be filtered by depth; this may provide supporting information for identifying locations where the resources have already been exploited and enables identification of arrays of multiple deep boreholes.

QUESTION 1 PLEASE GIVE YOUR REASONS

To what extent do you think our proposed approach to providing national-scale existing information about geology relevant to long-term safety is appropriate?

QUESTION 2 PLEASE GIVE YOUR REASONS

The proposed sources of information are summarised below.

To what extent do you think that these sources are appropriate and sufficient for this exercise?

Geological topic	Principal information sources
ROCK TYPE	– BGS maps, memoirs and stratigraphic summaries. – BGS GB3D model.
ROCK STRUCTURE	– BGS 1:1,500,000 "Tectonic map of Britain, Ireland and adjacent areas". – BGS 1:1,000,000 map and contour overlay "Pre-Permian geology of the United Kingdom (South)". – 1:50,000 BGS solid geology maps and supporting memoirs.
GROUNDWATER	– Information gathered under Rock Type attribute. – Information gathered under Resources about existing deep mines. – Environment Agency Maps of the distribution of superficial and upper bedrock aquifers in England and Wales. – Information gathered under Resources about onshore boreholes. – BGS baseline chemistry and dominant geochemical processes report series.
NATURAL PROCESSES	– British Geological Survey, National Nuclear Laboratory, University of Manchester Dalton Nuclear Institute Potential Natural Changes and Implications for a UK GDF. Minerals and Waste Programme Commissioned Report CR/12/127. 2013.
RESOURCES	– BGS 1:1500,000 Coal Resources map. – BGS Directory of Mines and Quarries. – BGS 1:1500,000 Metallogenic Map (1996). – BGS County Mineral Resource maps and reports. – BGS Economic Geology Memoir series. – BGS BRITPITS dataset. – BGS GeoIndex for information on onshore boreholes.

FORM OF OUTPUTS

3.32

The outputs of geological screening are designed to help communities who wish to engage with us about their potential to host a GDF. Feedback gathered during the development of the Guidance indicated a desire to have short documents that summarise the key points and are accessible to a non-specialist audience. We also recognise that some members of these communities would like access to more detailed information.

3.33

We therefore propose to present the outputs of screening as a series of brief narratives describing the key characteristics of the geological environment of the region and their relevance to safety. The narratives will be illustrated with maps, where appropriate.

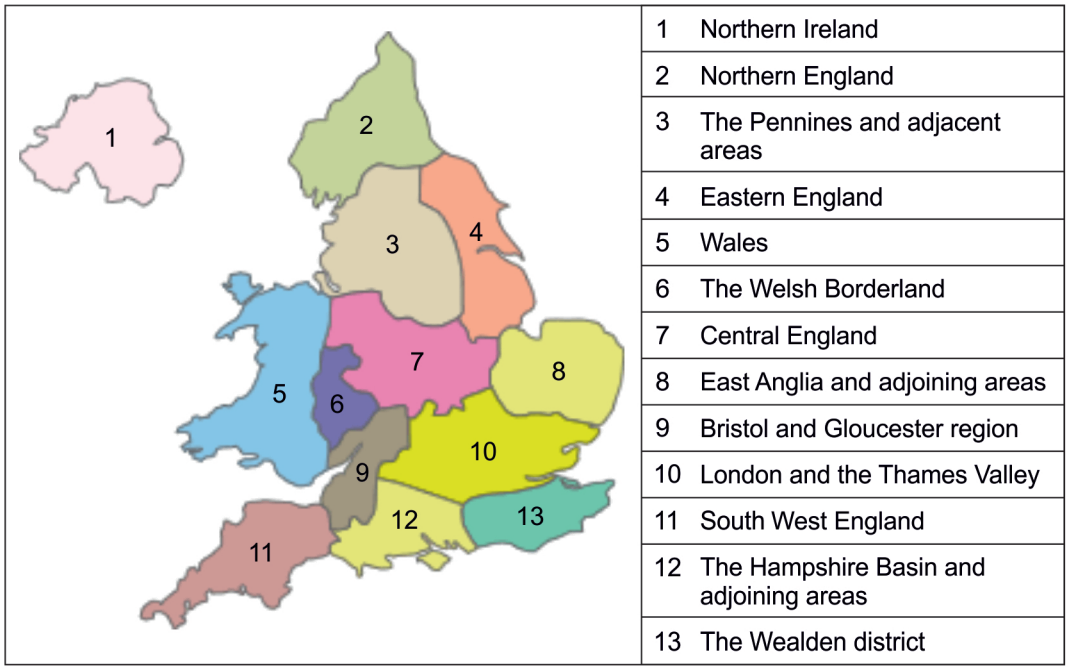
3.34
We will produce packages of outputs for each geological region of England, Wales and Northern Ireland. The geological regions will be those adopted by the BGS in its Regional Guides (shown in Figure 4). The Regional Guide publication series provides a structure for which there is a well-established source of more detailed information for those who would like to know more.

3.35
For some attributes information will be presented at a national level only, because data are very sparse or vary little across all regions, and so there will also be a short national output presenting this information, which is applicable to all regions.

3.36
The supporting information and maps on which the outputs are based and the records of the decisions taken in compiling and presenting the outputs will also be made available.

3.37
A summary of the outputs for each geological topic is presented in Table 3 opposite.

Figure 4 British Geological Survey regions



1	Northern Ireland
2	Northern England
3	The Pennines and adjacent areas
4	Eastern England
5	Wales
6	The Welsh Borderland
7	Central England
8	East Anglia and adjoining areas
9	Bristol and Gloucester region
10	London and the Thames Valley
11	South West England
12	The Hampshire Basin and adjoining areas
13	The Wealden district

2729-01-NDA/BGS

Table 3 Summary of outputs

Geological topic	Narrative	Maps (1:625000)
ROCK TYPE	Description of the potential host rocks, their depths and remaining uncertainties in properties and/or location. Description of rock formations surrounding potential host rocks with properties that may contribute to safety. The rock type descriptions will be illustrated with a geological column showing the sequence of rocks present in the region.	Regional maps of distribution of potential host rocks at 200-1000m depth (separate maps for the distribution of each of the three generic host rock types). Summary regional maps of areas beneath which at least one potential host rock may be present.
ROCK STRUCTURE	Explanation of the nature of the structures within the region that are relevant to safety. These will be major faults and fault zones and areas of folded rocks with complex properties.	Regional maps of the distribution of the structures described in the narrative.
GROUNDWATER	Explanation of the known shallow and deep groundwater flow regimes and groundwater chemistry, salinity and age. Discussion of the rock types and other geological features likely to influence groundwater movement and the interaction between deep and shallow groundwater in the region.	Regional maps of areas showing locations of deep boreholes, mines and mineralised or thermal springs.
NATURAL PROCESSES	Interpretation of national information (on seismicity, uplift rate, erosion rate, and past ice cover during glaciations) in the context of the region.	National map of the distribution of recent seismicity. National map showing the extent of past glaciation.
RESOURCES	Description of the past history of deep resource exploration and exploitation with a discussion of the potential for future exploitation of resources in the region.	Regional maps of historic and contemporary exploitation of metal ores, industrial minerals, coal and hydrocarbons) at >100m depths.

QUESTION 3

To what extent do you agree or disagree with the proposed form of the outputs from geological screening?

What additional outputs would you find useful?

QUESTION 4

Do you have any other views on the matters presented in the draft Guidance?

4

How to take part

4.1

We have published this consultation online at **www.nda.gov.uk/rwm/national-geological-screening/consultation**

It can be downloaded as a printable pdf from the website. You will need to have the free Adobe Reader installed on your computer. A Welsh language translation of the consultation document is available on the website.

4.2

If you prefer, we can send you a printed version through the post by request to:

National Geological Screening Consultation
Radioactive Waste Management
Building 587
Curie Avenue
Harwell
Didcot OX11 0RH

HOW TO RESPOND

4.3

You can submit your inputs to this consultation online, via the link on the RWM website www.nda.gov.uk/rwm. There is no requirement to answer all the questions.

4.4

Please make it clear whether the views you submit are individual or if they represent those of an organisation. When inputs being made on behalf of an organisation please tell us who the organisation represents and, where applicable, how the views of members were assembled.

4.5

When considering inputs to this consultation, we will give greater weight to inputs that are based on evidence, rather than simple expressions of support or opposition.

4.6

If you would prefer to respond by email or letter, it would be very helpful if you could use our response template. It can be downloaded as a PDF or a Word document at: www.nda.gov.uk/rwm or we can supply an electronic or paper copy on request. However, we will consider all responses, whether provided on this template or not.

4.7

Please email your response to:

NGSconsultation@nda.gov.uk or write to us at:

National Geological Screening Consultation
Radioactive Waste Management
Building 587
Curie Avenue
Harwell
Didcot OX11 0RH

Telephone: 0300 066 0100

QUERIES

4.8

If you have any queries about this consultation or about the draft screening Guidance please contact us via any of the channels shown above.

CONFIDENTIALITY AND DATA PROTECTION

4.9

When the consultation ends, we will publish the evidence submitted. Also, members of the public may ask for a copy of responses under the freedom of information legislation. If you do not want your response – including your name, contact details and any other personal information – to be publicly available, please say so clearly in writing when you send your response to the consultation. Please note, if your computer automatically includes a confidentiality disclaimer that will not count as a confidentiality request.

4.10

Please explain why you need to keep details confidential. We will take your reasons into account if someone asks for this information under freedom of information legislation. However, we must comply with relevant legislation and cannot promise that we will always be able to keep those details confidential.

CONSULTATION CONDUCT

4.11

Any comments about the way in which this consultation has been conducted should be set down in writing and sent, marked "National Geological Screening Consultation" to:

Radioactive Waste Management
Building 587
Curie Avenue
Harwell
Didcot OX11 0RH

Or by email to: **rwmfeedback@nda.gov.uk**

CONSULTATION QUESTIONS

QUESTION 1 PLEASE GIVE YOUR REASONS

To what extent do you think our proposed approach to providing national-scale existing information about geology relevant to long-term safety is appropriate?

QUESTION 2 PLEASE GIVE YOUR REASONS

The proposed sources of information are summarised below.

To what extent do you think that these sources are appropriate and sufficient for this exercise?

Geological topic	Principal information sources
ROCK TYPE	– BGS maps, memoirs and stratigraphic summaries. – BGS GB3D model.
ROCK STRUCTURE	– BGS 1:1,500,000 "Tectonic map of Britain, Ireland and adjacent areas". – BGS 1:1,000,000 map and contour overlay "Pre-Permian geology of the United Kingdom (South)". – 1:50,000 BGS solid geology maps and supporting memoirs.
GROUNDWATER	– Information gathered under Rock Type attribute. – Information gathered under Resources about existing deep mines. – Environment Agency Maps of the distribution of superficial and upper bedrock aquifers in England and Wales. – Information gathered under Resources about onshore boreholes. – BGS baseline chemistry and dominant geochemical processes report series.
NATURAL PROCESSES	– British Geological Survey, National Nuclear Laboratory, University of Manchester Dalton Nuclear Institute Potential Natural Changes and Implications for a UK GDF. Minerals and Waste Programme Commissioned Report CR/12/127. 2013.
RESOURCES	– BGS 1:1500,000 Coal Resources map. – BGS Directory of Mines and Quarries. – BGS 1:1500,000 Metallogenic Map (1996). – BGS County Mineral Resource maps and reports. – BGS Economic Geology Memoir series. – BGS BRITPITS dataset. – BGS GeoIndex for information on onshore boreholes.

QUESTION 3

To what extent do you agree or disagree with the proposed form of the outputs from geological screening?

What additional outputs would you find useful?

QUESTION 4

Do you have any other views on the matters presented in the draft Guidance?

A

Appendices

APPENDIX 1 DEVOLVED ADMINISTRATION POSITIONS

A1.1

Radioactive waste management is a devolved matter. Therefore, the Welsh Government, Northern Ireland Executive and Scottish Government each have responsibility for this issue in or as regards Wales, Northern Ireland and Scotland respectively. Their respective policy positions are summarised below.

A1.2

The 2014 Implementing Geological Disposal White Paper was issued jointly by the UK Government and the Northern Ireland Executive. It confirms the policy of geological disposal for higher activity radioactive waste including a voluntarist approach to the siting process for a GDF that is based on the willingness of local communities to participate.

A1.3

The Northern Ireland Executive has responsibility for ensuring that any proposed GDF will not have an adverse impact upon the environment, health or safety of Northern Ireland. Northern Ireland continues to support the implementation of geological disposal for the UK's higher activity radioactive waste, recognising that it is in the best interests of Northern Ireland that these wastes are managed in the safest and most secure manner.

A1.4

The Scottish Government is not a sponsor of the programme for implementing geological disposal, but does remain committed to dealing responsibly with radioactive waste arising in Scotland. On 20 January 2011, the Scottish Government published Scotland's Higher Activity Waste Policy. Scottish Government Policy is that the long-term management of higher activity radioactive waste should be in near-surface facilities. Facilities should be located as near to the sites where the waste is produced as possible. While the Scottish Government does not support deep geological disposal, it continues, along with the UK Government and other devolved administrations, to support a robust programme of interim storage and an ongoing programme of research and development.

A1.5

The Welsh Government has adopted a policy for geological disposal for the long-term, safe and secure management of higher activity radioactive waste[14]. The Welsh Government considers that a GDF will only be deliverable in Wales on the basis of a voluntary partnership with interested local communities willing to enter into discussions about potentially hosting a GDF and the successful conclusion of those discussions.

A1.6

The Welsh Government has recently issued a consultation on Community Engagement and Implementation Processes[15] to seek views on the processes by which a GDF might be sited in Wales, and to provide information to potential volunteer host communities which may want to enter discussions, without commitment, about hosting a geological disposal facility.

14 Welsh Radioactive Policy on the Management and Disposal of Higher Activity Radioactive Waste, 2015 http://bit.ly/1JjyZO1

15 Welsh Government Consultation Document: Geological Disposal of Higher Activity Radioactive Waste: Community Engagement and Implementation Processes, May 2015 http://bit.ly/1InINYO

APPENDIX 2 GEOLOGICAL ATTRIBUTES

A2.1

We call the characteristics of the geological environment relevant to long-term safety geological attributes. We have identified geological attributes relevant to long-term safety under five topics:

- Rock type.
- Rock structure.
- Groundwater.
- Natural processes.
- Resources.

A2.2

Rock type attributes relate to the nature and properties of rocks, including both the rock in which the geological disposal facility will be built (host rock) and any surrounding rocks, particularly overlying rocks, which could also contribute to the safety of a GDF.

A2.3

In the UK, all rocks which are more than a few metres underground are saturated with water which fills the minute pores, voids and cracks in the rock structure. If these pores and cracks are connected, water can move through them. In many parts of the UK, the properties of the rock mean that the water within them moves very slowly, if at all, and we can show that the water there today has been there for tens of thousands of years at least. These types of rock have potential as a host rock for building a GDF. We consider potential host rocks in three broad types which we call higher strength, lower strength sedimentary and evaporite.

A2.4

A suitable host rock must have sufficient volume and be deep enough to ensure that the waste remains isolated from the surface environment for hundreds of thousands of years. Account needs to be taken of what might happen as a result of processes such as erosion of the earth's surface.

A2.5

The rocks that surround the host rock, particularly the overlying rocks, may also contribute to safety, mainly by protecting the host rock or by inhibiting the movement of groundwater from the GDF to the near-surface. For example, clay layers through which water cannot flow easily typically prevent groundwater in the rocks beneath them from mixing with groundwater in the rocks above.

A2.6

The attributes we have chosen to provide information on rock type are:

- Distribution of suitable host rock types (higher strength rocks, lower strength sedimentary rocks, evaporite rocks) at the depths of a GDF.
- Properties of rock formations that surround the host rocks.

A2.7

Rock structure attributes relate to the three-dimensional form and arrangement of different rocks, particularly the presence of features such as folds, faults and highly-fractured zones, which distort or disrupt the rock mass. Demonstrating an understanding of these features will be important for building confidence in safety. Faults and folds may sometimes result in geological environments with variable and unpredictable physical properties and groundwater flow. Figure 5 shows an example.

The attributes we have chosen to provide information on rock structure are:

- Locations of highly faulted and folded zones.
- Locations of major fault.

A2.8

Groundwater attributes relate to the movement and chemical composition of groundwater present in rocks from surface to a depth of around 1000m. As groundwater moves through rock formations from the GDF towards the surface environment it may transport very small amounts of radioactive material from the GDF to the surface. Groundwater transport of radioactive and other toxic materials is influenced by the rate of movement of the water and the route it takes to return to the surface. Favourable characteristics with respect to groundwater are slow groundwater movement and long return paths between the GDF and the surface so that any radioactivity is further reduced by radioactive decay.

Figure 5 Slate and sandstone layers folded and faulted together – Cardigan Bay, Wales

A2.9

The attributes we have chosen to provide information on groundwater are:

- Presence and properties of aquifers.
- Presence of geological features and rock types which may indicate separation of shallow and deep groundwater systems.
- Locations of features likely to permit rapid flow of deep groundwater to near-surface environments.
- Groundwater age and chemical composition.

A2.10

Natural processes attributes relate to our understanding of how the geological environment would respond in the event of sea level change, erosion, earthquakes, regional uplift or the growth and retreat of ice sheets and glaciers. These processes are relevant to maintaining the safety of a GDF into the far future. Favourable conditions with respect to natural processes are those where the anticipated natural processes are sufficiently slow and are adequately understood so that their consequences can be shown not to compromise the safety of the multi-barrier system.

A2.11

The attributes we have chosen to provide information on natural processes are:

- Distribution and patterns of seismicity.
- Extent of past glaciations.

A2.12

Resources attributes relate to materials of value such as metal ores, industrial minerals, coal or oil that we know are present or think may be present deep underground. We include sites where resources have been exploited in the past because exploration for new resources often takes place around sites of past exploitation.

A2.13

Resources are primarily relevant to GDF safety because a future society, unaware of the presence and purpose of a GDF may unwittingly drill or mine the area in which it is situated. Intrusion by people, including mining and drilling, may affect the geological environment and the function of the multi-barrier system. The structures left after mineral exploration or exploitation may also provide a route by which deep groundwater may return to the surface environment.

A2.14

The attributes we have chosen to provide information on resources are:

- Locations of existing deep mines.
- Locations of intensely deep-drilled areas.
- Potential for future exploration or exploitation of resources.

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