

TECHNICAL NOTE

**Review of 1987-1991 Site Selection
for an ILW/LLW Repository**

**June 2005
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REVIEW OF 1987-1991 SITE SELECTION

FOR AN ILW/LLW REPOSITORY

EXECUTIVE SUMMARY

▪ INTRODUCTION

This document has been developed by Nirex to accompany the release of the historical list of sites previously considered as potential hosts for a repository for intermediate-level and low-level radioactive wastes. It reports a recent review of the whole decision-making process that resulted eventually in the decision to focus site investigations for a deep geological repository at Sellafield and identifies the sites that were considered in the evaluation process. We have prepared the document to provide the context behind the list of site names and to explain how sites were identified and considered. It outlines the lessons that have been identified from reviewing the previous process and how they could be applied in the future. The document indicates how a new site selection process could be different to the one used previously and highlights developments that have occurred since the previous process was undertaken. The document also outlines the current decision-making process on radioactive waste management policy and the opportunities for stakeholders and the public to be involved in the current debate.

We believe that the release of this historical list from a previous process is a step forward in the debate around how to manage the UK's radioactive waste in the long term. It is a debate that must be conducted in an open and transparent manner and we would urge all stakeholders to play a full and active part in the process. The following paragraphs provide a brief introduction to the context of the list of site names and an overview of the report.

▪ CONTEXT

Radioactive waste has been created in significant quantities in the UK since the 1940's. The UK has significant holdings of long-lived radioactive waste that will remain potentially hazardous for many thousands of years. Previous attempts to provide a long-term waste management facility for these wastes have ended in failure, most recently in 1997. The waste is currently being stored at 34 locations around the UK awaiting a long-term waste management facility.

We believe that radioactive waste management is an ethical issue – the waste exists and must be dealt with irrespective of any future decisions on nuclear power. We think that responsibility rests with this generation, now, to take the steps necessary for creating the framework in which a publicly acceptable way forward is found. The purpose, scope and arrangements for radioactive waste management must be, and be seen to be, legitimate and those responsible for radioactive waste management must be accountable to society as a whole. We believe that transparency must underpin everything that happens.

The most recent attempt to implement a deep geological repository to manage intermediate-level and low-level wastes ended with a refusal in 1997 from the Secretary of State for the Environment to allow the construction of an underground Rock Characterisation Facility (RCF) close to the Sellafield works. That ended the previous site selection exercise that led to Sellafield and Government will not begin to consider a new site selection process again until 2007/08, after deciding which option (or combination of options) to use for the long-term management of waste. The current draft shortlist of options, subject to consultation by the Committee on Radioactive Waste Management (CoRWM) is surface, or sub-surface stores, or a deep geological repository system with or without a period of retrievable underground storage. The decision to focus the

investigations at Sellafield in 1991 followed a detailed decision-making process that started by considering which areas in Great Britain could potentially be used to site a deep geological repository (over 30% of the landmass) and sieving down from 537 sites sequentially to 204, 165, and on down to a shortlist of 10 (and 2 generic offshore) sites that were evaluated in a multi-attribute decision analysis (MADA). The way evaluation criteria were used to assess the sites was never discussed with stakeholders and was conducted in secret.

The sites considered in the site selection process, other than Dounreay and Sellafield, have never been published in line with Government policy to keep the information confidential to prevent blight affecting any of the areas that had been considered as having possible sites. There have been several requests for the lists of the sites over the years which have been refused in line with Government policy. On 1 January 2005 the Freedom of Information Act came into force; along with the Environmental Information Regulations 2004, it puts greater emphasis on openness, transparency and the publication of information. In light of these developments, the Government has changed its previous policy and, in conjunction with Nirex, has decided that the process of site selection and the names of all of the sites considered should be published.

▪ **A NEW PROCESS**

Following the ending of the old site selection exercise in 1997, a new decision-making process on radioactive waste management policy 'Managing Radioactive Waste Safely' (MRWS) was launched by Government in 2001. The aim of this process is to enable a national debate that will lead up to a decision on long-term radioactive waste management policy for the UK. In 2003 the Government set up the CoRWM to oversee the evaluation of long-term radioactive waste management options and make a recommendation to Government about which option(s) to implement. CoRWM (<http://www.corwm.org.uk>) is due to make its recommendation in July 2006, after which the Government will make a decision about which option or options to implement. There will then be a further period of consultation concerning how to go about implementing the chosen option, including the site selection process and criteria that should be used.

The MRWS programme provides opportunities for stakeholders and members of the public to voice their issues and concerns and have an input into long-term radioactive waste management policy in the UK. As outlined above a new site selection process is going to be developed in the future as necessary. There will be an opportunity for people to influence the decision-making process, the criteria used to evaluate potential sites and their relative weight, and the power given to local communities in the process.

▪ **THE NEED FOR OPENNESS**

We have reviewed the events that have occurred in the past, spoken to our stakeholders, and tried to identify lessons that can be learned for the future. These are summarised below. We believe that the process used was technically sound, but it was conducted in secret and did not involve stakeholders, therefore it was not a legitimate process.

In summary:

- The whole site selection process must be open and transparent and facilitate the involvement of stakeholders, the public and experts. This is key.
- The site selection process, the criteria used to evaluate sites and the relative weight attached to each must be developed through national debate before any sites are looked at.
- Any possible constraints on the sites to be considered should be identified at the outset and discussed openly with stakeholders and the public so that they can be considered as part of the definition of site evaluation criteria.
- The role in the decision-making process of local communities in the areas being considered must be defined clearly at the beginning of the process, including rights such as veto and volunteerism.
- Community benefits should be discussed and agreed including measures to enable communities to engage in the decision-making process.
- The views of stakeholders on the important issues and the quantity of research undertaken on them must be taken into account.
- There must be a clear decision-making process with clear reporting points to give stakeholders and the public access to the process and the research being undertaken.

▪ **WILL THE LIST BE THE SAME NEXT TIME ROUND?**

The UK has not decided what long-term radioactive waste management strategy to implement. As part of the 'Managing Radioactive Waste Safely' programme, the Government's advisory committee, CoRWM, will make a recommendation in July 2006 on which technical option (or options) should be taken forward.

No matter which option is chosen this old list will not form the starting point of any new site selection exercise and changes on or around the sites themselves (new building work, planning changes, etc.) may make them less suitable (or unsuitable) for consideration again. There have also been many developments in the area of radioactive waste management in the UK and internationally since the previous site selection process took place. These developments will affect any new site selection process that is undertaken and consequently the list of potential sites produced as a result.

- The future site selection process, evaluation criteria and their weight should be developed openly with stakeholders upfront.
- A different siting process could be used in which communities volunteer to have their areas investigated.
- The environmental status and ownership of the sites on the old list may have changed since the previous exercise.

If the phased geological repository option were chosen from CoRWM's shortlist there would be a number of significant differences from the previous process:

- The Nirex Phased Geological Repository Concept has been changed to include a period of underground retrievable storage, which could influence the geological setting sought.
- More types of radioactive materials will be considered next time round i.e. high-level waste, spent nuclear fuel, and separated plutonium and uranium, in addition to intermediate-level waste and low-level waste, which could influence the geological settings required.

- Scientific understanding and computing capability have developed over the last 15 years, so that complicated sites that could not be considered previously may now be brought into a future process.

However, the geology in the UK has not changed, so sites that were considered to be potentially suitable previously on geological grounds could be considered suitable in a future site selection process. Equally, given the developments that have occurred, sites where the geology was viewed as less favourable previously could be included in the new site selection process. In short, the look of any future list cannot be predicted at this stage and no sites can be ruled in or out at this point.

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REVIEW OF 1987-1991 SITE SELECTION FOR AN ILW/LLW REPOSITORY

1 INTRODUCTION

This paper summarises the processes by which Nirex came to concentrate its site investigations for a deep geological repository for intermediate-level and low-level solid radioactive wastes at Sellafield. A systematic review has been conducted and this paper produced now, for the record, as a contribution to the debate on the development of a legitimate site selection process in the future, which will be central to the successful implementation of policy on the long-term management of radioactive waste in the United Kingdom (UK). The names of sites that were included in the past site selection process in addition to Dounreay and Sellafield have not been published previously, in line with the previous Government direction on not naming those sites [1]. The site selection process has been published previously in Nirex Report 71 [2], and in more detail in Nirex Proofs of Evidence to the RCF Local Planning Inquiry [3, 4]. However, this paper contains new information, not only in identifying all the sites that were considered, but also giving more information on how decisions were made than has been possible previously, when the sites could not be identified, and analysing why the process did not gain the essential support and confidence of stakeholders and the public.

Radioactive waste has been created in significant quantities in the UK since the 1940's. The UK has significant holdings of long-lived radioactive waste that will remain potentially hazardous for many thousands of years. Previous attempts to provide a long-term waste management facility for these wastes have ended in failure, most recently in 1997. The waste is currently being stored at 34 locations around the UK awaiting a long-term waste management facility.

We believe that radioactive waste management is an ethical issue – the waste exists and must be dealt with irrespective of any future decisions on nuclear power. We think that responsibility rests with this generation, now, to take the steps necessary for creating the framework in which a publicly acceptable way forward is found. The purpose, scope and arrangements for radioactive waste management must be, and be seen to be, legitimate and those responsible for radioactive waste management must be accountable to society as a whole. We believe that transparency must underpin everything that happens.

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The MRWS programme provides opportunities for stakeholders and members of the public to voice their issues and concerns and have an input into long-term radioactive waste management policy in the UK. As outlined above a new site selection process is going to be developed in the future as necessary. There will be an opportunity for people to influence the decision-making process, the criteria used to evaluate potential sites and their relative weight, and the power given to local communities in the process.

Section 2 outlines the historical context behind the site selection process that was undertaken. The site selection process followed by Nirex had two main strands, namely: a public consultation process (outlined in Section 3); and a technical process (outlined in Sections 4 to 8). These two strands were brought together by the Nirex Board in reporting on the short-listing of sites to the Government (Section 9), and in 1991, to focus investigations at Sellafield (Section 10). The paper describes the international guidance and scientific and technical considerations taken into account by Nirex in framing its historical (1987 - 1991) approach to site selection (Section 4).

Section 11 outlines key lessons that Nirex has identified with the aim of helping the successful development and implementation of any future site selection procedure to be adopted in the UK. These are based on reviewing what are now seen to be points of concern in the process that led to the rejection in March 1997 by the Secretary of State for the Environment (Mr John Gummer) of the appeal by Nirex against the refusal by Cumbria County Council of planning permission for an underground research laboratory, the Rock Characterisation Facility (RCF) at Sellafield. They also take account of an internal inquiry that Nirex conducted during 2000 [5].

Section 12 outlines some of the key changes that have taken place since the previous site selection process was conducted and how these might affect a new site selection process and the sites considered. Section 13 provides a summary of key issues for the future.

2 HISTORICAL CONTEXT

The national policy intended to be implemented through the site selection process described in the paper was defined on 1 May 1987, when the Secretary of State for the

Environment (Mr Nicholas Ridley) announced that he accepted Nirex's conclusions that disposal of low-level radioactive waste (LLW) in a multi-purpose repository (i.e. along with intermediate-level waste (ILW)) would be preferable on economic grounds to near-surface disposal, thereby bringing to an end the investigations at Bradwell, Elstow, Fulbeck and Killingholme for a near-surface LLW repository¹. He also explained that Nirex would therefore concentrate on identifying a "suitable location for a deep multi-purpose facility" for both ILW and LLW [6]

That represented just one of many policy changes that occurred leading up to, and in the five years following the formation of Nirex (initially as NIREX, the Nuclear Industry Radioactive Waste Executive) in 1982. The Department of Environment carried out test drilling in 1979 for research into high-level waste (HLW) disposal at Altnabreac in Caithness, and public inquiries were held into proposals for similar drilling in the Galloway Hills, Cheviot Hills and Leicestershire. In the light of public concern, the Secretary of State for the Environment announced in December 1981 that research into land-based disposal of HLW would be suspended in favour of a review of the applicability to the UK of the findings from research in other countries. In 1982, disposal at sea was an established practice for some of the nation's solid LLW and ILW and NIREX was to have managed future annual sea disposals of such wastes. However the Government declared a moratorium on sea disposal in 1983 and the practice was never again used. Later in 1983, two sites were announced by Nirex for investigation as potential sites for land-based disposal of LLW and ILW:

- the former Central Electricity Generating Board (CEGB) depot at Elstow for LLW and "short-lived" ILW; and
- the disused Imperial Chemical Industries (ICI) anhydrite (calcium sulphate) mine at Billingham, offered for purchase by ICI, for the disposal of long-lived ILW.

In early 1985, following strong opposition by the local community, the Billingham project was abandoned at the request of Government. Also the Government asked Nirex to select and identify at least two further potential near-surface disposal sites for investigation, in addition to Elstow. Accordingly, in February 1986 Nirex identified three further sites for investigation, at Bradwell, Fulbeck and Killingholme. Later that year the Government announced that, in response to the views expressed by the House of Commons' Environment Committee and by the four communities around the potential near-surface disposal sites, "a near-surface site should only be used for what is broadly described as low-level wastes". In consequence the Government attached some urgency to the development of a deep disposal facility to deal with both short-lived and long-lived ILW in storage awaiting disposal [7]. This chain of decisions ultimately led to the announcement of 1 May 1987.

Recently interviewed participants in the ensuing process of selecting a potential deep-disposal site stated that the earlier setbacks and the experience of public opposition and lack of trust at Billingham and the sites investigated for near-surface disposal influenced Nirex's approach in that:

- i) It sought a better understanding of public perception of, and attitudes to, radioactive waste management (see Section 3).
- ii) It sought to adopt a more rational approach to site selection, following more rigorously the available, recommended best practice (see Section 4).

Soon after the focus of policy turned to deep disposal, in September 1987, British Nuclear Fuels (BNFL) announced that it would initiate discussions with local authorities and community groups in the Sellafield area concerning preliminary geological investigations of the Sellafield site's suitability for developing a deep disposal facility. As described in

¹ Originally these sites were investigated for the disposal of short-lived ILW as well as LLW.

Section 3 of Nirex's discussion document, "The Way Forward" [8], the concept that BNFL had in mind was to locate the disposal facility in a layer of anhydrite (the same type of rock as considered at Billingham) that was thought to be accessible, offshore but close to the coastline, through an access tunnel from the Sellafield works. In 1988, BNFL working with the British Geological Survey (BGS) and other specialist contractors, conducted geophysical surveys (in particular a seismic reflection survey) and developed specifications for an exploratory borehole in support of their initiative. Through the Nirex Board, it was subsequently agreed with BNFL-appointed directors that, subject to various conditions, Nirex should be responsible for any continued investigation of Sellafield so that this would become part of its national site selection exercise. The information obtained by BNFL became available to support subsequent evaluations conducted by Nirex.

Nirex carried out the process of selecting sites for investigation in just less than two years following the Secretary of State's announcement of 1 May 1987. This involved what, for that time, was extensive public consultation (see Section 3) which, although not site-specific, was informed by the indication of "areas of search" (see Section 5). The exercise led to the recommendation by Nirex that it would, in the first instance, carry out geological investigations at Dounreay (in Caithness, Scotland) and Sellafield (in Cumbria, NW England) to determine the suitability of those locations as potential sites for a deep, "multi-purpose" (meaning ILW and LLW) repository. This was on the basis that there was a measure of local support for nuclear activities in the local communities around those sites. That recommendation was accepted by the Secretary of State for the Environment [9] following Government consultation with its Radioactive Waste Management Advisory Committee (RWMAC). The RWMAC published its advice [10], in which it supported the approach adopted by Nirex and accepted the logic of investigating the suitability of Dounreay and Sellafield.

The procedure that was followed by Nirex to produce the recommendation to investigate Dounreay and Sellafield was outlined in the published Nirex Report 71 [2]. It was subsequently described in more detail in proofs of evidence presented at the local planning inquiry to consider the Nirex appeal against refusal of planning permission for the RCF [3, 4]. In line with Government guidance at that time, these accounts did not name sites other than Dounreay and Sellafield, although the proofs of evidence added the information that two distinct sites at Sellafield and a second site in Caithness, alongside Dounreay, had been considered. The details of the attributes of the sites, and the views of interested parties on those attributes, are beyond the scope of this paper, but can be found in these published Nirex documents and in the report of the Inspector at the planning inquiry [11].

3 PUBLIC CONSULTATION

To inform its work on site selection, Nirex launched in November 1987 a public consultation exercise in the form of a publication "The Way Forward - A Discussion Document" [8]. This was designed to promote discussion and to seek constructive contributions to the task of ensuring that radioactive waste is managed safely. In order to make sure that the general public was made aware of "The Way Forward", copies were sent to all local authorities, county associations, parish and town councils, county and district libraries and to hundreds of organisations with potential interest in the subject. National advertising was undertaken, briefing meetings were held across the UK and more than 50,000 copies of the document were distributed. This exercise elicited more than 2,500 responses. The document explained the Company's approach to "the development of a geological repository for the disposal of low and intermediate-level radioactive waste" and options on repository configurations and on generic hydrogeological environments likely to offer potential for siting a repository. It posed a number of questions for discussion on those matters, in particular which factors should be taken into account in selecting a site.

Nirex explained in "The Way Forward" that it intended to follow a three-stage site selection process suggested by the International Atomic Energy Agency, (IAEA) (see Section 4). The document itself reported progress with the first stage (Regional Evaluation) of that process and noted that work on the second stage (Site Identification) would commence in 1988.

The responses to "The Way Forward" consultation were analysed on the Company's behalf in a report published in November 1988, "Responses to The Way Forward", by the Environmental Risk Assessment Unit of the School of Environmental Sciences, University of East Anglia [12]. There was found to be no overall unanimity of view. Amongst local authorities, some supported an underground repository and others on-site storage of wastes as an alternative. However, local authorities with nuclear installations in their areas, and advisory and scientific bodies did not on the whole support such storage. For all consultees, safety of the waste management facility was judged the paramount factor, with the safe transport of wastes being the next major area of concern. In procedural terms, there was a general welcome for the consultation exercise and opposition to use of the Special Development Order procedure for obtaining planning permission for investigative drilling or subsequent development (rather than making individual applications to the local planning authority as and when requirements were identified).

4 IAEA GUIDANCE

The procedure that Nirex intended to follow was that recommended by the IAEA in the relevant Guidebook [13], taking particular account of the following recommendations :

- repository sites should be evaluated on the basis of geological and ecological information as well as societal considerations;
- evaluation is performed in several stages, proceeding from generic to specific assessments; and
- the site selection should be undertaken in close connection with the work for the repository concept and design, and if necessary the introduction of engineered barriers should also be taken into account.

The idealised IAEA sequence of activities within the site selection process comprises three stages : "Regional Evaluation", "Site Identification" and "Site Confirmation". The first of these, Regional Evaluation, comprises a search on a national scale to select areas that have favourable characteristics for a repository and to reduce them to a few preferred areas for further study. At the second stage of Site Identification, specific candidate sites are identified for comparative evaluation and outstanding prospects are identified for physical exploration to confirm their suitability. At the third and final stage of Site Confirmation, one or more favourable sites are selected and final site selection follows. The IAEA guidance envisages that activities will be undertaken to characterise the sites at the Site Identification stage, and then in more detail at the Site Confirmation stage.

Published guidance was available on the regulatory and planning processes to be followed in the UK for securing permissions for the investigation of a potential repository site and subsequent development of an underground facility at a site [14]. The guidance (which was superseded in early 1997) focussed on the preparation of an environmental assessment, on the general lines of the draft "European Community Directive", to support an application to develop a disposal facility. The guidance required the environmental assessment to cover alternative sites; to bring out clearly factors other than radiological ones that influenced the choice of site; and to satisfy the Authorising Departments that a clearly better option for limiting radiological risks had not been ignored. The guidance stated that formal regulation under the Radioactive Substances Act 1960 was envisaged only at the stage a facility was constructed and ready to operate. It also stated that the developer would be expected to show that he had followed a rational procedure for site identification. Nirex believed this would be met by adoption of the IAEA procedure.

5 IDENTIFICATION OF AREAS OF SEARCH

It was the Nirex view that the process of site selection should consider a wide range of factors of which geology is just one. This view appeared to Nirex to be supported by the recommendations of the IAEA, as noted above, and led to Nirex's adoption of an approach that involved the analysis of a number of variable factors. The factors that were taken into account during the overall site selection exercise² were grouped broadly as follows:

- a) Safety – covering both the pre-closure and post-closure periods. Both conventional and radiological safety of repository and transport workers³ and of the public were considered for the pre-closure period.
- b) Socio-economic and Environmental Factors – covering planning and conservation issues along with the potential impacts of a repository on the local community, economy and environment.
- c) Transport – covering the then-current status and flexibility of the potential transport systems for movement of packaged waste, construction materials, excavated spoil, and personnel. This included consideration of the potential requirements for developments or improvements of the transport infrastructure.
- d) Costs – covering the capital costs of investigating and constructing a repository at a given site, along with the costs of operating the repository and associated transport system.
- e) Robustness – dealing with the extent to which the overall evaluation of a site could be sustained and ultimately verified in the light of then-current uncertainties and identified constraints. Particular attention was given to the confidence in the geological descriptions of sites and the ability to test these through future geological investigations.

Geological aspects were predominant in the initial Regional Evaluation stage conducted by Nirex to select areas having favourable characteristics. Nirex had a contractual relationship with the BGS to supply advice on geological aspects of radioactive waste management, as a result of which Chapman et al [15] had already proposed five generic geological environments as offering promising characteristics. The advice represented a significant development from that available previously since it emphasised the importance of suitable large scale hydrogeological environments rather than the properties of the geology, the rocks per se. The five hydrogeological environments defined as likely to offer potential for siting a deep repository were :

- a) hard rocks in low relief terrain, where the low relief gives little driving potential for groundwater flow;
- b) small islands, where the groundwater conditions beneath the seawater/freshwater interface were thought likely to be effectively stagnant;
- c) seaward dipping and offshore sediments, where groundwater movements are expected to be very slow and under the coast;
- d) inland basins of mixed sedimentary rocks - although considered to offer the potential of effectively stagnant groundwater, these were subsequently discarded as considered too complicated; and

² Site ownership was an important, separate consideration.

³ It is recognised that the Inspector at the RCF Local Planning Inquiry challenged the inclusion of the radiological safety of waste transport. Such observations would have to be taken into account in any future site selection exercise.

- e) low permeability Basement rocks Under Sedimentary Cover (BUSC), where regional-scale groundwater movement occurs predominantly in the sedimentary cover rocks with little connection to the underlying basement.

A map was published by Nirex in "The Way Forward" document in 1987 [8] showing the distribution of these hydrogeological environments across the British Isles. With the benefit of hindsight, the process then evolved in a way that was not transparent. In subsequently refining recommendations for areas of search, particular weight was given to the existing level of understanding of the properties of the geological formations and assurance with which the groundwater systems could be characterised and modelled for the purposes of investigation and radiological safety assessment. This led at an early stage, to the removal from consideration of inland basins of mixed sedimentary rocks and, later, to a strengthening of interest in the BUSC formations: these now included areas of basement rock overlain by chalk, which had not been identified in the map in "The Way Forward". Nirex included such formations in the exercise when BGS advised that such systems were better understood than had been thought earlier. However, the first public recognition of these changes came with the publication of the results of the siting studies in Nirex Report 71 in 1989 [2].

Nirex then reduced the area of search covered by the hydrogeological environments of interest by taking account of population density and planning matters. Population density was taken into account using the Health and Safety Executive Nuclear Installations Inspectorate guidance on siting of nuclear power stations. This guidance was used to devise a population density criterion which excluded more highly populated parts of the country. This was on the basis that acceptance of the siting of a nuclear power station at a given level of population density was likely to equate to acceptance of siting a radioactive waste repository at that same level although "The Way Forward" document noted that this was "not an absolute constraint, since in reality containment deep underground eliminates significant risks to the public". On planning matters, particular attention was given to avoiding nationally designated areas of protection covering landscape and/or nature conservation interests. This led to a considerable reduction of the areas of search.

6 IDENTIFICATION AND REVIEW OF SITES

6.1 Process adopted for this paper

Previous accounts which Nirex has published of the identification of possible sites, and of the sieving process to move from the "Regional Evaluation" to the "Site Identification" stage of the IAEA-recommended procedure, have implied a highly synchronised approach. Furthermore, it has been implied that there were clearly identifiable numbers of sites at each successive stage of the process. This is not the case.

In conducting internal inquiries into past activities, Nirex has collected together all identifiable documents relevant to the site selection exercise and has re-evaluated the exercise to provide lessons for any similar exercise in the future. This paper uses that re-evaluation exercise as its basis. It is important to note that the total number of sites initially considered is unlikely to be recorded accurately because it appears that sites were added and deleted as the starting list was being assembled. The initial list of 537 sites came about because that was the number of listed sites on the date when Nirex decided to start the sieving process. The listings of sites in this paper are in the form of those sites which were eliminated at successive stages. The consultant that was contracted by Nirex to advise on planning matters at the time of the site selection exercise (Pieda, now DTZ Pieda Consulting) recorded the names of sites in precisely that way as a record of the process. Although the Pieda report, "Deep Repository Project – Land Based Repository Site Search" [16], is classified as a draft report to Nirex, it has been confirmed with DTZ Pieda Consulting that the report was verified under the Company's quality assurance procedures.

6.2 Identification of Possible Sites

Following the identification of areas of search, the next step for Nirex was to identify possible, individual sites for evaluation. This step was strongly influenced by the non-technical, but critical, consideration that Nirex was not granted compulsory purchase powers to enable it to acquire a site for the development of a repository [2]. Accordingly, Nirex was restricted principally to considering sites that were owned by central Government or by its nuclear industry shareholders. Some privately-owned sites were also considered: in the main these were volunteered by the owners in response to the public consultation exercise. 537 sites can be identified from Nirex's records as having been involved in the exercise.

That number of sites was built up by Nirex from a number of contributions, as follows:

- i) The exercise initially included all sites in the clay formations of the UK that had been considered previously for the siting of a near-surface LLW/short-lived ILW facility (approximately 200 in number). These sites had been identified from information provided in the Department of the Environment Land Register of surplus public land ownership, by the Ministry of Defence or by Nirex's nuclear industry shareholders. These sites were not necessarily matched to the areas of search defined by the hydrogeological evaluation and the population and planning considerations.
- ii) Map-based research was carried out to determine mainland sites in public ownership, or large areas of land in single, private ownership, within the areas underlain by the other potentially suitable geological settings in addition to clay.
- iii) Small islands that on a cursory evaluation might be expected to offer the required hydrogeological environment at depth.
- iv) These main sources were supplemented by further volunteered offers of sites from private landowners and the identification by the nuclear industry of further sites in its ownership.

Recently interviewed participants in the site selection exercise have emphasised that they felt that the restriction to sites that were owned by central Government or the nuclear industry was a severe constraint and led to a strategy of maximising the number of such sites for initial evaluation. The principles defining the areas of search were treated initially as guidance rather than hard and fast rules. The notable exceptions to this strategy were :

- the exclusion of consideration of sites in Northern Ireland, because of the political situation; and
- removal from consideration of a large proportion of the potential sites in Wales, in particular Forestry Commission landholdings, following previous experience from the LLW/short-lived ILW siting studies when personal threats were received by staff involved in the consideration of such sites.

At the initial stages of the process, sites were identified very simply, by name, by size of land-holding and by the one-kilometre square Ordnance Survey grid reference corresponding most nearly to the centre of the land-holding when this was known. When the land-holding was not available, typically because it was not registered, a grid reference was assigned on the basis of a favourable transport access point that might define the location of waste receipt facilities. The names held on Nirex records are not always as informative as might be wished, referring only to the town or village near where the land-holding was located. Checks of the grid references show that on occasions these were provided or recorded incorrectly and some were changed as more information about a given site became relevant.

7 SIEVING OF SITES

7.1 Initial Screening – 537 to 204

An initial screening exercise was conducted to establish the realistic potential of the possible sites identified. 333 sites were eliminated at this stage. This was done at a very basic level, to eliminate sites that had obvious deficiencies, and was based on advice from a planning consultant (from Pieda) and a geoscientist (from the BGS) who spent two days together to review their assessment.

A number of small islands were eliminated on reconsideration of their likely hydrogeology at depth or on consideration of the quality of their environmental designation. A number of sites on the mainland were eliminated because the deep geology would clearly not be consistent with the identified geological requirements: a very high proportion of the previous LLW/short-lived ILW sites fell in this category.

The eliminated sites are listed in Appendix 1.

7.2 Land Ownership – 204 to 165

The sites were then checked for ownership of the land. No such checks had been made up to that point on the small islands identified initially. Some mainland sites had been identified sufficiently long before that their ownership might well have changed, given the prevailing policy on sale of publicly-owned assets. All sites where the land was not in public ownership were eliminated (except those privately-owned sites where the owner was known or thought likely to make land available). This led to the elimination of 39 sites, of which 23 were small islands.

There was no attempt made to establish whether the remaining sites would be made available for development of a repository. There was generally no contact with land owners, so there would have been little or no awareness on their part that their land had been identified in the siting exercise.

The eliminated sites are listed in Appendix 2.

7.3 Size of Site – 165 to 117

In a third stage of sieving, the sizes of sites were reviewed for adequacy against the required land-take for the surface infrastructure and underground "footprint" of a repository (of order 400 hectares for a facility located wholly under land onshore). The configurations of sites were also checked to ensure that there were no peculiarities that would rule out the envisaged development (e.g. a long, narrow site such as might be afforded by disused railway sidings). No sites were eliminated on the basis of configuration, but 48 were eliminated on the basis of being too small and having no obvious likelihood of being able to accommodate the development of an underground repository.

In this stage of sieving, there was no rigorously applied lower limit to the size of site that led automatically to a site's elimination. Sites that were promising in other respects and approximated to the required land area were retained.

The eliminated sites are listed in Appendix 3.

7.4 Geological Evaluation – 117 to 39

It is stated in Nirex Report 71 [2] that "All sites remaining under consideration were then re-examined in further detail by BGS in terms of their geological potential for development as a deep repository". The Nirex records of the site selection exercise identify a single BGS report [17] as the source of this evaluation. That report contains purely geological descriptions of the remaining sites; there is no record of a process of evaluation. The report also post-dates the publication of Nirex Report 71 and the issue of the Pieda report on the sieving process (identified in Section 6.1 above) [16].

However, a later internal document, prepared in 1995 by a consultant to Nirex [18], assisting the legal team prior to the RCF local planning inquiry, gives summary reasons for the rejection of sites on geological grounds at this stage. These reasons are traceable to factual information in the BGS report issued in 1989. Interviewed participants in the site selection exercise recount that the consultant who authored the 1995 report conducted systematic interviews to achieve a retrospective audit trail of the decisions made at the time (1987 in this instance).

78 sites were eliminated at this stage of the process. These are listed in Appendix 4.

7.5 Initial Comparative Evaluation – 39 to 17

By this stage, Nirex was considering how it would make a selection between different options developed to suit different geological environments and different site locations. It commissioned generic assessments of radiological safety, geology, socio-economic and environmental issues, repository design concepts and transport that could be applied to the option(s) being developed for each remaining site. The team of specialist consultants involved in developing the assessments joined Nirex staff at the Staff Training Centre of the CEGB, at Bricket Wood, in December 1987. They used the assessment capability developed by that time for the subjects identified above to allocate scores to the sites in each hydrogeological category, thereby identifying the best 3 or 4 sites in each category to carry forward for more detailed evaluation.

This stage is referred to as the 39-site stage in Nirex Report 71 [2] and elsewhere, following the record made in the Pieda report described in Section 6.1 [16]. Detailed records of the Bricket Wood meeting show that 34 sites were listed for consideration. Recently interviewed participants recall that because different types of assessment work were proceeding at different paces, there was not a common view on the number of sites remaining under evaluation.

There has been much discussion about the "late introduction" into the process of the BUSC option at Sellafield that Nirex went on to investigate in detail. The records of the Bricket Wood meeting show that, at that stage, the BUSC option was in fact the only one at Sellafield considered, and that the other option at Sellafield proposed originally by BNFL, potentially using a sedimentary formation (anhydrite), thought to be present close to the coastline, was not considered. In 1994, Nirex increased the confusion in this area by advising Cumbria County Council incorrectly that the BUSC option was only considered at a later, final stage and it is regrettable that a more careful evaluation such as that now undertaken to support the production of this paper was not conducted.

The records of the Bricket Wood meeting confirm that up to this point in the site selection exercise, a site was viewed in terms of land ownership, rather than as a specific location within the land area under consideration. Some "sites" had two or more repository options associated with them which would potentially exploit different geological or hydrogeological settings believed to lie under the site and which would be located at correspondingly different locations on the site. In these cases, the "site" was considered as one site. There is no evidence that this approach was considered sufficiently important to be explained to other than those staff and consultants directly involved in the exercise.

The identification of the best 3 or 4 sites in each hydrogeological category led to the elimination of 22 sites. The 17 sites carried forward from this stage had all been subject to the same assessment process.

The eliminated sites are listed in Appendix 5.

7.6 More detailed comparative analysis – 17 to 10 land-based sites (and two offshore geographical options)

A similar exercise to the December 1987 Bricket Wood meeting was conducted, again at Bricket Wood, in July 1988, in respect of the land-based sites remaining in the exercise,

numbered as 17 in the records of the process and in relevant publications such as Nirex Report 71 [2]. This benefited from the availability of much more detailed assessments, especially radiological safety assessments, of the options under consideration. The process used for assessment of post-closure radiological safety at this and subsequent stages was published in the proceedings of a major international conference [19]. In addition, two broad geographical locations (east and west of the British Isles) for a generic offshore repository concept were brought into consideration⁴.

The aim of this stage was to identify the most suitable land-based sites for each geological category. These were to be carried forward to a process, described in Section 8, that would attempt to rank locations representing different geological categories, and that would include the offshore repository options.

This stage of more detailed comparative analysis resulted in the elimination of eight land-based sites. These are listed in Appendix 6. However, on progressing to the next stage of the process, two siting options at Sellafield were evaluated separately thereby increasing the number of land-based options remaining from nine to ten. These were as follows (in alphabetical order):-

Altnabreac, Caithness (low-relief hard rock)
Bradwell, Essex (coastal BUSC)
Dounreay, Caithness (low-relief hard rock)
Fuday, Western Isles, Scotland (small island)
Killingholme, Humberside (seaward dipping sediments)
Potton Island, Essex (coastal BUSC)
Sandray, Western Isles, Scotland (small island)
Sellafield 'A' (anhydrite), Cumbria (seaward dipping sediments)
Sellafield 'B' (Borrowdale Volcanic Group), Cumbria (BUSC)
Stanford, Norfolk (inland BUSC)

Hence a shortlist of ten land-based sites and two generic offshore options, sometimes referred to as a shortlist of twelve sites, was created.

7.6.1 The two Sellafield options

At the second Bricket Wood meeting in 1988, Sellafield entered the process identified as a single site. However, maps were provided to participants by Nirex showing that both the BUSC option and location (which became identified as Sellafield 'B'), and the sedimentary rock (anhydrite) option and location (which became identified as Sellafield 'A') were to be considered. The BUSC option had, by then, been better defined through the availability of geophysical survey data and outline design studies. In particular, advice was available from the BGS that the basement Borrowdale Volcanic Group (BVG) rocks to the east of the Sellafield works could provide a more suitable, inland site, compared with the BVG underlying the works, due to the favourable, much lesser depth of the BVG in the inland location. The records show that the participants believed the BUSC option to be much superior to the sedimentary option. There was a growing realisation of the complexity of the deep geology at the edge of the East Irish Sea Basin, underlying the coast. There is no record of the reasons for the "re-entry" of the sedimentary option but correspondence between BNFL and Nirex notes the nature of political support for any repository as

⁴ Assessments were carried out of the suitability of the ports of Hunterston (Strathclyde, W. Scotland) and Redcar (Cleveland, NE England) to service the west and east offshore options respectively.

strongly conditional upon its location beneath the nuclear site. At that time, such a location would have applied to the sedimentary option only, since the basement rocks were then considered to be at too great a depth directly below the nuclear site.

8 SITE IDENTIFICATION USING MULTI-ATTRIBUTE DECISION ANALYSIS

In order to make a comparison between the ten land-based options, remaining after the comparative analysis conducted at Bricket Wood in July 1988, and the generic offshore options, a highly formalised process of multi-attribute decision analysis (MADA) was used under the guidance of one of its leading exponents, Dr Lawrence Phillips of the Decision Analysis Unit of the London School of Economics and Political Science. In brief, MADA is a tool for applying logic systematically to help make choices between options which have to be assessed with respect to multiple and varied attributes or criteria. In this case, the necessary evaluations were carried out in a series of meetings by a group consisting of Nirex staff and specialist contractors who agreed the methodology and the weighting and scoring of attributes with facilitation by Dr Phillips [4].

The multiple attributes relating to the siting of a repository, and including the transport of wastes to the repository, were grouped into four collective branches within MADA. These were as follows :

- Safety, which included conventional as well as radiological safety, with radiological safety covering both the operational and "post-closure" periods of a repository;
- Robustness, which covered the sustainability and verifiability of performance ratings in the light of uncertainties and included consideration of geological predictability;
- Costs, which covered capital and operating costs for a repository and waste transport system; and
- Socio-economic and Environmental Impact, which covered proximity to people, nature conservation, nature resources, and environmental factors such as transport, noise and visual impact.

The treatment of post-closure safety in MADA has received considerable attention at the RCF planning inquiry and elsewhere. The approach adopted may be summarised as follows :

- a) siting options were only included in this stage of site selection on the basis that they were considered to be capable of meeting the relevant radiological safety standard set by Government Departments, the individual dose target equivalent to a risk of one in a million per year of contracting fatal cancer [14];
- b) a value was ascribed to any margin of safety with respect to the target that was offered by various options; and
- c) in comparing this attribute with others, a low weight was attached to variations in calculated post-closure performance.

It was considered by the MADA group that this approach was consistent with the statements on the nature of the dose target in the relevant guidance [14] which were subsequently reaffirmed, with respect to a risk target, in the 1995 Government White Paper on Radioactive Waste Management policy [20].

A key outcome of the MADA exercise was that where the post-closure safety requirement was considered to be met (i.e. a repository at the site could give a performance consistent with the regulatory dose target) then this attribute did not discriminate between such options and costs emerged as the major discriminating factor between options. The MADA group conducted sensitivity tests in which different weightings were assigned to

attributes in order to explore different perspectives on the issue. In particular these tests explored a higher weighting being attached to differentials of calculated safety. In the base case exercise established by the MADA group, the option of a repository located in the basement rocks at Sellafield ranked first, and this option was consistently highly ranked irrespective of different weightings used in sensitivity tests. Community attitudes did not emerge as a major factor in establishing that ranking.

Two main factors contributed to the consistently high ranking of the Sellafield Basement Rock option. The costs associated with the transport of wastes to a repository at Sellafield were highly favourable since at that time it was estimated that approximately 60% of the waste requiring long-term management would be produced at the BNFL Sellafield Works and would not require transport in the public domain to a repository in that location. Secondly, the reduced requirement for transport in the public domain resulted in a benefit to the calculated radiological impact of transport that offset any greater margin of post-closure safety that might be achieved elsewhere.

The output of the multi-attribute decision analysis was used by the Nirex management as technical guidance and advice to the Nirex Board on options for site investigation. Clear guidance was given on those sites that should be physically investigated and the minimum number that should be involved in such investigations. The guidance was based on a systematic analysis of the advantages and disadvantages of each site, which included consideration of the presence of a local community with knowledge and understanding of nuclear technology.

9 THE DECISION-MAKING PROCESS – 10 TO 2

By July 1988, the Nirex Chairman had received a request from the Secretary of State for the Environment (Mr Nicholas Ridley) for a report on the work carried out by Nirex, including the technical justification for the short list of sites identified as potential locations for the repository. The requested report was discussed by the Nirex Board at meetings in September and October 1988, and finally sent, following removal of the list of sites and further revision in the light of comments from Board members, under a letter dated 15 November 1988. The report sent to Government was Nirex document UKNL (88)45, "Repository Development and Site Selection – The Present Position", dated 3 November 1988 [21].

On the basis of preliminary outputs from the MADA process that was underway, the October 1988 Board Meeting was advised that 6 principal and 3 reserve land-based sites had been identified at that time, along with a generic offshore option in hard rock. In this advice, Sellafield was identified as a single site although both options at Sellafield were still under consideration, and the generic offshore option was not sub-divided into the east and west geographical options. Hence there was an inconsistent identification of just ten sites including a generic offshore option, compared with the twelve options under consideration by the MADA process. The sites are listed in the Interim Draft "Description of Sites" paper NC/88/40 dated October 1988 [22], which was presented in a revised form to the October 1988 Board meeting.

The letter of 15 November 1988 from the Nirex Chairman to the Secretary of State contained a number of significant statements in relation to the identified sites, including:

- '... the emerging consensus that whatever the technical merits of the various short-listed sites... they in fact divide into two categories: those where there is a measure of local support for nuclear activities in the local community (Sellafield and Caithness) and those where there is not. We are doubtful whether, given the expected level of opposition, it would prove possible to pursue to a successful conclusion a site where there is no measure of support in the local community no matter how good its technical features.....'.

- '... the best way forward will be to carry out site geological exploration during 1989 at both Sellafield and Caithness in parallel (covering both the sites at Caithness which are geologically different).' It was made clear that this was an expression of the Chairman's personal judgement.
- 'I do not consider it practical in public acceptability terms to pursue other sites before the suitability of Sellafield and Caithness have been explored.'
- 'It would not be my intention to disclose the identify of possible other sites until the suitability of Sellafield and Caithness has been established one way or the other.'

In line with this last point, correspondence and relevant Nirex and consultants' documents were generally marked CONFIDENTIAL from about this date.

Subsequently, at a Board Meeting in December 1988, the outcome of the MADA process was reported by the Nirex executive. The outcome was summarised in the conclusions of a report prepared for Nirex by the Decision Analysis Unit of the London School of Economics [23], where the modelling work of the MADA group was translated into the following recommendations to be put to the Board:

- Both offshore sites are overall so poor that they should be investigated only if the land-based sites prove to be unacceptable.
- Sellafield-A is significantly the worst of all land-based sites and should not be investigated.
- Sellafield-B is consistently good; it should be investigated.
- Stanford and Bradwell are relatively good, and though Stanford is marginally better than Bradwell, especially under pessimistic assumptions, one of them should be investigated. There is no need to investigate both because they are geologically similar.
- Dounreay and Altnabreac look relatively good and either, or preferably both, (because they are geologically different), should be investigated.
- Fuday is as good, overall, as Dounreay and Altnabreac, and is particularly good on robustness, but loses as more weight is given to environmental issues. It should be considered.
- It is recommended that at least three sites be investigated and there may be merit in investigating up to five:
 - If three sites: Sellafield-B; Stanford or Bradwell; Dounreay or Altnabreac.
 - If four sites: Sellafield-B; Stanford or Bradwell, Dounreay or Altnabreac; Fuday.
 - If five sites: Sellafield-B; Stanford or Bradwell; Dounreay; Altnabreac; Fuday.

Thus five sites were identified as offering the best prospects and a decision was sought from the Board on the number and identities of those to be pursued. One of the sites, Fuday, the recommended small island, was considered sensitive on environmental and planning grounds. Apart from confirming that because of this, the focus of attention should be on the four remaining sites, the Meeting came to no firm conclusion. It was agreed to return to the issue at the next meeting of the Board and that meanwhile the Chairman would speak to the Secretary of State for the Environment regarding the likely availability of the Stanford site, to be added to the two Caithness sites and Sellafield.

A protectively marked CONFIDENTIAL reply from the Secretary of State (Mr Nicholas Ridley) to the letter of 15 November 1988 is recorded as having been received by the

Chairman on 31 January 1989, with a request from the Department of the Environment that it should not be circulated to Board members. To inform Board members, a letter was drafted by the Managing Director reporting that the Secretary of State considered the parallel investigation of "the Sellafield area and the Caithness area" to raise no problems for national strategy.

Subsequently, a letter was written to seek formal agreement from Board members that only the three sites (Altnabreac, Dounreay and Sellafield-B) would be investigated in the first instance. This was on the basis that, if investigations at those sites did not lead to the identification of a satisfactory site for a repository, it would be necessary to turn to others amongst the shortlist of outstanding sites. Subsequent to the agreement of the Board to proceed on that basis, it was learnt that the Altnabreac site⁵ was proposed for designation as part of a Site of Special Scientific Interest. Although not presenting an absolute bar to any further interest in the site, the site was dropped as a location for early investigation because the proposed designation raised questions about the availability of planning consent for investigations. Accordingly, on 21 March 1989, Nirex nominated Dounreay and Sellafield for investigation [24].

10 DOUNREAY AND SELLAFIELD SITES

10.1 The Focus of Investigations on Sellafield

After two years of desk studies, from 1987-1989, considering a large number of potentially suitable locations, and narrowing the list down to a manageable number for field studies, two sites, Dounreay and Sellafield, were assessed for their geological suitability. Both sites have a hard basement rock geology overlain by a sedimentary cover. The evaluations of the preliminary geological investigations, carried out between 1989-1991, concluded that a deep repository could have been developed at either of the two sites. Sellafield had considerable advantages over the Dounreay site in that it was estimated at that time that some 60% of the wastes destined ultimately for the repository were generated on site, making a significant potential reduction in the impact on the transport system. It was therefore decided by the Nirex Board (on 18 July 1991) to concentrate future efforts at Sellafield, while retaining Dounreay as an option should the Cumbrian site be unsuitable.

10.2 Locating the Sellafield Site at Longlands Farm

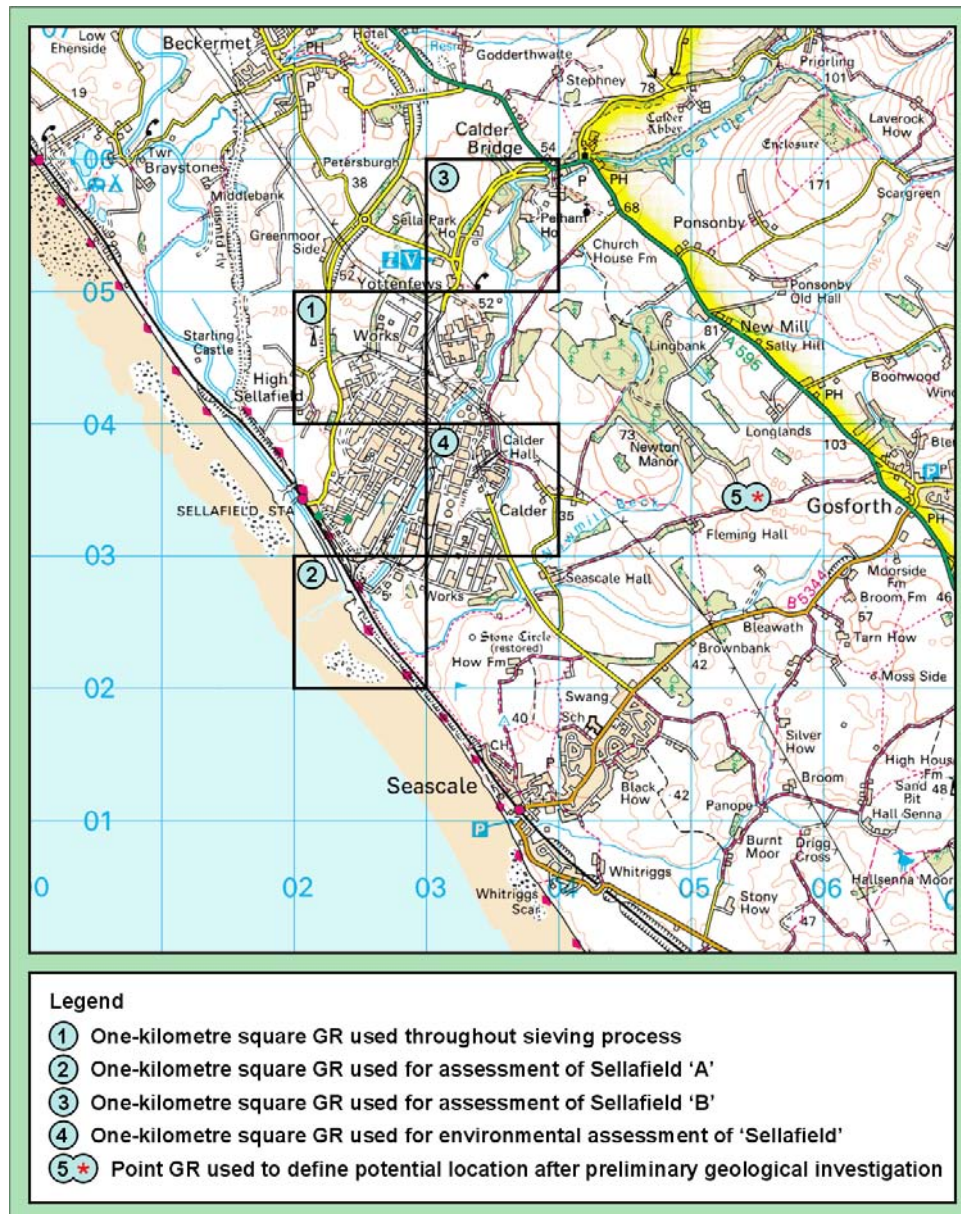
Throughout the site selection exercise, Sellafield was always treated as a big swathe of land and consequently Ordnance Survey grid references (used to define sites as described in Section 6.2) of the Sellafield site(s) moved as more geological information became known.

During all the stages in the sieving process described in Section 7, Sellafield was identified by a single grid reference NY 0204. This corresponded to neither of the geological settings that were under consideration. When it became necessary to use precise information on site locations to conduct radiological safety assessments in the final stage of site selection, described in Section 8, a grid reference of NY 0202 was used for Sellafield 'A', and NY 0305 was used for Sellafield 'B'. The choice of NY 0305 for Sellafield 'B' was made on the basis that Pelham House School was known to be in the ownership of BNFL and had the potential to be developed as the offices for a 'BUSC' repository located nearby. For the purposes of non-nuclear environmental assessments in the final stage of site selection, Sellafield was still largely treated as a single site, identified by the single grid reference NY 0303. Subsequent preliminary geological investigations resulted in an improved understanding of the deep geology. In particular the drilling of Nirex Borehole No. 2 in August 1990 provided critical data in locating the

⁵ At this stage the Altnabreac site was referred to as Braehour.

BVG and confirming its favourable characteristics. As a result the area around Nirex Borehole 2, to the south of Longlands Farm, appeared most suitable and a contemporary Nirex internal note in 1991 "Review of Repository Location" gives a grid reference of NY 055034. This use of grid references is illustrated in Figure 1 below.

Figure 1 Ordnance Survey Grid References (GR) Used to locate the Potential Sellafield Repository Site(s) at Different Stages of Site Selection (use of present day 1:50,000 map by permission of Ordnance Survey)



11 EVALUATION AND LESSONS LEARNED

11.1 Definition of the 1987-1991 Site Selection Process

The process by which sites would be identified for investigation was defined in considerable detail by Nirex in its November 1987 document "The Way Forward". This document was intended as one of the main vehicles for public consultation. However, the approach adopted meant that, in practice, the public did not have the opportunity to help shape the process of site selection. A number of issues that later emerged as very important to stakeholders and the public were described in "The Way Forward", but they were not addressed in the subsequent process.

Lessons Learned : How a site is to be chosen is one of the crucial processes in the long-term management of radioactive waste. Transparency in the process will be essential for commanding public confidence. Any future site selection process for a long-term waste management facility should be defined on the basis of extensive consultation with stakeholders and the public. The process to be adopted, the organisations responsible for implementation, and the evaluation criteria used to distinguish between sites and the weights attached to them should all be determined at the outset, in response to issues and concerns. Given the national importance of finding a solution, the whole site selection process should be determined through an open, Government consultation process, as envisaged under the current Government consultation, putting public interest and concerns at the heart of the long-term management of radioactive waste. The institutional framework for the definition of the site selection process, as with all other aspects of long-term radioactive waste management, should be designed to give visibility to the issues.

11.2 Attributes in Site Selection

"The Way Forward" publication identified many attributes that Nirex considered would be important in selecting sites for investigation. However, it did not identify a key constraint, that the land involved would most likely be in Government or nuclear industry ownership. "The Way Forward" also stated that a group of three hydrogeological environments were preferred over the one, Basement Under Sedimentary Cover (BUSC), that came to be favoured after initial technical evaluations. These two pieces of information strongly influenced the site selection exercise but were only made available to the majority of stakeholders and the public with the publication of Nirex Report 71 in 1989, supporting the announcement of the plan to investigate Sellafield and Dounreay.

Lessons Learned : Any possible constraints on a site selection process and on the sites to be considered should be identified at the outset and discussed openly with stakeholders and the public so that they can be considered as part of the definition of site evaluation criteria. While recognising that "The Way Forward" invited proposals from owners of potentially suitable land, largely constraining a search to land in public ownership is not necessarily the only approach to siting a facility of national importance, particularly if fair and reasonable compensation arrangements were defined up front to enable acquisition of suitable sites.

A site selection process does not cease to be legitimate if new research findings show that a previous conclusion needs to be revisited. An open process is required where the new findings can be discussed with stakeholders and the public, allowing a decision to be reached on a possible change of direction. It follows that time must be allowed to cover such occurrences. Clearly there would have to be a balance since significant changes of direction could cause a loss of confidence in the process and potentially undermine the legitimacy of progress made up to then. This suggests that agreeing the evaluation criteria to be considered at the start of the process is a key requirement.

11.3 Openness of Implementation

Given that 537 potential sites were identified initially, and there was pressure from the Government to reach a conclusion, Nirex adopted a pragmatic approach in reducing the number of sites to 204 for progressively more detailed evaluations. Nirex's specialist contractors provided essential support for this process. The perception of some stakeholders was that, precisely because of the involvement of such experts, the evaluations at the initial sieving stages were much more detailed than was the case.

Lessons Learned: The implementation of the site selection process itself is of great relevance to experts and non-experts alike and should be open and transparent to facilitate the involvement of stakeholders and the public and to allow legitimate adjustment if appropriate. It requires a high level of scientific and technical competence, but this must be used in a way that is not elitist, but rather informed by and responsive to stakeholders and the public, who must be involved in a way that promotes preview of the proposed work programme as well as review of its outcomes.

Lesson Learned: The views of stakeholders on the extent and nature of analysis of issues required must be taken into account. Realistic but ultimately flexible timescales need to be agreed with stakeholders to allow the time for consideration of these issues.

11.4 Reporting Progress

The process adopted by Nirex had several identifiable stages. Many of these had already been gone through by the time of publication of "The Way Forward". These stages were not visible to any but those directly involved in the process and, in the absence of any formal requirement to do so, there was no identification of intermediate milestone stages where acceptance would be sought from other interested parties before progressing to the next stage.

Lesson Learned: Any future site selection process should have reporting points or frequencies agreed upfront to give stakeholders and the public access to the results of the ongoing evaluations and the conclusions drawn from them. There should be some mechanism, for example a commitment to formal periodic reviews, for registering that the conclusions reached at each reporting stage are acceptable before proceeding to the next stage. It will be important to clarify at the outset the key decision points in the process, and how these decisions are to be taken. This lesson in particular raises the issue of naming of sites and it might be that the stage at which sites are identified and named could be defined as part of the process.

11.5 Trackable Decision-Making

The previous Nirex site selection process was not documented as it progressed. Many key decisions were made by the Nirex executive on the basis of oral reports by Nirex staff and consultants with the relevant written evaluations being produced, if at all, considerably later (e.g. the geological evaluations of sites by BGS). Often those staff and contractors involved in the decision-making did not share the same information or understanding of the information available.

Suggested Improvement: As part of the implementation of an overall site selection process, management systems need to be put in place to ensure the process is defined in advance and followed; individual roles are carefully defined and checked to be fulfilled; and information flow ensured.

Suggested Improvement: Arrangements must be made to ensure that all decisions are recorded by the decision-makers at the time they are made, with an accompanying record of the information that supported the decision. These arrangements should ensure that the process is not only traceable and transparent to stakeholders, but is recorded in a manner that provides a record for formal scrutiny, for example at a Public Inquiry.

11.6 Addition of Sites

In the previous site selection exercise, Nirex was unclear on what area was covered by a site, which led many stakeholders to take the view that Nirex had added new sites at late stages of the process. (This applied to the Sellafield BUSC site, in particular). Although this view owed more to the lack of clarity by Nirex on the definition of a site, it raises an important issue of principle.

Suggested Improvement: There should be a formal definition of each term such as “site”, “location” or “area” used in the process.

Suggested Improvement: The inclusion of sites for consideration has to be seen as "fair", and in particular the same level of scrutiny and evaluation should be applied to all sites. Given the importance of choosing a good site, there should not be a procedural barrier to including further sites in response to new information provided that this is openly described. However, further sites should not be added after any stage of comparative evaluations has been initiated unless those evaluations can be repeated objectively with the further sites included in the process.

11.7 Government Policy and Direction

In the previous site selection exercise, there were significant political constraints that were not communicated outside the participants.

Suggested Improvement: One of the key lessons learned over the last ten years is that the long-term management of radioactive waste is an ethical and socio-political problem and not just definable as a problem of science and technology. This needs to be specifically recognised. Any site selection process will involve ethical, social and political judgement as to the weightings to put on any particular factor.

Ownership of key decisions must be clear. Nirex supports the Government's 'Managing Radioactive Waste Safely' programme, the creation of the Committee on Radioactive Waste Management (CoRWM) and the decision to make Nirex independent of industry. We hope these will help create a framework in which the politicians can make judgements that are transparently based on a legitimate institutional framework and policy development process.

11.8 Identification of Site Areas

"The Way Forward" document identified areas of search to the public. However, large areas associated with potential BUSC sites that became an important focus of the evaluations were not shown, and more generally many sites that fell outside the delineated areas remained in the process through successive stages. Thus the link between "areas of search" identified to the public and "sites" that were being evaluated was a tenuous one and a true picture was not available.

Suggested Improvement: The criteria by which the suitability of a site would be evaluated should be agreed at the outset through public consultation. Modern tools such as Geographical Information Systems (GIS) should be considered as a means of displaying and interrogating the information that is relevant to these agreed criteria.

11.9 Working with Local Communities

It was significant that the extensive public consultation during 1987 and 1988 around "The Way Forward", which was an attempt at a new, more open approach to dealing with a possible repository development - was not conducted on a site-specific basis. Local communities and, in some cases, private landowners, were not aware of the subsequent evaluations carried out into the possible siting of a radioactive waste management facility, respectively in their locality or on their land.

Suggested Improvement: The identification of specific sites should be arrived at through a transparent process where stakeholders and the public have been afforded access to information, involvement and influence. It should be clear to local communities when in the process sites would be identified and how that would be done, such that the concerns and issues of local communities are taken into account and the decision is recognised as legitimate. Ideally, this would lead subsequently to a co-operative evaluation of the site, with the local community providing a valuable resource of guidance and local knowledge.

EU directives on Strategic Environmental Assessment [25] and Environmental Impact Assessment [26] will be very helpful in setting a framework for these requirements.

11.10 Volunteerism and Veto and Community Benefits

Although Nirex invited private land-owners to volunteer potentially suitable sites, the concepts of local community volunteerism and veto (and, by implication, community benefits) formed no explicit part of the site selection process described in the paper.

The relationship between the potential host community and the UK as a whole was never clearly defined. Therefore, the community's role in the decision-making process, their level of influence and the service they were providing for the UK were never explicitly acknowledged.

Suggested Improvement: Since 1987 the issue of siting radioactive waste facilities has moved on, internationally and in the UK. Most recently, in Japan, a wholly volunteer process is underway, as was the case in France following policy review in 1991, in which communities have self-selected themselves for future study. In Finland, the local council has a veto on the development of facilities. We would recommend that both these approaches need to be discussed at the start of the process for deciding site selection criteria.

It must be clear at the outset that potential host communities are providing a service for the rest of the UK. They must have a clear role in the decision-making process and be entitled to community benefits to enable them to participate in the debate and recognise their role in the process.

11.11 Top-down Process

The site selection exercise initiated in 1987 implied a bottom-up process whereby it was implied that the "best sites" would be identified against a range of evaluation criteria, or attributes. However the logic changed part of the way through the exercise to a top-down process, so that sites were identified for investigation on the basis that there was a measure of local support for nuclear activities; and ultimately Sellafield was preferred because a high proportion of the waste requiring long-term management would be produced at the Sellafield Works.

Suggested Improvement: The merits or otherwise of a bottom-up process need to be considered carefully when deciding on the overall site selection process. This would necessarily complement discussion about local community veto and volunteerism and community benefits.

12 CHANGES SINCE THE PREVIOUS SITE SELECTION PROCESS

It is important to note the context for the past site selection exercise described in this paper, and how this would be different if siting of a deep geological repository were to be considered again, under the Government's MRWS consultation process. The following sections outline the changes that have taken place and how they could affect a future site selection process.

12.1 Stakeholder Involvement in the Site Selection Process

Section 11 outlines the lessons that Nirex believes can be learned from the failure of the previous site selection process. The aim is to have these applied in any future site selection process, to ensure that it is open, transparent and inclusive, unlike the previous siting process, and that there is stakeholder involvement throughout it so stakeholders and the public have the ability to influence the process. A new decision-making process on radioactive waste management policy 'Managing Radioactive Waste Safely' (MRWS) was launched by Government in 2001 [27]. The MRWS programme will not begin to consider a new site selection process until 2007/8 when it will be included in a period of consultation on implementation of selected radioactive waste management options. This is likely to include the site selection process, the criteria to evaluate the sites and their relative weights. Therefore, the following could be different in a future site selection process:

- The site selection process, including how stakeholders and the public are involved;
- The criteria used to evaluate sites;
- The relative weight of the different site evaluation criteria;
- How local communities are involved in the siting process:
 - Their ability to volunteer to have their area investigated;
 - Whether they have the power to veto the decision on the sites;
- Community benefits for communities near sites.

These will influence which sites are considered and how they are evaluated.

12.2 Legislative Developments

The Aarhus Convention [28] came into force in 2001. It aims to protect and improve the environment to ensure sustainable and environmentally sound development and identifies this as a duty of all citizens. To enable citizens to fulfil their duty the convention aims to:

- Give people access to information;
- Enable citizen participation in decisions;
- Give access to justice in environmental matters;
- Provide assistance to enable citizens to exercise their rights;
- Increase the accountability and transparency of decision making;
- Increase public support for decisions.

The requirements of the Aarhus Convention are reflected in UK legalisation [29, 30] that implements the Strategic Environmental Assessment Directive [25] and the Environmental Impact Assessment Directive [26]. Sustainability appraisals also have to be undertaken for developments in the UK [31] to ensure the social, environmental and economic impacts of proposals are assessed and mitigated if possible. Together these pieces of legislation make stakeholder involvement in the early stages of a decision-making process compulsory, they give stakeholders the right to influence the scope of the assessments to be undertaken and the decision-making process itself. Nirex believes that the legislation provides frameworks to:

- Engage stakeholders in dialogue about a long-term solution to radioactive waste and structure the work undertaken;
- Encourage and enable stakeholder involvement in the decision-making process;

- Define and communicate the scientific and technical work;
- Integrate scientific and social science research on radioactive waste management into the decision-making process;
- Ensure a systematic assessment of the potential sites against a wide range of evaluation criteria.

These developments could change the site selection process and the site evaluation criteria and their weight as they ensure stakeholders are involved from the beginning of the decision-making process. The legislation also outlines the impacts of a development that have to be assessed, which could be different to those assessed in the previous site selection process.

12.3 The Repository Concept

The repository concept that was under consideration in the previous siting studies was based on a repository that was envisaged to be backfilled and sealed as soon as possible after all the waste was emplaced in its vaults. In response to feedback from its stakeholders and the public, Nirex has since developed the Phased Geological Repository Concept. This allows the monitoring of the waste in underground storage, under controlled conditions, for a period of perhaps hundreds of years until society takes the decision to backfill, seal and close the repository or, alternatively, to manage the waste in some other way.

There has also been a significant amount of research undertaken on geological repositories in the UK and overseas since the previous site selection process. Therefore, the understanding of what a repository concept requires from a site has been refined. This would be likely to affect the geological characteristics that would be sought in potential sites.

12.4 The Volume and Types of Waste Being Considered

The volume of intermediate-level waste and low-level waste under consideration in the 1980s totalled two million cubic metres. Now the total volume of ILW in the National Inventory of Radioactive Wastes that have been, or will be, produced from existing nuclear installations is put at 237,000 cubic metres and only a small volume, of order 15,000 cubic metres, of LLW is envisaged to be placed in a geological repository, if such an option were to be implemented. The decrease in estimated volumes is due to the removal from consideration of ILW and LLW to be produced from projected, but not committed, nuclear operations and the routing of all but a small volume of LLW to the Drigg near-surface repository. Thus the volume of waste under consideration now is significantly smaller. No consideration was given to the long-term management of heat-generating, high-level waste, where one future option would, in principle, be to develop a modular repository system that was suitable to receive this waste as well as the ILW/LLW. The long-term management of separate stocks of plutonium and uranium and spent fuel are also being considered in the MRWS programme, and these wastes could also be considered for inclusion in the repository concept. These changes will affect the size of the repository, and therefore the size of the site that is required, and also the geological requirements of the site.

12.5 Advances in Understanding

While the UK's geology remains the same as it was and very little new information has been acquired on the geology in the past 20 years, our ability to investigate and model deep geology has improved significantly. Also our understanding of deep geological processes has improved such that further characteristics would be viewed as favourable indicators of geological suitability, in addition to those recognised previously.

Improved surveying methods include most notably 3-dimensional seismic surveying which has been used successfully to characterise large-scale sedimentary basins in the French and Swiss radioactive waste management programmes. The availability of such surveying methods could bring in geological settings that were previously viewed as difficult to investigate.

There have been major advances in computing and modelling technology that now provide the capacity to handle huge amounts of data. Rock masses are very variable, and settings previously excluded as 'too complex to model' could now be considered. Coupled with the capability to use data and models in three and four dimensions with visualisation, use of this technology could produce different results when screening sites against geological criteria.

After twenty more years of experience in the UK and internationally, there is an improved understanding of what is required from the geological barrier in a repository multiple barrier containment system. Coupled with a better understanding of relevant geological processes this means that different geological settings could now be included or excluded. Good examples include the understanding of

- a. geochemistry as an indicator of groundwater flow patterns, water/rock/fluid interactions and isolation and containment properties – including the use of dense brines as an indicator of very slow groundwater movement;
- b. the effects of past and future climate change on both the surface (for example changes in sea level, depth of erosion including by glaciers, changes in rainfall and its effect on groundwater levels) and on the deep geology; and
- c. palaeohydrogeology, as a means of determining the rate of change of groundwater flows and compositions in response to past geological processes, including those resulting from past climate change.

13 SUMMARY

This paper has summarised the processes by which Nirex came to concentrate its site investigations for a deep waste repository for the long-term management of intermediate-level and low-level solid radioactive wastes at Sellafield. It has been produced now, for the record, as a contribution to the debate on the development of a legitimate site selection process in the future, which will be central to the successful implementation of policy on the long-term management of radioactive waste in the UK.

The key lessons that need to be learned for the future are:

- The whole site selection process must be open and transparent and facilitate the involvement of stakeholders, the public and experts.
- The site selection process, the criteria used to evaluate sites and the relative weight attached to each must be developed through national debate.
- The role in the decision-making process of local communities in the areas being considered must be defined clearly at the beginning of the process, including rights such as veto and volunteerism and any community benefits that may be made available.

We believe that the release of this historical list from a previous process is a step forward in the debate around how to manage the UK's radioactive waste in the long term. It is a debate that must be conducted in an open and transparent manner and we would urge all stakeholders to play a full and active part in the process.

APPENDIX 1

List of 333 Sites Eliminated at First Stage (Initial Screening – 537 to 204)

Extract from Pieda Report Ref. No. 6038/JM [16]

The sites were listed in alphabetical order by broad geographical types as follows:

COASTAL

Arpinge Firing Range	Bawdsey	Castle Martin	Chatham
Chepstow College	Eskmeals	Farthingloe	Gosport RN yard
Gravesend	Hythe Army Range	Lee on Solent RN sta	Orfordness
Portland	Predannack	Sealand Range	St Athans
Thorney Island	Torpoint	Woodvale RAF	

SMALL ISLANDS

Ailsa Craig	Ascrib Islands	Balta	Bardsey Island
Berneray	Boreray	Brother Isle	Calf of Eday
Calf of Man	Canna	Cara Island	Carna
Copinsay	Crowlin Islands	Eigg	Eilean Dubh Mor
Eilean Mor	Eilean nan Ron	Eilean Trodday	Ensay
Eorsa	Eriskay	Eynhallow	Fara
Farne Islands	Fladda-Chuain	Flat Holm	Foula
Gairsay	Garvellachs	Gasker	Gigha
Gometra	Gruinard Island	Harlosh Island	Hascosay
Hildasay	Holm of Huip	Inch Kenneth	Insh Island
Iona	Island of Danna	Island of Macaskin	Isle Martin
Isle of Ewe	Isle of May	Isle of Stroma	Isle Ristol
Isles of Scilly	Jura	Kerrera	Killegray
Lamba	Linga	Linga	Linga
Linga Holm	Lismore	Little Colonsay	Little Cumbrae
Longa Island	Longay	Luing	Lundy
Lunga	Mealasta Island	Monarch Isles	Muck
Muckle Green Holm	Nave Island	North Rona	Oronsay
Oxna	Papa	Papa Little	Papa Stronsay
Priest Island	Ramsey Island	Rhum	Scarba
Scarp	Shuna Island	Skokholm	Skomer
Soay	St Kilda	Steep Holm	Summer Isles
Switha	Taransay	Tarner Island	Texa
Tiree	Treshnish	Ulva	Urie Lingay
West Linga	Wiay		

INLAND

Abingdon	Alderley Edge	Aldermaston	Ancells Fm,Fleet
Andover RAF	Arborfield	Arncott Depot	Ashchurch
Ashdown Forest	Aston Down	Bampton Castle	Barford St. John
Barnard Castle	Barnham Army Camp	Barnsfield	Barnsley
Barton Rd, Cambr.	Bassingbourn	Bawtry RAF	Bearley
Beith	Benson RAF	Bentwaters	Besford Airfield
Binbrook RAF	Bolsover	Bowes Moor	Bramcote
Bramley	Brampton RAF	Bramshot	Branston
Burghfield	Burtonwood	Camberley	Canterbury
Cardington RAF	Chalgrove	Chapelcross	Chelverston Afd
Chetwynd RAF	Chicksands USAF	Chilmark	Chilwell
Chipping Warden	Colerne	Cosford	Cotgrave Wolds
Credenhill	Crickhowell	Cricklade	Croughton USAF
Culdrose	Culham	Dartmoor	Dean Hill
Derby	Devizes Barracks	Dinton	Dishforth
Donnington	Droitwich	Dunkeswell	Eastlays
Edlesborough	Elstead	Ernesettle	Fairford
Fareham	Farnborough 1	Farnborough 2	Farnborough 3
Fauld	Feltwell	Filton	Finningley
Forest Moor	Fradley Airfield	Fylindales	Gaydon Airfield
Gedling	Goldington	Grafham	Greatworth RAF
Halton RAF	Hardwicke	Harrogate	Hart
Hartlepool	Harwell	Havering	Henlow
High Wycombe	Hilton	Holcombe Moor	Honington
Houndstone Camp	Hullavington Afd	Innsworth	Keevil
Kemble	Kenilworth	Kibworth Rifle Range	Kingsbury
Kingston upon Hull	Kirknewton	Langport	Lasham
Latimer	Lawford Heath	Leavesden Airfield	Levensat Quarry
Lichfield	Lidlington	Little Rissington	Little Staughton
Locking RAF	Long Marston Afd	Long Marston Depot	Loughborough
Lyneham	March	Marchwood	Meaford
Melton Mowbray	Meriden	Merrifield	Middle Wallop
Middlesbrough	Molesworth Afd	Monks Park	Monkton Farleigh
Moorends Mine	Moreton on Lugg	Newbury	Newton Airfield
North Luffenham	Norton Barracks	Norton Manor Camp	Nuneaton
Oakington	Odiham RAF	Ogborne St George	Old Dalby
Old Park Barracks	Old Sarum	Otmoor	Ouston

INLAND (continued)			
Pershore Afd	Pontrilas	Porton Down	Portsmouth
Quedgeley	Ratcliffe-on-Soar	Redford, Edinburgh	Richborough
Ripon	Riseley	Risley (1)	Risley (2)
Ruddington	Salford	Sandhurst	Seighford
Shawbury	Shellingford Afd	Slough	South Cerney
South Tyneside	Southwick	Spadeadam	St David's RAF
St Eval	St Leonards	Stockton on Tees	Stradishall RAF
Summerfield	Swanton Morley RAF	Swynnerton	Tangmere
Tern Hill Airfield	Tholthorpe Afd	Thurleigh Airfield	Trawsfynydd
Upavon	Upper Hulme	Upwood USAF	Vale Royal
Waltham Abbey	Waterbeach	Watton RAF	Wedgnock
Welford	Wellesbourne Afd	West Moors	Westcott
Weston-on-the-Green	Westwood	Wethersfield RAF	Wigan
Willsworthy Ranges	Winchester	Winchester Range	Winfrith
Winslow Afd	Winterbourne Gunner	Wittering RAF	Wombleton Afd
Woodbridge USAF	Workington	Worthy Down	Wroughton
Wymeswold Afd	Yardley Chase	Yeading	Yeovilton

APPENDIX 2

List of 39 Sites Eliminated at Second Stage (Land Ownership – 204 to 165)

Extract from Pidea Report Ref. No. 6038/JM [16].

The sites were listed in alphabetical order by broad geographical types and by reference to Areas of Search (Section 5) as follows:

SEDIMENTARY AREA COASTAL

Langbaugh	Wainfleet
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SEDIMENTARY AREA INLAND

Blyton Airfield	Broadford	East Moor Afd	Elsham Wold
Flixborough	Lindholme RAF	Martin Airfield	Newton Covert Afd
Nocton	Ossington Afd		

SMALL ISLANDS

Auskerry	Berneray	Bigga	Cava
Coll	Colonsay	Faray	Flannan Islands
Inchmarnock	Isay	Mingulay	Mousa
Muckle Skerry	Oronsay	Pabay	Pabbay
Pabbay	Rona	Samphrey	Sanda
Scalpay	Shiant Islands	Shuna	

LOW RELIEF HARD ROCK AREAS COSTAL

Clardon Hill	Dunnet Forest
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LARGE SITES OUTSIDE AREAS OF SEARCH COASTAL

Lochaline

LARGE SITES OUTSIDE AREAS OF SEARCH INLAND

Billingham

APPENDIX 3

List of 48 Sites Eliminated at Third Stage (Size of Site - 165 to 117)

Extract from Pieda Report Ref. No. 6038/JM [16].

The sites were listed in alphabetical order by broad geographical types and by reference to Areas of Search (Section 5) as follows:

SEDIMENTARY AREA INLAND

Barkston Heath RAF	Barlow	Beckingham Range	Bourne Wood
Carlisle depot	Chester Barracks	Church Fenton	Coltishall RAF
Coningsby RAF	Digby	Driffield	Elvington
Fulbeck Airfield	Grantham	Inskip	Keadby
Kirton in Lindsey	Leconfield	Linton on Ouse	Misson RAF Range
Ollerton	Owston Ferry	Scampton RAF	Swinderby RAF
Syerston RAF	Topcliffe	Weeton	Wigsley
Woodhall Spa	Wrawby Moor Forest		

LOW RELIEF HARD ROCK AREAS COSTAL

Balmedie Rifle Range	Fort George	Loch Fleet	Ross of Mull
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LOW RELIEF HARD ROCK AREAS INLAND

Brawlbin

LARGE SITES OUTSIDE AREAS OF SEARCH COASTAL

Boulmer	East Yelland	Hartlepool
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LARGE SITES OUTSIDE AREAS OF SEARCH INLAND

Cottam	Denver	Didcot	Elstow
Ferrybridge	Hams Hall	Laggan Bay, Islay	Monks Fryston
Mormond Hill	Shrivenham		

APPENDIX 4

List of 78 Sites Eliminated at Fourth Stage (Geological Evaluation – 117 to 39)

Extract from Pieda Report Ref. No 6038/JM [16]

The sites were listed in alphabetical order by broad geographical types and by reference to Areas of Search (Section 5) as follows:

SEDIMENTARY AREA COASTAL

Anthorn

SEDIMENTARY AREA INLAND

Burn Airfield	Capenhurst	Catterick	High Marnham
Laughton Forest	Leeming RAF	Longton	Much Hoole
Springfields	Strensall Common	Waddington	

BUSC INLAND

Alconbury	Bedford	Bicester	Wattisham
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SMALL ISLANDS

Raasay	Swona
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LOW RELIEF HARD ROCK AREAS COASTAL

Culbin Forest	Holyhead	Lossie Forest	Morrish More
Roseisle Forest			

LOW RELIEF HARD ROCK AREAS INLAND

Achairn	Halsary	Lossiemouth RAF
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LARGE SITES OUTSIDE AREAS OF SEARCH COASTAL

Aberporth	Barry Buddon	Berkeley	Chivenor
Connah's Quay	Druridge Bay	Eastriggs	Heysham
Hinkley Point	Hunterston	Kinloss	Kirkcudbright
Leuchars	Lulworth	Machrihanish	Newborough Forest
Oldbury	Pembrey	Pendine	Penhale
Portreath	Rosyth	Scoor	St Mawgan
Torness	Tregantle	West Freugh	Wylfa

LARGE SITES OUTSIDE AREAS OF SEARCH INLAND

Aldershot	Barton Stacey	Blandford	Bordon
Boscombe Down	Bovington Camp	Brize Norton	Broughton Moor
Caerwent	Crookham	Davidstow Moor	Feldom
Greenham Common	Kineton	Longmoor	Minley
Nesscliff	Otterburn	Porton	Salisbury Plain
Sennybridge	Trecwn	Upper Heyford	Warcop

APPENDIX 5

List of 22 Sites Eliminated at Fifth Stage (Initial Comparative Evaluation – 39 to 17)

Extract from Pieda Report Ref. No. 6038/JM [16].

The sites were listed in alphabetical order by broad geographical types and by reference to Areas of Search (Section 5) as follows:

SEDIMENTARY AREA COASTAL

Cowden RAF Range	Drigg	Holbeach
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SEDIMENTARY AREA INLAND

Cranwell RAF	Sculthorpe USAF
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BUSC SITES COASTAL

Sizewell

BUSC SITES INLAND

Colchester Barracks	Colchester Ranges	Fingrinhoe	Great Fen
Lakenheath	Marham	Mildenhall	Wyton

LOW RELIEF HARD ROCK AREAS COASTAL

Caltinish,S.Uist	Crimond Airfield
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LOW RELIEF HARD ROCK AREAS INLAND

Dyke

LARGE SITES OUTSIDE AREAS OF SEARCH COASTAL

Cape Wrath	Dungeness	Lydd Camp & Ranges	West Islay
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LARGE SITES OUTSIDE AREAS OF SEARCH INLAND

Cottesmore

APPENDIX 6

List of 8 Sites Eliminated at Sixth Stage (More Detailed Comparative Analysis -17 to 10)

Extract from Pidea Report Ref. No. 6038/JM [16].

The sites were listed in alphabetical order by broad geographical types and by reference to Areas of Search (Section 5) as follows:

SEDIMENTARY AREA COASTAL

Donna Nook	North Coates	Theddlethorpe
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SEDIMENTARY AREA INLAND

Osgodby Moor

BUSC SITES COASTAL

Shoeburyness

SMALL ISLANDS

Oigh Sgeir

LARGE SITES OUTSIDE AREAS OF SEARCH INLAND

Altnaharra	Naver Forest
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