

**CUMBRIA COUNTY COUNCIL**

**APPEAL**

by

**UNITED KINGDOM NIREX LIMITED**

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**Assessor:** C V Knipe BSc CEng CGeol MIMinE MIMM FGS  
**Dates of Inquiry:** 5 September 1995 to 1 February 1996  
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## ABBREVIATIONS AND ACRONYMS

### **Parties** *[and see the document codes at the start of the Documents List]*

Construction Workers	=	Cumbria Construction Workers
Copeland	=	Copeland Borough Council, the district planning authority
CORE	=	Cumbrians Opposed to a Radioactive Environment
Cumbria	=	Cumbria County Council, the respondent planning authority
FOE	=	Friends of the Earth Ltd
FOE Cumbria	=	Cumbrian Groups of Friends of the Earth
FOLD	=	Friends of the Lake District, the local branch of the Council for the Protection of Rural England
GAG	=	Gosforth Action Group
Gosforth	=	Gosforth Parish Council, the parish council
Greenpeace	=	Greenpeace Ltd
HMIP	=	Her Majesty's Inspectorate of Pollution
Nirex	=	United Kingdom Nirex Ltd, the appellant company
NSCNFLA	=	National Steering Committee of Nuclear Free Local Authorities
Shop Stewards	=	Windscale & Calder Joint Shop Stewards Committee
SCC	=	South Cumbria Citizens, a coalition of interested persons

### **Other Acronyms & Technical Terms** *[and see the Glossaries]*

(NB Orders of magnitude are generally expressed according to the normal scientific convention, eg:-  $10^8$  = a hundred million &  $10^{-6}$  = a millionth or one in a million)

ACSNI	=	Advisory Committee on Safety of Nuclear Installations
ALARA	=	as low as reasonably achievable
aOD	=	above Ordnance Datum

BGS	=	British Geological Survey
BH	=	borehole
BNFL	=	British Nuclear Fuels plc
bOD	=	below Ordnance Datum
BPEO	=	best practicable environmental option
Bq	=	becquerel(s)
BUSC	=	basement (rock) under sedimentary cover
BVG	=	Borrowdale Volcanic Group (of rocks)
CDF	=	Cumulative Density (Distribution) Function
cm	=	centimetre(s)
COMARE	=	Committee on Medical Aspects of Radiation in Environment
cu	=	cubic
DSA	=	Detailed Safety Assessment
DWR	=	deep waste repository
ECJ	=	European Court of Justice
ES	=	Environmental Statement
FHFZ	=	Fleming Hall Fault Zone
F<no.>	=	Fault <number>
Green Book	=	Disposal Facilities on Land for Low & Intermediate-Level Radioactive Wastes: Principles for the Protection of the Human Environment 1984 [Doc.GOV/302]
g	=	gram(s)
ha	=	hectare(s)
HLW	=	high-level, or heat-generating, (radioactive) wastes
IAEA	=	International Atomic Energy Agency



ICRP	=	International Commission on Radiological Protection
ILW	=	intermediate-level (radioactive) wastes
k	=	kilo
LDBFZ	=	Lake District Boundary Fault Zone
LLW	=	low-level (radioactive) wastes
LP	=	Copeland Local Plan, deposit version as recommended to be modified
M	=	million(s)
m	=	metre(s), or as first letter in compound abbreviations = milli-
MADA	=	multi-attribute decision analysis
MASCOT	=	program of suite of sub-models to quantify radionuclide flow from repository to biosphere
NAMMU	=	groundwater modelling program of the continuum porous medium type
NAPSAC	=	groundwater modelling program of the fracture network type
NEA	=	Nuclear Energy Agency (of the OECD)
NII	=	Nuclear Installations Inspectorate
NRPB	=	National Radiological Protection Board
NRVB	=	Nirex Reference Vault Backfill
NSARP	=	Nirex Safety Assessment Research Programme
OECD	=	Organisation for Economic Co-operation & Development
pa	=	per annum [ <i>and see /y below</i> ]
PCPA	=	Post Closure Performance Assessment
PCRA	=	Post Closure Risk Assessment
PCSA	=	Post Closure Safety Assessment

PCSR	=	Pre-Construction Safety Report
PDF	=	Probability Density or Distribution Function
PERA	=	Preliminary Environmental & Radiological Assessment [Doc.COR/501 - Nirex Report No.71]
PRZ	=	potential repository zone, the main part of the appeal site
PSA	=	Probabilistic Safety or Systems Assessment
RADWASS	=	(IAEA's) Radioactive Waste Safety Standards Programme
RCF	=	rock characterisation facility
RCM	=	rock characterisation monitoring (boreholes)
REV	=	representative elemental or elementary volume (of rock)
RSA	=	Repository Safety Assessment
RWMAC	=	Radioactive Waste Management Committee
SFZ	=	Seascale Fault Zone
SP	=	Cumbria & Lake District Joint Structure Plan 1991-2006, adopted July 1995
SSG	=	Sherwood Sandstone Group
STZ	=	Saline Transition Zone
Sv	=	sievert(s)
t	=	tonne(s)
TBq	=	Tera-becquerel (a million million - $10^{12}$ - becquerels)
THORP	=	Thermal Oxide Re-processing Plant
TOR	=	Tolerability of Risk
URL	=	Underground Rock or Research Laboratory
VEM	=	Visual Envelope Map
/y	=	per year
ZLEC	=	zone of locally enhanced conductivity

## TECHNICAL GLOSSARY

*This gives the meanings of some technical terms used frequently in these reports. For a more detailed glossary, see Document COR/519.*

- Actinide** = An element following Actinium in the Periodic Table. Many of the actinides are long-lived alpha-emitters; examples are uranium and plutonium.
- As low as reasonably achievable (ALARA)** = Radiological doses or risks from a source of exposure are as low as reasonably achievable when they are consistent with the relevant dose or risk standard and have been reduced to a level that represents a balance between radiological and other factors, including social and economic factors; the level of protection may then be said to be optimised.
- Authorisation** = Permission given by a regulator to dispose of radioactive waste subject to conditions which must be met.
- Backfilling** = The refilling of the excavated portions of a disposal facility after emplacement of the waste.
- Barrier** = A feature that delays or prevents migration of material to or from the disposal facility.
- Becquerel** = The standard international unit of radioactivity equal to one radioactive transformation per second.
- Best Practicable Environmental Option (BPEO)** = A concept developed by the Royal Commission on Environmental Pollution so that decisions on waste management could be based on an assessment of alternative options evaluated on the basis of factors such as the occupational and environmental risks, the environmental impacts, the costs and the social implications.
- Best Practical Means (BPM)** = Within a particular waste management option, the BPM is that level of management and engineering control that minimises, as far as practicable, the radiological impact of the option

whilst taking account of a wider range of factors, including cost-effectiveness, technological status, operational safety, and social and environmental factors. In determining whether a particular aspect of the proposal represents the BPM, the regulators will not require the applicant to incur expenditure, whether in money, time or trouble, which is disproportionate to the benefits likely to be derived.

- Biosphere** = Those parts of the environment to which humans normally have access, plus the deep oceans. This will normally include soils, freshwater bodies, the atmosphere and the marine environment, and also the plant and animal life present in those parts of the environment.
- Boreal** = [Climate] - of a sub-arctic climate zone having long cold winters and very short summers [but with at least one month having an average temperature of at least 10°C], and typified by coniferous forest vegetation.
- Caldera** = A basin-shaped volcanic depression usually many times greater than the size of the included vents.
- Closure** = The backfilling and sealing of all points of access to a disposal facility so as to enhance the containment of the waste.
- Collective dose** = The dose received by a defined population from a particular source obtained by summing the dose received by each individual in the population and expressed in units of man-sieverts (man-Sv).
- Colloid** = A mixture of finely dispersed particles of one component suspended in a continuous phase of another component, with properties between those of a solution and a fine suspension. The term is often applied to the solid suspended phase in such a mixture, taken by Nirex to have particle diameters typically smaller than 10  $\mu\text{m}$  ( $10^{-5}\text{m}$ ) [COR/529, Box 19] (though more usually between  $10^{-7}$  and  $10^{-9}\text{m}$ ).

<b>Conductivity</b>	=	[hydraulic, of rock] - The volume of fresh water at standard temperature and pressure that will move through a porous medium in unit time under unit hydraulic gradient through a unit area measured at right angles to the direction of flow. Unit = metres per second (ms <sup>-1</sup> ).
<b>Containment</b>	=	The confinement of radioactive material so as to prevent or limit its dispersal, or the device used to effect the confinement.
<b>Criticality incident</b>	=	The accidental occurrence of a self-sustaining fission chain reaction in fissile material.
<b>Deterministic radiation effect</b>	=	A radiation-induced health effect for which the severity of the effect is related to the magnitude of the exposure, with an exposure threshold below which no effect occurs.
<b>Diapirism</b>	=	The phenomenon by which rock salt under the influence of sustained overburden pressure, or igneous rock in molten condition, may flow and form an intrusive dome in the overlying strata.
<b>Disposal</b>	=	The disposal of solid waste is the emplacement of the waste in a specialised land disposal facility without intent to retrieve it at a later time: retrieval may be possible but, if intended, the term regarded as appropriate by the Government and regulators is "storage".
<b>Disposal facility</b>	=	An engineered facility for the disposal of radioactive wastes.
<b>Disposal system</b>	=	All those aspects of the waste, the disposal facility and its surroundings that affect the radiological impact.
<b>Dose</b>	=	A measure of the radiation received, in Sieverts or Grays.
<b>Dose constraint</b>	=	A restriction on annual dose to an individual in order to ensure that when aggregated with doses from all sources, excluding natural background and medical procedures, the dose limit is not exceeded; the dose constraint places an upper bound on the outcome of any optimisation study and will therefore limit any inequity which might result from the economic and social

judgements inherent in the optimisation process. The Government has set a maximum dose constraint value of 0.3 mSv/y when determining applications for discharge authorisations from a single new source, and a dose constraint value of 0.5 mSv/y for a complete site (which may include several sources).

- Dose limit** = For the purposes of discharge authorisations, the UK has (since 1986) applied a limit of 1 mSv/y to members of the public from all man-made sources of radioactivity (other than from medical applications). This compares with an average radiation dose to members of the UK population of 2.2 mSv/y from natural background radiation and an average of 0.3 mSv/y from medical applications. The Government accepts that assessments of dose against the limit should include effects from past discharges.
- Dyke** = A wall-like mass of igneous rock intruded into joints or faults in older rocks [See also 'sill'].
- Effective dose** = The summation of the equivalent doses to the individual tissues of the body, weighted by the appropriate tissue weighting factor, see ICRP Publication 60 [GOV/506].
- Eh** = (the redox potential) A measure of the electrochemical potential of a solution, determined by the concentration and oxidation states of the electroactive species dissolved in the solution. Unit = volts.
- Emplacement** = The placement of a waste package in a designated location for disposal.
- Environmental head** = The groundwater head as directly measured in a borehole and taking density variations into account; it represents the head of a column of water having the same average density from the measuring point to the water surface. Environmental heads can be compared, and used to show the potential for flow, in a vertical direction only (cf 'freshwater head').

- Environmental pathways** = The routes by which radioactivity can be transferred through the accessible environment, including the food chain, and result in the exposure of humans to radiation.
- Evaporite** = A sedimentary rock resulting from the evaporation of saline water, either a body of sea water or an inland lake; includes rock salt (halite, sodium chloride) and anhydrite (calcium sulphate).
- Exposure pathways** = The routes by which radioactivity can be transferred from the disposal facility so as to result in the exposure of humans to radiation.
- Facies** = In relation to a sedimentary rock, the environment in which it formed, as shown by rock type, mineral content, particle sizes and sedimentary structures, fossil content, etc.
- Freshwater head** = The groundwater head as measured in a borehole but then corrected for density variations to derive the equivalent head (above a common datum) of a column of fresh water. Freshwater heads can be compared, and used to show the potential for flow, only between points in the same horizontal plane (cf 'environmental head').
- Geosphere** = Those parts of the environment below the ground or seabed and beyond the normal range of human access. This may include sub-soils as well as rocks, and does include the near field.
- High level waste (HLW)** = Wastes in which the temperature may rise significantly as a result of their radioactivity, so that this factor has to be taken into account in designing storage or disposal facilities.
- Host rock** = The geological medium in which a disposal facility is located.
- Ignimbrite** = Volcanic rock deposited from a high temperature cloud of gas with ash or lava droplets or crystals; the fragments when deposited are so hot that they tend to weld together or even coalesce and flow (in which case they are commonly called welded tuff).

- Intermediate level waste (ILW)** = Wastes with radioactivity levels exceeding the upper boundaries for low level wastes, but which do not require heating to be taken into account in the design of storage or disposal facilities.
- Inventory of Radioactive Waste Arisings in UK** = A report produced periodically which gives details of stocks and projected arisings of radioactive wastes in the UK. Wastes produced from power reactors, commercial reprocessing and fuel manufacture, medical and industrial sources, research and development and Ministry of Defence activities are considered.
- Isostasy** = The tendency of the Earth's crust to maintain a state of equilibrium, as for example depression under the load of an ice-cap and recovery following its melting, or periodic uplift of mountains in response to erosion.
- Karstic** = Describing the characteristic weathering of limestones or the preferential dissolution of the rock by percolating groundwater along joints, bedding planes or other discontinuities, often leading to cave formation.
- Lithology** = The general characteristics of a rock or sedimentary formation.
- Low level waste (LLW)** = Wastes containing radioactive materials other than those acceptable for disposal with ordinary refuse, but not exceeding 4 GBq/t alpha or 12 GBq/t beta/gamma activity.
- Near field** = The part of the geosphere immediately surrounding the waste packages in a disposal facility, usually defined as the region disturbed by the excavation of the cavity, and including any material used to backfill the cavity and the waste packages themselves.
- Neotectonics** = Large scale, deeper structural geological effects of ice loading (such as faulting and folding of strata associated with the Pleistocene glaciations).



<b>Palaeohydrogeology</b>	=	The study of the evolution of rock-groundwater systems through long periods in the past. This normally involves measurements of the hydrochemistry and isotopic differences of groundwater bodies, as well as data on rock mineralogy.
<b>Palaeozoic</b>	=	Relating to the era of geological time between the start of the Cambrian period to the end of the Permian. The Cambrian, Ordovician and Silurian periods are classified as Lower Palaeozoic, the Devonian, Carboniferous and Permian as Upper Palaeozoic.
<b>Periglacial</b>	=	[Climate] - Close to an ice-sheet margin, with long cold winters and very short cool summers [with the average temperature of the warmest month between 0° and 10°C], and typified by tundra vegetation.
<b>Permeability</b>	=	The ability of the rock to transmit fluid; often expressed in milliDarcies, equivalent to $1 \times 10^{-15} \text{ m}^2$ .
<b>pH</b>	=	The hydrogen ion concentration of a solution (as the logarithm of the reciprocal of the concentration in moles per cubic decimetre); systems with a pH above 7 are alkaline, below 7 are acidic.
<b>Porosity</b>	=	The ratio of the volume of voids within it to the total volume of rock (usually expressed as a percentage). Primary porosity (matrix porosity) relates to processes occurring during the rock's formation; secondary porosity, through the subsequent development of fractures and dissolution features. Effective porosity is a measure of the connected voids.
<b>Post-closure performance safety assessment</b>	=	Analysis to predict the performance of the radioactive waste disposal site to establish its long-term safety.
<b>Probabilistic risk assessment</b>	=	In the context of performance assessment of a waste disposal facility, probabilistic risk assessment is the assessment of radiological risk, taking account of quantifiable uncertainty.

<b>Quaternary</b>	=	The most recent period of geological time, from about 1.6-2.0 million years ago to the present, and comprising the Pleistocene and Holocene (Recent) epochs.
<b>Radiological risk</b>	=	The probability that an individual will suffer a serious radiation induced health effect.
<b>Radiological safety assessment</b>	=	An analysis to predict the performance of a system or subsystem, where the performance measure is radiological impact or some other global measure of impact on safety.
<b>Risk target</b>	=	A level of risk to a member of the critical group from a single disposal facility which provides a numerical standard for assessing the long-term performance of the facility (NB No definition of the critical group is given because that is in issue in this case).
<b>Safety case</b>	=	The safety case is the compilation of documents for the regulators by the developer of a disposal facility demonstrating that the public are sufficiently protected from hazards which may arise as a result of the disposal of radioactive wastes to the facility.
<b>Sievert</b>	=	The standard international unit of radiation dose.
<b>Sill</b>	=	A flat, originally generally horizontal mass of igneous rock intruded between 2 layers of older rocks. [See also 'dyke'].
<b>Source</b>	=	A facility, or group of facilities, which can be optimised as an integral whole in terms of radioactive waste disposals.
<b>Stochastic radiation effect</b>	=	A radiation-induced health effect for which the probability but not the severity of the effect is related to the magnitude of the exposure.
<b>Storage</b>	=	Placement of waste in any facility with the intent to retrieve it at a later time.
<b>Stratigraphy</b>	=	The study of stratified rocks, their nature, their occurrence, their relationship to each other and their classification.

<b>Tomogram</b>	=	Graphical representation of physical conditions in a selected plane section through a solid body determined by a technique of measuring waves or radiation passing through it, so a seismic tomogram is a contoured representation of shock-wave velocities in the strata between boreholes.
<b>Transmissivity</b>	=	The hydraulic conductivity of the rock unit multiplied by its thickness; unit = metres squared per second ( $m^2s^{-1}$ ).
<b>Tritiated waste</b>	=	Low and intermediate waste containing the radionuclide tritium. Tritium has a 12 year half life and is of low radiotoxicity.
<b>Tuff</b>	=	Consolidated, lithified volcanic ash or other small fragments ejected from a volcano.
<b>Very low level waste</b>	=	Wastes which can be safely disposed of with ordinary refuse (dust-bin disposal), each 0.1 m <sup>3</sup> of material containing less than 400 kBq beta/gamma activity or single items containing less than 40 kBq beta/gamma activity.
<b>Waste form</b>	=	The physical and chemical form in which the waste will be disposed of, including any conditioning media but excluding the container.
<b>Waste package</b>	=	The waste form and its container, as prepared for disposal.

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21 November 1996

To the Right Honourable John Gummer MP  
Secretary of State for the Environment

1.1 I have the honour to report that on 66 days between 5 September 1995 and 1 February 1996 I held an inquiry at The Civic Hall, Cleator Moor, Cumbria into an appeal by United Kingdom Nirex Limited under Section 78 of the Town & Country Planning Act 1990 against the refusal of Cumbria County Council to grant planning permission for a rock characterisation facility on land at & adjoining Longlands Farm, Gosforth, Cumbria. The site and its surroundings were inspected several times before & during the inquiry, with the accompanied inspection taking place on 23 October 1995.

1.2 "Rock characterisation facility" (RCF) is the title of the development. The description of the development has been amended by agreement since the appeal was made, and is now:-

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

1.3 The application was refused for the Reasons that:-

1. The proposed development lies within an area of undeveloped open countryside where development would normally only be permitted if required for local infrastructure needs which cannot be located elsewhere. In addition, the proposed development is not well related to existing developed areas of the countryside in terms of siting, scale and design. The proposed development is therefore contrary to Policy 13 of the Structure Plan.
2. The application site is located close to the Lake District National Park and it is considered that it would be detrimental to the present characteristics and qualities of the National Park. The proposed development is therefore contrary to Policies 2 & 11 of the Structure Plan.
3. It is considered that the proposed development does not enhance the quality of the existing environment and is not well integrated into the existing pattern of

surrounding land uses. It is therefore contrary to Policy 25 of the Structure Plan.

4. The proposed development is considered to be a major development more national than local in character. The County Council is not satisfied that the sum of national, regional & local benefits clearly outweighs the adverse environmental impact of the proposed development. Convincing reasons have not been demonstrated as to why such a development should be permitted while national policy uncertainties remain. It is therefore contrary to Policy 54 of the Structure Plan. (NB The County Council now withdraws the claim that national policy uncertainties remain, but still pursues the view that the sum of benefits has not been shown to clearly outweigh any harm or risks.)
5. The County Council is not satisfied that a rational basis for focusing detailed investigation solely on Sellafield has been demonstrated. In particular, the Council considers that the RCF represents a significant pre-commitment to eventual repository development in economic terms. The RCF need not, therefore, be looked at in isolation. The expenditure involved and local damage introduced represent a "halfway" commitment to development of a repository at Sellafield. The issue of why the site was "selected" and became the focus of detailed investigation is, therefore, in planning terms, a clear material consideration, and the steps leading to the RCF are manifestly a matter for consideration at this stage. In the absence of such justification, the proposed RCF development is contrary to Policies 2, 11, 13, 25 & 54 of the Structure Plan.
6. The County Council is not satisfied, on the basis of the currently available geological, hydrogeological & safety assessment information, that the potential repository zone holds sufficient promise to justify the proposed RCF development contrary to Policies 2, 11, 13, 25 & 54 of the Structure Plan.

1.4 The Reason for directing that the appeal should be determined by you instead of an appointed person was that the appeal relates to proposals which give rise to significant public controversy.

1.5 On the information available by February 1995, the matters about which you particularly wished to be informed for the purposes of your consideration of the appeal were:-

1. The relationship of the RCF proposal to the policies and proposals in the existing development plan for the area.
2. The relationship of the RCF proposal to the policies and proposals in the emerging development plans for the area. (*In February 1995 the Cumbria & Lake District Joint Structure Plan 1991-2006 was still an emerging plan.*)
3. In determining the appeal, the weight that should be attached to emerging plans, having regard to the advice set out in PPG 1.

4. The environmental impact of the RCF proposal.
5. The impact of the RCF proposal on the local highway network and the works, if any, required directly to accommodate additional traffic arising.
6. The results available so far from studies & surveys of the geology & hydrogeology of the area; the additional information that might become available only from the RCF, if developed; and the benefits to be gained from obtaining that additional information, if any, weighed against the possible impact the RCF might have on the site and the surrounding area.
7. The question of whether any planning permission which may be granted should be subject to any conditions and, if so, the form they should take.
8. Any other issues which the Inspector considers relevant to the determination of the appeal.

1.6 Pre-inquiry meetings were held on 15 May & 4 July 1995, and a 3rd procedural meeting on 29 September 1995. Notes of the meetings were circulated [Docs.INQ/4].

1.7 The Assessor & Assistant Inspector sat with me for most of the inquiry. I am greatly indebted to them for their assistance & support before, during and after the inquiry. The Assessor's comprehensive advice is in a written report which is appended to this report. I accept all his conclusions, and I have also benefited from the Assistant Inspector's views, but the conclusions of my report are my sole responsibility. I am very grateful to the Programme Officers, A & A Scott, for their very thorough & dedicated administration of the inquiry.

1.8 An environmental statement made under the Town & Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988:1199) was produced [Doc.COR/101], as were comments from statutory consultees [Doc.COR/107] and representations duly made [Doc.COR/108], together with further information supplied without prejudice [Doc.COR/101A] in response to a formal request by the County Council under Regulation 21 [Doc.COR/118, letter of 3 October 1994]. This environmental information has been taken into account by me, but legal submissions about the adequacy of the environmental statement are summarised in Section 3 of this report.

1.9 Several other legal & procedural submissions were made about various aspects of the appeal and the inquiry. Again some of those are summarised in Section 3. However, particularly in the light of the provisions of Section 286(1) of the Act of 1990, Copeland Borough Council chose not to pursue its claim that it is the relevant local planning authority for the appeal development.

1.10 The appellant objected to the Acting Chief Inspector of HMIP giving evidence at my invitation at the start of that part of the inquiry which dealt with radioactive waste management policy & scientific matters. The grounds of objection [Doc. COR/101E] were briefly that most of the questions to be put by other parties and myself to the Chief Inspector were either irrelevant, or might prejudice the Environment Agency's consideration of a subsequent application for an authorisation under the Radioactive Substances Act 1993, or

were not within the competence of the Chief Inspector. It was also submitted that the order in which the evidence would be heard was unfair to the appellant and would never be followed for evidence being given to a planning inquiry by a Government Department or Agency. I did not uphold the objection, since all the questions were arguably relevant, particularly to item 6 set out in para.1.5 above: also the Chief Inspector was at liberty to decline to answer questions as he saw fit (which indeed he did): and HMIP was a division of a Government Department, with its evidence being given at the conventional place in the order for a Department, as had previously been agreed at the procedural meeting.

1.11 It was unfortunately necessary for me to withhold permission from a number of persons to appear at the inquiry, under Rules 12(2) & 14(4) of the Inquiries Procedure Rules. The Statements of Case of 18 of the 24 persons to be called by the coalition of South Cumbria Citizens showed that their evidence would be unduly repetitious. The case of Mr P Metsers [Doc.WR/M/179] would also have been defamatory. The Statement of Case of Dr W R Burton showed that his concept of a "geostore" [Doc.WR/B/57] would be in unsaturated rock, with direct drainage to the sea: this could not be a deep repository as required by Government policy, and hence would be irrelevant.

1.12 Several parties requested a public transcript of the inquiry's proceedings, to enable participants and the public to be aware of the evidence given at the times when they were unable to attend. The Department declined to provide a transcript because it considered that my report would be an adequate record of the proceedings; and the Planning Inspectorate did not have funds available for the purpose. The appellant commissioned its own transcript of the proceedings; whilst in the end the National Anti-Dump Network & the County Council combined to make copies of a second transcript available for public use free of charge.

1.13 Before dealing with legal interpretations in Section 3, this report refers in Section 2 to the background in terms of the legal, political & regulatory framework; the site description & the detailed proposals; and the development plan. Then Section 3 reports sequentially the gist of submissions on 3 basic legal issues. Chapter 3A is concerned with the inter-related questions of the extent of the project in which the RCF is included, and of the relationship between the RCF & the potential deep waste repository (DWR). Chapter 3B examines whether it is necessary to look at alternatives to the proposals, especially alternative sites; and also whether the environmental information supplied so far to the planning authorities is adequate. In Chapter 3C, the significance of any eventual radioactive discharge from the DWR into the Irish Sea is considered. The submissions & preliminary conclusions on these legal issues not only lead on from one to another but also relate to some of the representations made on the planning merits.

1.14 The gist of the latter representations is set out on a topic basis, starting with conformity with the development plan in Section 4, which briefly explores how the relevant statutory & emerging policies should be applied in this case. Other topics are then broadly categorised into environmental effects in Section 5, and scientific & technical benefits in Section 6. Section 5 in effect deals with the extent to which the proposals would lead to harm to interests of acknowledged importance, whilst Section 6 is concerned with the advantages of the proposals. The latter ranges over various aspects of the programme for the provision of a DWR which have been raised in issues between the parties concerning the

extent of the benefits to be gained from the RCF. Much of the Section is directly concerned with the suitability of the site & of the proposed development, but some parts cover the relationship between the nature & timing of the RCF and the overall DWR programme.

1.15 The layout of the report is usually for agreed basic facts to be stated at the start of each chapter. Although the weightiest points made by the various participants are ascribed to them individually, the identities of particular parties are not always given: and points made merely in emphasis or repetition are not separately reported. Every chapter ends with my preliminary conclusions on its topic, including my views on the strength of the connection with the appeal proposals. All the preliminary conclusions are eventually summarised and drawn together in my final conclusions & recommendation.

1.16 Lists of appearances & documents are appended after the Assessor's report. References in square brackets in the report are to inquiry documents. References in the left-hand margins of conclusions are to other paragraphs of the report, or, occasionally, to documents. Where there are no such marginal references for specific, factual conclusions, this is because they have been adopted directly from the relevant chapter in the Assessor's report.

1.17 The report does not take into account the Regional Planning Guidance for the North West (RPG 13) issued in April 1996, or Circular 12/96 on the Environment Act 1995, Part III - National Parks published on 11 September 1996. Also the version of Doc.COR/301 referred to in this report, including the head-note to Chapter 2C, is that dated 19 October 1995. After the close of the inquiry, I referred this back to the principal parties for the correction of a minor error in the wording of Policies ENV 1-4 of the emerging Local Plan. However, due to a misunderstanding, a revised version incorporating modifications formally proposed by Copeland after the close of the inquiry was returned. The latter has not been utilised in the preparation of the report.

1.18 Finally, I would draw attention to the representations of the National Trust [WR/NTR/2], which request the Secretary of State to re-consider the establishment of a Planning Inquiry Commission into this appeal on receipt of my report [idem, para.25].



## **2A. LEGAL, POLITICAL & REGULATORY FRAMEWORK**

### **Law**

2A.1 Nirex is following a contingent programme to confirm the suitability of the PRZ for a deep underground repository for ILW and high  $\alpha$  emitting LLW, and the construction & operation of the RCF would be critical stages in this programme. The ES for the RCF assumed that the RCF was a separate project and so was submitted under Article 4(2) of Directive 85/337/EEC and Regulation 2(1) & Schedule 2 of SI 1988:1199, whereas an ES for the repository would be required under Article 4(1) & Annex 1 and Schedule 1 respectively. A Common Position has been agreed by Council Environment Ministers on Amendments to the Directive [GOV/139]. Environmental impact assessment in a transboundary context is also subject to the 1991 Espoo Convention [FLD/2/3], to which the EC is a signatory.

2A.2 In the EU, atomic energy is basically governed by the Euratom Treaty. Radiation safety standards to protect the health of workers and the general public are set by the Euratom Basic Safety Standards Directive 80/836/Euratom as amended by 84/467/Euratom. Amongst other things, the Directive requires any practice involving exposure to radiation to be justified before adoption. The Directive is also currently being revised [GOV/505] to reflect changes in protection criteria recommended in ICRP 60 [GOV/506]. Documents published as part of the IAEA's RADWASS Programme [eg GOV/501-10] are advisory, but the IAEA Convention on Nuclear Safety 1994 is open for signature, and a Convention on the Safety of Radioactive Waste Management is being negotiated.

2A.3 The PRZ is close to the Irish Sea and it is predicted by Nirex that, under most circumstances, groundwater which has passed through a repository in the PRZ would eventually reach the Sea. The pollution of seas is covered by the 1958 Geneva Convention on the High Seas and the 1982 Convention on the Law of the Sea. The dumping of radioactive waste at sea is also subject to the 1972 London Dumping Convention as amended and the 1974 Paris Convention on the Prevention of Pollution from Land-Based Sources. This is to be replaced by the 1992 OSPAR Convention, which although not yet formally ratified by the UK is being applied to all UK waters.

2A.4 Several pertinent matters of international law are now also subject to Agenda 21 as agreed at the 1992 Earth Summit. Such matters include the management of radioactive wastes; the principles of sustainable development, including the precautionary principle; and public access to environmental information. Detailed rules for the latter are already set out in Directive 90/313/EEC and the Environmental Information Regulations SI 1992:3240.

2A.5 Generally the safety of nuclear installations as such, including the management of radioactive waste on site, is governed in the UK by licensing by the Health & Safety Executive under the Nuclear Installations Act 1965. The regulation of radioactive substances is generally otherwise carried out under the Radioactive Substances Act 1993. In England, authorisations of disposal & accumulation of radioactive waste under that Act are now granted by the Environment Agency.

## National Policy

2A.6 The conclusions of the Government's latest Nuclear Review are contained in the White Paper Cm 2860 of May 1995 [GOV/215]. The final conclusions of the Government's parallel Review of Radioactive Waste Management Policy are in the joint White Paper Cm 2919 of July 1995 [GOV/208], paras.50-52 of which set out the revised aims which are to guide policy. Two related policy documents preceded this White Paper. A consultation document of August 1994 published the Preliminary Conclusions of the Review [GOV/306]: and a Parliamentary Answer coincided with the publication of Cm 2860.

2A.7 Annex F of the consultation document was a description of the role which the planning process plays in relation to radioactive waste management [see para.183]. Nirex and Cumbria agree that this Annex cannot now be a policy document; and that it is not of itself a material consideration to which weight must be given [COR/801]. PPG23 had been issued in the previous month to the consultation document, but does not cover radioactive substances, although its advice on the non-duplication of planning & regulatory functions applies equally well to radioactive waste management [para.1.6].

2A.8 The Parliamentary Answer & para.101 of Cm 2919 set out the Government's conclusions that Nirex should continue with its programme to identify a suitable site for a DWR; and that, once a suitable site has been found, the repository should be constructed as soon as reasonably practicable. After emplacement of the relevant radioactive waste arisings [1991 projection in NRX/15/40] for an operating period of about 50 years, the repository would be closed. Para.100 of Cm 2919 states that the local government-favoured option of retrieval (supported by many written representations on this appeal) would be relatively straightforward during operations, and still available following closure. But the fundamental concept is that the continued safety of future generations must not depend on further monitoring, surveillance & preventative or remedial actions after closure of the facility.

2A.9 The precise timetable for the construction of the repository will depend on the granting of planning consent and compliance with regulatory requirements, including the establishment of a sound safety case. Para.105 of Cm 2919 states that it is not within the RCF appeal inquiry's scope to seek to use it as a focus to reopen general debate of the national policy on the deep disposal of ILW. Para.110 points out that the matters about which you specifically wish to be informed by the RCF inquiry concern the local impact of the facility's construction: and that the Government has already promised to hold a full public inquiry into an application for the repository itself, wherever it may be situated.

2A.10 Paras.108-9 summarise the historical process which has led to this position. In 1987 the Government agreed with Nirex that it was preferable to develop a multi-purpose deep site for LLW & ILW rather than proceed with further investigations for a near-surface facility [GOV/210]. By 1989 Nirex had prepared a short-list of sites, and the Government accepted that the next steps should be to carry out detailed geological studies on land in the vicinity of Sellafield and Dounreay [GOV/211]. In 1991 Nirex announced [NRX/12/1] that initial investigations at the 2 sites suggested that either could potentially support the safety case necessary for a deep disposal site. However, Nirex proposed to concentrate on Sellafield because of the advantages it offered in terms of transport, with the majority of ILW for disposal arising from BNFL's operations at Sellafield.

## Regulation

2A.11 Prior to the 1994-5 review, environmental safety criteria for radioactive waste repositories were set out in the 1984 Green Book [GOV/302]. The policy provisions of this document have now been superseded by Cm 2919, and its regulatory requirements are out of date. The latter are being replaced by regulatory Guidance, of which 2 consultation drafts have been published by HMIP [GOV/307 & HMP/1/1].

2A.12 The basic regulatory approach is now laid down in Cm 2919. Reliance cannot be placed exclusively on estimates of risk to determine whether a disposal facility is safe. Other technical factors, including ones of a more qualitative nature, will also need to be taken into account. However a risk target of  $10^{-6}$ /y of developing either a fatal cancer or a serious hereditary defect should be used as an objective in the design process. Where estimated risks to the public are below this target and the best practicable means have been adopted by the operator to limit risks, the regulators should not seek further reductions in risk. If the estimated risk is above the target, then the regulators will need to be satisfied not only that an appropriate level of safety is assured, but also that any further improvements in safety could be achieved only at disproportionate cost.

2A.13 There should be no prescribed cut-off for the period over which the risk should be assessed. That period will depend on the nature of the site-specific safety case. The regulators' Guidance should include the factors which applicants need to take into account over different time-frames. With regard to the commencement of the period to which the risk target applies, the current draft of the Guidance [HMP/1/1, Ca.6] provides for it to start after closure of the facility, with the different radiological protection standard of dose constraint applying before then. The draft also refines Cm 2919's implicit transition point between the 2 standards, by envisaging that there might be a period of control after closure of up to some hundreds of years before final withdrawal from the facility [idem, para.6.4].

2A.14 In England the environmental safety regulator concerned is the Environment Agency, implementing the Radioactive Substances Act as successor to MAFF & HMIP. It is still envisaged that Nirex, as expected in Cm 2919, would make an early application for a disposal authorisation under the Act, at about the same time as an application for planning permission to develop the repository. This would probably be in the course of a staged application approach, which is to be explained in greater detail in a revised & updated version of "Radioactive Substances Act 1960, a guide to the administration of the Act". Discussions were also taking place at the time of the RCF inquiry on a voluntary agreement between Nirex and the regulator for an early exchange of information & views, and to settle a programme for the progressive supply of information once an authorisation application is submitted.

2A.15 The aim of such procedures would be to give the regulator 2 key decision points. The first would be to submit a provisional view to the full planning inquiry into the DWR planning application on whether there appeared to be any impediment to the eventual authorisation of disposal. The second would be whether, after completion of repository construction and commissioning, to approve the start of disposal operations. However the Environment Agency has no statutory regulatory role prior to the submission of the application for the disposal authorisation: and it will have no regulatory role at any time in

relation to the selection of the site for a repository, which is a matter for the applicant and the planning process.

2A.16 Moreover, **NSCNFLA** submits that, by virtue of the exemption in Section 13(4) of the Act of 1993, Nirex as a waste receiver at the final disposal site would not even require an authorisation for waste which was being disposed of in accordance with an authorisation already granted to the waste producer: this interpretation is reinforced by the provisions of Section 18(3), which expressly contemplate that a local authority receiver might not have its own authorisation for the place of deposit. **Nirex's** counter-submission is that, on the contrary, Nirex would need its own authorisation under Section 13(1), as the user of premises for the purposes of its own undertaking (see Section 47): Section 18(3) is actually concerned with the controlled burial of some LLW, and so is irrelevant. This is a legal matter, but **my opinion** is that, whilst there clearly is a significant exemption in Section 13(4) irrespective of the purpose of section 18(3), it cannot be assumed that all the waste to be disposed of by Nirex, nor the methods of disposal, would be governed by extant authorisations of the waste producers.

2A.17 On the other hand, it is agreed that the other intended regulator, the Nuclear Installations Inspectorate of the HSE, does not so far have any statutory basis. This is because Regulations have yet to be made to specify a DWR as requiring a licence under the Nuclear Installations Act 1965. However, once this is done, the NII already has a staged licensing procedure in place, with modern Safety Assessment Principles for Nuclear Plants [GOV/703] & "Notes for applicants for nuclear site licences" [NRX/12/10]. The intention is that the early application to the Environment Agency and the application to the NII would proceed in parallel, with the requisite Detailed Safety Assessment and Pre-Construction Safety Report being submitted to the respective regulators at broadly the same time. The regulators would be statutory consultees of each other, and in practice would liaise closely.

## 2B. SITE & PROPOSALS

### Summary of Site & Surroundings

2B.1 The appeal site and surroundings are described in detail in COR/112. The site itself [COR/102B/008000B] comprises a large block of land overlying the PRZ plus 2 service corridors, amounting to about 223 ha in all [COR/102D]. Much of the land consists of the holdings of 3 farms, with the farmstead of the largest at Longlands Farm standing about 1 km north-west of the edge of the village of Gosforth [COR/102B/008001B], although the south-eastern tip of the site is only about 400 m from the fringe of the settlement. The perimeter of the Sellafield Works complex is just over 2 km to the west of the Farmstead. Just beyond the Works the West Cumbrian railway (Carlisle-Barrow-Carnforth) runs beside the shore of the Irish Sea.

2B.2 The site lies in the undulating coastal belt between the Sea and the foothills of the Lake District [NRX/2/3/Fig.4.1]. Most of the north-eastern boundary of the site is alongside a length of the A595 Lillyhall-Grizebeck trunk road, on the other side of which is part of the western boundary of the Lake District National Park. This length of the A595(T) runs south-eastwards from the small village of Calder Bridge, through the hamlet of New Mill at the northern point of the site, to pass just to the south-west of Gosforth. There it is joined by the B5344 coming up north-eastwards from the village of Seascale, which also has a road connection (U4465) north-westwards to the Sellafield complex [NRX/9/14/Fig.4.1]. Another road - the C4013 - leads north-eastwards up the Calder valley from the Works to join the A595(T) at traffic lights at the west end of Calder Bridge village. The third, and main, route from the Works is even further to the north-west, along the C4037 to reach the trunk road at the Blackbeck roundabout, a little to the south-east of the Egremont Bypass.

2B.3 The 2 Services Corridors [COR/102B/008008D] lead north-westwards & south-westwards respectively from the southern part of the PRZ, with the northerly Corridor A providing options for electricity supply whilst the southerly Corridor B is for drainage. The Services Corridors also effectively continue within the PRZ, leading to the internal Surface Site [idem, 008007B & 008060] of about 38 ha on which the new surface activities connected with the RCF would take place. At the core of the Surface Site, and just south-west of Longlands Farmstead, is the Platform Site of about 4 ha [idem, 008009B]. This would contain the heads of the 2 shafts which would be the focal points of the RCF, together with related buildings & other structures. The Farmstead itself has the benefit of planning permission for conversion to a visitor reception area & offices, plus car park & viewing platform [idem, 0080032A-37A], subject to the grant of permission for the RCF itself.

2B.4 The surface of the PRZ is mainly undulating farmland, with a general fall down to the south-west from a high point of 110 m aOD next to the A595(T). But to the west of the Farmstead there is a mound flanked by 2 NW-SE clefts; and the deeper, north-easterly cleft becomes a steep-sided valley which turns southwards & widens out to the south-west of the Farmstead. The Platform would be extended across this depression as it turns south [idem, 008014B]. The valley floor is drained by an intermittently flowing rill [NRX1/3], which itself is an arm of the southern tributary of Newmill Beck, the other arm of which rises in the south-eastern part of the appeal site [COR/101/Fig.3.5.2]. The northern tributary of the

Beck is much longer, rising in the foothills north-east of the A595(T), passing through the hamlet of New Mill, and bending around the north-western part of the appeal site, before joining the southern tributary near Corridor B & entering the mouth of the River Calder at Sellafield [COR/101/Fig.3.7.1].

2B.5 One southward stretch of the northern tributary is part of the south-western boundary of the PRZ: and the Beck's valley there & north-west of the Zone contains plantations which extend into parts of the appeal site. Nirex's landscape proposals would add to that framework [NRX/2/3/Fig.5.3]. They would result not only from the RCF development but also from the borehole development which has already taken place on the site. Out of the 13 regional boreholes drilled by Nirex to obtain basic hydrogeological data on the Sellafield area [idem, Fig.4.3, ie excluding No.6], three - Nos.2, 4 & 5 - are in the PRZ [best seen on idem, Fig.5.1]. There are also in the PRZ 2 old minerals exploration boreholes now used for monitoring, called Boonwood & Holmrook 13 [idem, Fig.4.3 again].

2B.6 Another 14 ha of the Surface Site are occupied by further, temporary borehole development which would complement the RCF itself. The total additional boreholes approved are RCF1-4 to help establish the exact positions of the shafts, RCM1-4 to monitor the effects of shaft-sinking, and PRZ1-5 to assist further in the characterisation of the Zone. RCF1 & 2 sites would be retained as part of the Surface Site, whilst the sites for RCF3 and RCM1, 2 & 4 would be incorporated into the Platform.

2B.7 The current works on site are already served by a purpose-built access from the A595(T), constructed with permission in 1993 to DoT standards [COR/102B/0080011A, 12B & 13A]. But also leading westwards through the site, from the A595(T) opposite the entrance to Gosforth village, is a narrow byway called Sides Lane. This is shown on the Cumbria County Definitive Rights of Way Map 1989 only as a bridleway [idem, 0080038B]; and it is metalled from the main road just as far as the sites of regional Boreholes 2 & 4, to which it provided the original access. South-west of these borehole sites and still within the PRZ, an unsurfaced drive leads off Sides Lane, uphill north-westwards into the fringes of the plantations. After about 1 km, the drive bends north-eastwards, and at about 800 m farther on it joins the A595(T) through a gateway overlooked by a dwelling called Newton Manor Lodge.

2B.8 The drive is indeed that of the Newton Manor Estate, and no public right of way over it is indicated on the Definitive Map nor acknowledged by BNFL as the landowner [NRX/11/8]. Newton Manor itself [best seen on NRX/2/3/Fig.5.1], now converted into flats, lies in the wooded valley bottom of Newmill Beck in the north-western part of the PRZ. Just south-east of the Manor is a bungalow called Saddlebank. Going round the drive towards the lodge gate, a detached dwelling called High Lingbank lies south-east of the drive & about 250 m back from the main road. About 250 m south-east down the A595(T) from the Lodge, a Grade II listed dwelling called Sally Hill stands on the other side of the road. Further to the south-east, and clustered around the mouth of Boonwood Lane opposite the former entrance to Longlands Farm, are Boonwood Cottages & Garden Centre and the Red Admiral (formerly Boonwood) Hotel. Back inside the PRZ, and about 500 m along Sides Lane from the A595(T), Sides Bungalow stands on the north-western side of the byway. Another 1 km to the west along the Lane, and just outside the PRZ, are Fleming Hall Farm & The Bungalow.

## Summary of Proposals

2B.9 The RCF development as amended [COR/102A-D] since the original planning application [COR/102 & 103] is described in detail in COR/111, and the latest version of the work programme is COR/102B/008010B. If the construction & science activities were to run their full course, this would take about 13 years from mid-1997, assuming that permission were granted early that year. The Platform would be built at 84.5 aOD by cut & fill and in the form of an extension of the platforms of boreholes RCF3 & 4 across the valley [idem, 008014B]. During site establishment, cut-off & subsoil drainage from the Platform would lead to an oil interceptor & lined settlement pond in the valley [idem, 008015B], whilst the rest of the Surface Site would be drained into existing soakaways. On completion of establishment, surface water from the Platform & access road would go via a perimeter drain to a multi-bay settlement tank [idem, 008016A], and thence be discharged under controlled conditions to Newmill Beck down a 1.2 km drain in Corridor B. Foul water would go to an on-site sewage treatment plant, with a controlled outflow to a 3.5 km effluent pipe along Corridor B to the Calder Interceptor Sewer within Sellafield Works.

2B.10 The 2 shafts would be sunk about 50 m apart [idem, 008009B], with the North Shaft begun up to 3 months after the South. Contractor's construction headgears 25-30 m high [idem, 008061] would be used during sinking, to be replaced after sinking by operational headgears 29.2 m high, each with heapsteads & winder houses [idem, 008018-21C]. Concrete & grout batching plants would also operate during most of the construction periods. In addition there would be a fan duct & house at the South Shaft and a spoil conveyor & bunker at the North Shaft. Service buildings would include a workshop & stores [idem, 008023C]; and an office block for laboratories, training, changing & first aid as well as administration [idem, 008022C]. Smaller structures would include an electrical substation, wheelwash, gatehouse & firewater tank, with stores for explosives & detonators to the north-west of the Platform [idem, 008024-26B].

2B.11 A final decision has yet to be made on electricity supply: it might come underground or overhead along Corridor A from Sellafield, or it might be taken directly from the grid via a transformer. The initial construction period would require high levels of lighting in the working hours of 0700-1900, typically between 100 & 300 lux with lights mounted between 8 & 20 m high. Subsequently, external lighting would be typically between 20 & 50 lux. In response to concerns expressed about the impact of security fencing & lighting, one amendment has been to reduce the illuminated length of fence line by about 30% and confine it to the Platform Site, car park, gatehouse & explosives stores. The lights would be on 6 m high columns at 30 m intervals, with illumination typically in the range 5 to 20 lux [NRX/1/5].

2B.12 The shafts would be of 5 m finished internal diameter; and would most probably be excavated by the drill & blast method, although the possibility of freezing some of the ground to limit unexpected water inflows cannot be entirely discounted. The South Shaft would be the primary access for personnel, whilst the North Shaft would be primarily for equipment, materials & spoil, and also would be the fresh air intake. After the construction of the collars & foreshafts down to about 36 m, the shafts would be hydrostatically lined as they went down through the SSG & Brockram [idem, 008053A]. A connecting gallery would be dug between the shafts at 650 m bOD: but a decision about the preferred repository level would

not finally be made until the development was well under way, so that the option is being retained to construct the shafts down to any level in the BVG between 650 & 900 m bOD plus 30-35 m for sumps.

2B.13 Probe drilling & groundwater monitoring ahead of excavation would attempt to identify & quantify potential water inflows. The most likely form of ground treatment is grouting selected zones in the SSG to restrict volumes to manageable quantities [NRX/16/10/Fig.4.1]. Groundwater would in addition seep through the hydrostatic lining; and water with tracers added would also be introduced for drilling & cleaning purposes. Subject to differentiation as a result of the tracers, water would be pumped out of the shafts; treated by settlement & oil interceptors; and added to the foul water discharge through the effluent pipe.

2B.14 Spoil would be brought mainly up the North Shaft, and taken to a large field, lying north-west of the Platform and inside the bend in the Newton Manor drive [idem, 008030C & NRX/2/3/Fig.5.2], which has been earmarked for the spoil disposal area. In all, about 40,000 cu m of sandstone would be produced, with between 60,000 and 75,000 cu m of Brockram & BVG depending on the depth of the shafts. Allowing for bulking, this would amount to 140,000 to 160,000 cu m of spoil, although about 15,000 t of BVG could be taken off the site for tests of its marketability. In the disposal area, the spoil would be placed on stripped ground in transverse phases; and gradually spread over about 6 years to a maximum height of 4 m, with progressive restoration. There would be screening mounds along the south-western boundary of the field.

2B.15 Phase 1 of the RCF Science Programme would embrace the excavation of the shafts & the first connecting galleries [idem, 008027A]. The purpose of the Phase is to deliver information required to enable Nirex to make a decision whether to propose a repository in the PRZ and so prepare the requisite planning application, plus the PCSR & DSA for the regulators. Mapping & hydraulic measurements would take place as continuous elements of shaft & gallery construction in order to obtain information in particular on the structural characteristics & flow channels of the various rocks; and on the pressure, flow & chemical composition of the groundwater. Fracture infill would be sampled for mineralogical analysis & radiometric dating. Mechanical & hydraulic changes due to disturbance by shaft construction would be measured; and a further excavation disturbance experiment would be carried out around a gallery at the preferred repository horizon in the BVG towards the end of the Phase.

2B.16 A decision to proceed with the repository could be taken at the earliest about halfway through Phase 1. Conversely, such a decision might be deferred until some time during the later Phases. Should the Programme show at any point that the site is unsuitable for a repository, then restoration works would commence. At present the activities planned for Phases 2 & 3 are primarily designed to confirm the final design of the repository and to deliver information to help the regulators decide whether to approve the start of disposal operations after the construction & commissioning of the repository itself; but the Phases are indicative only [idem, 008028 & 29A], and the Programme would be reviewed & might be revised, especially if the decision were deferred. Deferment might result in the balance of science activities being shifted from experiments predominantly on processes in flow channels



within the BVG to tests of extrapolations of distributions of connected fractures within the rock.

2B.17 The galleries would be excavated by drill & blast, like the shafts. The current indications for Phase 2 are of 3 main galleries each about 150 m long, but maybe with varying cross-sections, and in approximately NNW, SSE & WSW directions. Phase 3 is presently envisaged as extending the NNW gallery to up to 375 m, and the SSE one to up to 600 m. Basically the scientific activities in Phase 1 would be continued in the galleries throughout Phases 2 & 3, but there would also be experiments within zones of connected fractures & in single fractures to measure rock matrix diffusion and observe colloid transport. Phase 2 would include too a Site Characterisation & Demonstration Experiment [NRX/16/10/Fig.5.2] and various Seal Experiments [idem, Figs.5.4-7]. In Phase 3 there would be a Ventilation Tunnel Experiment, to measure the hydraulic conductivity of about a 100 m length of BVG [idem, Fig.5.3]; and experiments to measure gas entry pressure into fractures & gas & water flow characteristics. The effects of chemical disturbance by highly alkaline fluids on networks of connected fractures would also be measured. The final location of the repository vaults would be confirmed by drilling from the Phase 3 galleries, possibly above or below the putative alignment of the vaults.

2B.18 The closure & restoration of the RCF [NRX/1/1] would involve underground salvage followed by backfilling of the sealed-off shafts with a clean & inert material such as limestone; the dismantling & demolition of the surface buildings; and the restoration of the landscape [COR/102B/008051B], soil management & re-vegetation. About 4.6 ha of the landscape planting would be retained, linked by a further 2.21 ha of woodland planting plus new hedgerows [idem, 008049B]. Whilst grassland areas would be restored to a condition suitable for agriculture, other parts would be suitable for nature conservation or forestry, due to the re-structuring of the landscape and the provision of wildlife resources, such as a wetland in the valley as well as the scrub & woodland.

## 2C. DEVELOPMENT PLAN

*COR/301 is a useful reference document in that it sets out many of the policies referred to below, and indicates generally whether they were regarded as relevant by Nirex or Cumbria. However, it is not an exhaustive or definitive account of this aspect of their final cases to the inquiry, and it certainly does not commit any of the other parties in any way.*

2C.1 The statutory development plan for the appeal site consists of the Cumbria & Lake District Joint Structure Plan 1991-2006 adopted in July 1995 [COR/303]; and such parts of the Mid Copeland Local Plan adopted in 1990 [COR/305] as are in general conformity with this new Structure Plan [COR/305A].

2C.2 Cumbria has also identified for the purposes of para.5.56 of PPG 12 the detailed policies which appeared in the previously approved structure plan and yet are now more appropriate to local plans [COR/302A]. These development control policies, excluded from the new Plan, will be spent when the relevant local plan is adopted; but according to the PPG they will be given weight in the transitional period depending on the particular circumstances.

2C.3 Objections [COR/307] to the deposit version of the Copeland Local Plan [COR/306] were considered by an Inspector who held a local inquiry in June & July 1995. Copeland has received the Inspector's report [COR/307A]; and the position at the end of the appeal inquiry was that Copeland was to be advised to accept the Inspector's recommended modifications particularly in respect of Policies DEV 4, IMP 1 & ENV 33 [idem, pp.2-3, 11-13 & 67-71]. Of course further steps are likely to have been taken towards the adoption of the Plan between the close of the appeal inquiry and the submission of this report.

2C.4 The Lake District National Park Plan was published in 1978 and reviewed in 1986 [COR/308]. Chapter 9 of the Plan comprises the Conservation Map prepared under Section 3 of the Wildlife & Countryside (Amendment) Act 1985. The Lake District National Park Local Plan was placed on deposit in March 1994 [COR/309]; proposed changes were published in April 1995 [COR/310]; and a local inquiry into objections opened in October 1995, & has now been concluded. The Plan deals with minerals & waste planning inside the Park; whereas a consultation draft of a Minerals & Waste Local Plan for the parts of the County outside the National Parks was published in July 1995 [COR/311].

### **Structure Plan**

2C.5 SP Policies 1-10 form part of the strategic framework for other SP policies, LP policies and other material considerations. Policy 2 is to protect from inappropriate development Cumbria's scenic beauty, natural resources & the quality of its built environment, especially those areas and features of international or national conservation importance where harmful development will not be permitted. Under Policy 5, the same attributes of the National Parks will be firmly protected & enhanced, whilst fostering the quiet enjoyment & understanding of the Parks and the social & economic well-being of their communities in a manner which does not conflict with the conservation objectives.

2C.6 Policy 8 is to address Furness & West Cumbria's economic problems through an enhanced priority to the refurbishment of town centres, environmental improvements, new industrial site development, tourism projects and improvements in road & rail communications. Policy 9 is to improve inter-urban communications by upgrading the road network to meet economic development needs and to bring environmental benefits to bypassed towns and by encouraging the movement of passengers by bus & rail and bulk commodities by rail to reduce the environmental impact of road traffic. New road building, or significant upgrading of existing roads, affecting areas & features of international conservation importance will only be carried out in exceptional circumstances.

2C.7 According to Policy 10, the future development of tourism should normally be based on visitors' enjoyment & understanding of the County's distinctive scenic, cultural & historic character. Development will be encouraged where it will help meet a particular economic need, but will not be allowed to prejudice the County's environmental quality. To protect the intrinsic qualities of the National Parks, the growth of tourism should be restrained and future development should not conflict with their quiet enjoyment.

2C.8 SP Policies 11-29 are concerned with managing the environment. By virtue of Policy 11, development & other land use changes detrimental to the present characteristics & qualities of landscape of the National Parks (& other areas of national importance) will not normally be permitted. Particular regard will be paid to the protection & enhancement of undeveloped open countryside and, amongst other features, the character of land identified on Section 3 Conservation Maps. Development required to meet local infrastructure needs which cannot be located elsewhere will normally be permitted provided it is sited to minimise environmental impacts and meet high standards of design.

2C.9 Policy 13 deals with countryside where the landscape is not of designated national or county importance. Development will normally be permitted which in its use, siting, scale & design is well related to existing developed areas of the countryside and does not harm distinctive features of local landscape significance. In the undeveloped open countryside development will not normally be permitted except when it is required to meet local infrastructure needs, and then is subject to the same qualifications as in Policy 11.

2C.10 Outside the National Parks & AONBS in Cumbria, forests plantations & woodlands will normally be acceptable under Policy 16 where there is no material conflict with agriculture, landscape, historic features, conservation & public access, and should usually provide positive benefits to these interests. Development & other land use changes which are detrimental to important nature conservation interests will not be permitted by Policy 17 unless the harm caused to the value of those interests is clearly outweighed by the need for the development. Where development is permitted, the loss of conservation interest should, where practicable, be minimised.

2C.11 Policy 21 is not to permit development which, through emissions or by noise vibration or risk of accident, exposes workers or the public to undue hazards, nuisance, or has an effect on health, or has a significant adverse effect on the natural environment. Similarly, Policy 22 is not to permit development & other land use changes resulting in the discharge of inadequately treated sewage or effluents which have a damaging impact on water quality. Also, under Policy 24, the erection of buildings or the raising of land will not normally be

permitted where there would be a direct risk from erosion or flooding, or be likely to increase the risk of flooding elsewhere.

2C.12 Policy 25 deals with the quality of development. The siting, appearance & landscaping of all new development and alterations should aim to enhance the quality of the existing environment. It should be in keeping with the local character of the .. landscape, be well integrated with the existing pattern of surrounding land uses and, where appropriate, be in keeping with the local vernacular tradition. Normally development should make provision for access by disabled persons. Furthermore, by virtue of Policy 26, development & other land use changes will not normally be permitted if they ... damage, obscure or remove important archaeological sites or other historic features, or are detrimental to the character or setting of a Listed Building or Ancient Monument.

2C.13 The remaining SP Policies 30-70 are for the purposes of guiding development. Policy 36 provides that development will not normally be permitted where there is insufficient capacity in the service or transport infrastructure. Permission may be granted where satisfactory improvements can be made at the developer's expense.

2C.14 Nine Policies - Nos.54 to 62 - are for controlling major projects. Policy 54 relates to major developments which are more national than local in character and have significant environmental effects, and Nirex accepts that the RCF proposal falls within that description. By virtue of the Policy the RCF will only be permitted if 4 stipulated criteria are met:-

- i. the sum of national, regional & local benefits is shown to clearly outweigh any harm or risks to the wider environment, &
- ii. the proposed scheme will be carried out in such a manner as to cause the least practicable harm, &
- iii. direct & indirect adverse impacts during construction and during operation (including those from the winning & working of construction materials and their transportation) will be minimised, &
- iv. it does not harm areas or features of international or national conservation importance except where it can be demonstrated that the value of the benefits that would arise clearly outweigh the international or national value of the interest affected...

2C.15 If the site were in the National Park, criterion iv. would add a requirement for a case to be made in the national interest, and for all reasonable alternative locations & methods of satisfying the need to have been explored & shown to be unacceptable. If this new development were judged to be "concerned with the reprocessing, storage or final disposal of nuclear waste", then Policy 57 would apply, and the first criterion of that is, in the case of applications which must be accompanied by an ES, for due consideration to be given to alternative locations and for the site to be suitable for the use proposed. Six other criteria would be imposed too, relating to safety, security & environmental consequences; the existence or provision of the requisite infrastructure; the social & economic impact on West Cumbria & the National Park; location in the vicinity of the Sellafield licensed site or within

the Drigg licensed site; minimisation of harm to the visual character & amenity of the area; and the identification of acceptable principles for decommissioning & site restoration.

2C.16 With regard to the general disposal of waste, Policy 60 states that adequate sites should be provided for the disposal of wastes arising within the County. Permission will not be granted where there are adverse effects on local communities or the environment, or where the infill & restoration of existing sites would be seriously prejudiced. Under Policy 62, strict conditions will be imposed on all permissions for mineral extraction and waste disposal to ensure their full restoration to an acceptable use. A progressive scheme to restore land at the earliest opportunity will be required wherever practicable. The creation of diverse & attractive landscapes, including water areas & woodland to enhance nature conservation & recreation interest, will be favourably considered.

2C.17 Policies 63 & 70, amongst others, elaborate on the key transportation Policy 9. Policy 63 states that key routes which provide for long distance inter-urban road transport should be improved by the year 2006. The improvement of each route should be comprehensively planned & rigorously assessed against the environmental & other relevant policies in the Plan. One of the routes to be improved is described as "between the M6 and the West Cumbria and Furness areas (A590, A66, A595/A596/A5092)" [COR/303, p.59]. Whilst the Key Diagram confirms that this includes the whole of the A595(T), none of the specific schemes in the revised Schedule 2 to the Plan include the length past the appeal site. Policy 70 provides that large flows of bulk commodities and all dangerous materials should be transported by rail wherever possible in order to reduce the growth in heavy goods haulage by road and to reduce the possibility of serious damage to the environment. Steps to facilitate this should include the location of new development generating such movements on sites where this traffic can be handled by rail freight services, and the favourable consideration of proposals for interchange facilities between road & rail and for the rail freight servicing of existing industry.

### **Mid Copeland Local Plan**

2C.18 A number of the policies in this adopted Plan which were referred to at the inquiry are not land use policies, but policies which seek to influence other public agencies [COR/305, para.1.2, p.1]. They are Policies 2A, 2C, 4A, 4B, 4E, 4F & 4K. Reference was also made at the appeal inquiry to Policy 6C, which urges the Government & Nirex to identify & develop a site for the disposal of ILW as a matter of urgency, and states that Copeland will continue to resist applications to increase ILW storage capacity (at Sellafield) while there is a lack of clear commitment to such a site. However Policy 6C is now regarded as conflicting with SP Policy 57 since it fails to take forward the relevant tests [COR/305A, p.2]. Moreover the Policy does not specify that the ILW disposal site should be in the Borough.

2C.19 Another policy referred to at the inquiry but now regarded as conflicting with the new Structure Plan is Policy 6N. This is to protect Sites of Special Scientific Interest, other sites of wildlife interest and ancient woodlands from inappropriate development, but it is now stated to conflict with SP Policy 17 since that protects nature conservation interests subject to relevant tests [idem, p.3]. Paras.6.19-20 & the Proposals Map of the adopted Plan define the sites subject to Policy 6N, of which there are 4 dotted around the south-western & north-

western margins of the appeal site but none within it [cf COR/101, Fig.3.5.2 & COR/305, Proposals Map]. This approach of mapping the wildlife sites is being replaced in the emerging Local Plan by listing them in an appendix [COR/306, Appendix 7]. However the last lengths of Newmill Beck before it reaches the River Calder & the sea, about 2 km downstream from main part of the appeal site, pass through a breeding & foraging habitat of natterjack toads, a species protected by Annex IVa to the Habitats Directive 92/43/EEC [COR/101, Fig.3.5.2 again]; and the habitat is proposed to be designated a SSSI [COR/101, paras.3.5.36-45].

2C.20 Amongst land use policies still in conformity with the extant Structure Plan, Policy 6I is that new development in the rural areas will be required to have regard to traditional building design and to the use of local materials. The reasoned justification for this in para.6.15 of the Local Plan [COR/305, p.40] is that it is important that modern "anyplace" estate development or house designs are not allowed to spoil existing vernacular architecture. In addition, Policy 6J provides that the Council will normally not ... grant consent for works which would be detrimental to the character of a listed building.

2C.21 Policy 6Q is that, on land with existing trees or woodland, development will only be permitted in cases where the trees are substantially retained and will not be prejudiced by the proposed development. Under Policy 6R, the Council will protect Ancient Monuments & other important archaeological sites from inappropriate development, and further where such sites are at risk from development proposals ensure that adequate opportunities are given for recording & research.

#### **Transitional Development Control Policies**

2C.22 Policy C5 from the 1988 Joint Structure Plan is that proposals for an alternative use for redundant buildings in the countryside outside the National Parks may be favourably considered where such a use would ensure the preservation of a building of historic or architectural interest or provide premises for business use, and is capable of being provided with public utilities; and would not conflict with adjoining land uses or the character of the landscape.

2C.23 Despite being retained, 1988 Policy C20 is in fact similar to that part of the current SP Policy 26 which relates to the character or setting of listed buildings. 1988 Policy F4 has affinities with the statutory Local Plan Policy 6Q in that it provides for development & other change which involves the clearance of semi-natural or amenity woodland or important trees normally to be resisted unless there is no significant loss to landscape, amenity & nature conservation interests.

2C.24 Retained Policy M1 sets out 10 criteria as the basis on which proposals for the extraction of minerals will be assessed. These relate to landscape impact; local community impact; employment potential; ecological or historic features; impact on the road network; agricultural land or productivity; local, regional or national need; progressive restoration; removal of past dereliction; and the prospect of beneficial after-use. Retained Policy P6 sets out 5 considerations on proposals for the use of land for solid waste disposal, which are similar in some respects to those in Policy M1.

2C.25 Retained Policy T17 normally expects adequate provision for car parking to be included in new development proposals. It anticipates the adoption of car parking guidelines to assist developers, albeit that the application of the guidelines may be specifically withheld in certain areas. Under Policy T21, new development likely to generate substantial traffic movements will not be permitted in locations which would increase flows through mainly residential & other environmentally sensitive areas.

### **Emerging Copeland Local Plan**

2C.26 The appeal site is outside any town or village development limits defined on the Proposals Map. Part of Policy DEV 1, as recommended to be modified, is that development will not normally be permitted beyond these limits unless the proposals are in accordance with other local plan policies. Seven sets of such policies are then listed. The modified 6th set would be development for service infrastructure, energy or in relation to the nuclear industry (including ENV 33) [COR/307, Change No.241 & COR/307A, R.2.8.B, p.8].

2C.27 The reference to emerging Policy ENV 33 in this 6th set is because it is the key policy relating to the RCF proposal. As recommended to be modified, Policy ENV 33 now provides [COR/307A, R.10.20.E, pp.70-1] that the Council will support the proposal for a RCF at Longlands Farm, Gosforth so long as the following criteria are satisfied:-

1. The proposal is framed by reference to a national radioactive waste management strategy and justified in relation to the need to establish the geology & groundwater flows in the vicinity of the proposed repository site, bearing in mind the Council's fundamental requirement that safety is paramount.
2. The proposal demonstrates at this stage that further investigations of the suitability of the Sellafield site for an ultimate repository via the RCF are justified.
3. The application demonstrates how the RCF fits into the overall research programme and contributes to the development of the safety case.
4. The non-nuclear environmental impact is acceptable, including impact in relation to landscape, nature conservation & traffic generation. The proposal should comply with the provisions of Policy DEV 4.
5. The requirements of Policy IMP 1 are met.
6. There is provision for the site of the RCF to be eventually restored to agriculture subject to any safety requirements dictated by the operation of the repository (if approved).

2C.28 The recommended Policy DEV 4 [COR/307, Change No.73 & COR/307A, R.2.1.A, p.2] referred to in ENV 33.4 above is that the Council is committed to the principles of sustainable development outlined in the Development Strategy. In dealing with all proposals for development it will have regard to the long-term effects on the Borough's environmental,

social & economic resources so as not to prejudice their use & enjoyment by future generations. A number of other LP policies are then listed as being particularly important in this regard.

2C.29 The recommended wording of Policy IMP 1 [COR/307A, R.3.1, p.13], referred to in its turn in ENV 33.5 above, is that in considering proposals for development the Council will seek to overcome planning objections by entering into a legal agreement with the applicant, usually under Section 106 of the Town & Country Planning Act 1990, where these objections cannot be overcome by the use of planning conditions. In the case of proposals for major development, where there is shown to be a significant adverse social or economic cost or effect which arises directly from the development concerned, then the Council would expect an agreement to address this cost or effect. Provision secured by such an agreement should be commensurate with the scale & nature of the individual development. In particular where a proposal is shown to discourage investment in the area by prospective employers or to discourage the development of tourism then mitigation of these effects would be sought through a planning obligation to assist in measures which would positively encourage investment.

2C.30 Policy DEV 3, as recommended to be modified [COR/307, Change No.139 & COR/307A, R.2.9, p.10], provides that in determining proposals for new development the Council will normally expect a high quality of building design & layouts which respects the character of the surrounding area and helps contribute to a strong sense of place. The Council will, therefore, require 8 particular principles to be applied to the design & layout of all new developments where relevant. The first of these principles is careful attention to building scale, height, bulk, proportion, roof shape, & external materials. Related design policies are SVC 6, that all services within new development areas should normally be sited underground; and ENV 6, requiring details sympathetic to the particular character of Landscapes of County Importance. The 4th principle of DEV 3 is the incorporation and, wherever possible, enhancement of existing landscape features and sites of geological & wildlife interest within layouts and their protection during construction works. The 6th principle requires compliance with Policies TSP 5-8, amongst others, as regards access, the needs of pedestrians, disabled people and cyclists, and car parking/manoeuvring space.

2C.31 In relation to that group of TSP policies, TSP 5 requires new development proposals to incorporate satisfactory standards of access to existing highways: TSP 6 normally permits such proposals which are likely to generate significant traffic volumes particularly involving the regular movement of HGVs only where the site has direct access to an appropriate standard of road and/or where the applicant undertakes to improve highway conditions along agreed routes: TSP 7 expects proposals to take into account the needs of pedestrians, disabled people & cyclists and emergency vehicles in the design & layout of buildings & facilities on site: and TSP 8 requires compliance with car & lorry parking standards.

2C.32 Another transportation policy referred to at the inquiry is TSP 2, which is to actively seek essential improvements to the A595(T) including a bypass scheme at Calder Bridge (for environmental, safety & economic reasons). But that Policy has been recommended for deletion from the Plan because it is matter of influencing other public agencies [COR/307A, R.6.2, p.38]. The final transportation policy relied on in representations to the inquiry is TSP 13, which as recommended to be modified [COR/307, Change No.157 & COR/307A,



R.6.7, p.40] is to support the transfer of freight traffic to the railway, and that proposals for new development likely to have high rail-dependency will normally be approved subject to other policies in the Plan.

2C.33 Also regarded by some as relevant are Policies EMP 11, the first part of which is that new large scale employment related developments outside established employment areas and those designated by Policies EMP 1 & 2 will not normally be permitted; and EMP 17, which relates to the conversion of buildings to employment use in rural areas, subject to certain criteria [COR/307, Changes Nos.111 & 230 & COR/307A, R.5.8, p.35].

2C.34 Emerging Policy SVC 1, to which there has been no objection, is that all development must incorporate an adequate means of sewage disposal which will not have a detrimental effect on ... the environment. Proposals for development will not normally be permitted where it would be likely to increase the risk of downstream flooding, damage ecological habitats or watercourse stability, prejudice water quality in watercourses, underground strata or along the coast... Where these objections can otherwise be met by suitably designed attenuation or mitigation measures or by other mitigation measures which the developer is willing to undertake or pay for then the Council may be prepared to grant permission in association with an agreement under Section 106 of the Town & Country Planning Act 1990. Similarly Policy SVC 5 as proposed to be changed [COR/307, Change No.253] requires proposals for sites in excess of 0.4 ha to be accompanied by details of all land drainage arrangements, which must be designed so as to ensure that there is no deleterious effect on adjoining occupiers of land, important wildlife habitats or watercourses in the vicinity.

2C.35 A number of LP Environment Policies have been cited in addition to ENV 33. The recommended wording of Policy ENV 1 [COR/301, p.16 & COR/307A, R.10.2, p.58] is now to afford protection to sites of international nature conservation importance in line with the Habitats Directive 92/43/EEC, whereas it is the recommended Policy ENV 2 which relates to sites of national nature conservation importance. The recommended Policy ENV 4 [COR/301, p.17 & COR/307A, R.10.4-5, p.59] will permit development leading to a loss or significant alteration to a locally important nature conservation site, or adversely affecting the continuity & integrity of certain landscape features, only where it can be demonstrated that there are sound reasons for the development which clearly outweigh the need to safeguard the intrinsic nature conservation value. The landscape features in question are heath, woodland, hedgerow, unimproved pasture, marsh, ponds, green lanes, wetland, coastal habitat systems & river corridors. Where development is permitted, the retention of wildlife habitats, their enhancement or creation of new habitats, if feasible, will be secured through planning conditions or agreements. Furthermore, the recommended Policy ENV 5 [COR/301, p.17 & COR/307A, R.10.6, p.60] will not permit development which would have an adverse effect upon the conservation interest of any site supporting species protected by law.

2C.36 The recommended wording of ENV 11 [COR/301, p.17 & COR/307A, R.10.10, p.62] is to support proposals for new tree planting, particularly using native species, subject to the form & extent of any scheme respecting the landform, and subject to the restrictions in ENV 4. Under ENV 13, a landscaping scheme will normally be required as a condition of any approval for new development, and this will be expected to show the retention of existing landscape features.

2C.37 The first part of Policy ENV 14 is to protect existing rights of way from development at the planning stage. According to Policy ENV 15 as recommended to be modified [COR/307, Change No.196 & COR/307A, R.10.12, p.63] development will not be permitted where it is at risk from flooding or is likely to increase the risk of flooding elsewhere. This prohibition includes, amongst other things, extensive culverting. Proposals should not cause interference to or loss of access to a watercourse.

2C.38 Emerging Policy ENV 23 is that, when consulted on proposals for the disposal of inert waste, the Council will support them where there is no adverse impact on landscape or nature conservation interests, and where there is good access from the main road network, and where satisfactory arrangements are made for subsequent landscaping & after-use. Again, under ENV 27, support will be given to the development of facilities necessary either for the implementation of the development policies of the Plan or which are necessary to enable water & sewerage undertakers to meet statutory obligation & environmental standards as established by the Government & the European Commission.

2C.39 The now recommended wording of Policy ENV 26 [COR/307, Change No.206 & COR/307A, R.10.17, p.65] includes seeking to minimise harmful or offensive aerial discharges in dealing with new development. Similarly Policy ENV 29 is not to permit development likely to generate unacceptable levels of noise unless it can be reduced to acceptable levels by soundproofing measures or by controlling hours of operation or methods of working.

2C.40 Emerging Policy ENV 49 is normally only to approve applications for development affecting the setting of a Listed Building when there is no significant adverse impact on the Listed Building. Policy ENV 50 applies similarly to Scheduled Ancient Monuments.

2C.41 Policies ENV 51 & 52 effectively elaborate on the archaeological aspects of SP Policy 26, in line with PPG 16. Under ENV 51, the Council will seek to minimise the effect of proposals for new development on any site of local archaeological or historic importance. Where proposals are likely to affect such sites, 5 sets of requirements may come into play. An initial assessment of the archaeological value will be required as part of the planning application: if further warranted, a full archaeological field evaluation will be required before a decision is made: the statutory protection & permanent in situ preservation of any nationally important remains before development commences will be sought: the permanent in situ preservation of locally important remains by agreement will also be sought: and where such in situ preservation is not appropriate full investigations & recording will be required. Policy ENV 52 makes it clear that an initial site assessment may be required even where chance finds or developing archaeological knowledge merely indicate possible archaeological importance.

#### **Other Plans**

2C.42 The Lake District National Park Plan is not a statutory development plan, and is a management plan prepared under the Local Government Act 1972, but currently contains long standing development control policies. Paragraph 2.12(a) of the Plan states that the individual character of the landscape of the different areas of the Park will be protected. The Conservation Map delineates some "mountain, moor & heath" on the foothills to the north-

east & south east of the appeal site [COR/308, Ca.9 & CCC/3/1, Fig.2], whilst the Ravenglass Estuary to the south is defined as a coastal feature. Most of the Park's western foothills, including this delineated mountain, moor & heath, are defined as part of the Quieter Areas in the deposited Lake District National Park Local Plan [COR/309, Proposals Map & CCC/3/1, Fig.2]. Emerging Policy NE 5 is that development will not normally be permitted where harm to the character & appearance of the Quieter Areas would result by reason of:... (c) visual intrusion, noise or other forms of disturbance [COR/309, p.10].

2C.43 Appendix I to the Consultation Draft of the Cumbria Minerals & Waste Local Plan (excluding the National Parks) [COR/311] constitutes a position statement by Cumbria on radioactive waste. Although it is partly out of date because it was written before the White Papers Cm 2860 & 2919 were published, it makes it clear that County Council policy for the time being on nuclear waste processing & disposal is contained entirely within SP Policy 57 [COR/311, eg p.83]. However, Draft Policy 43 would grant planning permission for mineral exploration provided that there are no significant adverse effects on local communities or the environment [idem, p.56]: and Draft Policy 51 would permit landfill sites for the disposal of inert waste arising from major construction projects provided the site is adjacent to the project and there are net environmental, economic & social benefits compared with disposing of the wastes at existing sites [idem, p.66].

### 3A. NATURE OF PROJECT & RELEVANCE OF REPOSITORY

*The Irish Government's representations to the inquiry are without prejudice to its rights to pursue its case through other channels. That Government, and NSCNFLA & FOLD, have registered formal complaints with the European Commission on this & related matters. It should also be noted that submissions similar to some of those summarised in this Chapter 3A have been made by other parties, but they relate more directly to policy than to law and so are reported in subsequent chapters, especially Chapters 4A & B.*

**3A.1 The Irish Government, Patricia McKenna MEP & Mr J Fitzsimons MEP, NSCNFLA, FOLD, Mr S Balogh & Ms J Sutcliffe and some written representations** submit that the RCF proposal is inseparable from the DWR proposal in practice, and thus in law: the RCF is seen as an integral stage of the DWR project. The RCF is not a generic research facility; and its site has been chosen precisely so as to characterise the preferred location of the DWR, and to help design the repository & obtain detailed regulatory approvals for its operation. Nirex has been working on the concept of a repository at Sellafield since 1991 [COR/206, pp.4 & 5]; and is assuming that the RCF shafts might be used for DWR construction access, and would probably be utilised for DWR ventilation & in emergencies.

3A.2 The estimated costs of the RCF construction & science programme at 1995 prices excluding interest & inflation are £195M [NRX/12/16, following up Table 4.1 of NRX/12/18], and other Sellafield-specific costs on the same basis are forecast at £(543-195=)348M [NRX/12/18, Table 4.2] by the time of the end of the RCF. This would result in a very high level of commitment to the construction of a DWR at this location. If the PRZ were shown to be capable of holding radioactive waste and the pertinent planning criteria were met, it is difficult to conceive of a disposition to seek another site. UK Government policy is that, once a suitable site is found, the DWR should be constructed as soon as reasonably practicable [GOV/208, para.101]. It is significant that no other RCFs are being proposed anywhere else in the UK, and that there have not even been preliminary studies elsewhere of comparable detail to those at Sellafield. Although the process of developing a DWR here would be discontinued if the RCF were to encounter a problem which Nirex does not expect, that cannot detract from the points that the PRZ is the preferred location and the RCF is a confirmative exercise.

3A.3 It is inevitable that, at the stage of applying for permission for the DWR, Nirex would invoke as a material economic consideration the costs of the RCF & related work. There is also the fact of the PRZ's proximity to the UK's largest source of radioactive waste at the Sellafield Works. The continuity of the programme for a DWR at Sellafield is the fundamental substance of the matter; and the formal insistence on dividing the planning procedure into 2 stages by labelling the RCF as merely investigatory cannot legally be allowed to override the reality of this situation. The appeal site is the potential repository zone, not just a hypothetical repository zone. The actual project in this instance is arguably not merely "deep drilling" but an "installation solely designed for the permanent storage or final disposal of radioactive waste" in the terms of Annex I(3) of Directive 85/337/EEC & Schedule 1(1)(3) of UK Regulations SI 1988:1199 respectively (albeit the words "solely" & "designed" are transposed in the latter).

3A.4 For the purposes of the Directive, "project" means the execution of construction works or of other installations or schemes, & other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources [Article 1(1)]. The UK Regulations use as its equivalent the word "development," with the meaning which that expression has under the Town & Country Planning Acts [Regulation 2(1)]. However, there is of course a principle of EU law that domestic legislation which implements EU measures should be interpreted so as to conform with the relevant European legislation.

3A.5 As to the interpretation of "project", the Advocate General's Opinion delivered on 3 May 1994 to the ECJ in Bad Naturshutz in Bayern eV, Richard Stahnsdorf & Others v Freistaat Bayern Case C-396/92 expressed the view that the purpose of the Directive should not be lost ... by a definition that is over-strict or otherwise inappropriate .. of the projects in respect of which application must be made....The important question is..whether ..there is an obligation to take account of the fact that the project forms part of a larger project, which is to be carried out subsequently, and..the extent to which account is to be taken of that fact. Given the purpose of the Directive to take effects on the environment into account at the earliest possible stage in all the technical planning & decision-making processes [Preamble], the Advocate General went on to advise that as far as practically possible account should also be taken in the assessment of any current plans to extend the specific project in hand.

3A.6 In relation to the UK, the European Commission has, in formal correspondence with the CPRE & the UK Government on the Wilton Power Station & its transmission lines and the Channel Tunnel Rail Link & its London terminal respectively, expressed views very similar to the Advocate General's opinion. The argument that the assessment of a smaller development must cover the environmental effects of a future, larger development likely to follow in its wake was accepted obiter by Simon Brown J in R v Swale Borough Council & Medway Ports Authority, ex parte RSPB [1991] JPL 39, at pp.47-8, and by Macpherson J in R v Secretary of State for Transport, ex parte Surrey County Council 24 November 1993 (unreported CO 2929/93). The fundamental importance of taking the environmental effects into account at the earliest possible stage has been agreed by McCullough J in Twyford Parish Council & Others v Secretary of State for the Environment [1992] 1 CMLR 276 & by Potts J in R v Secretary of State for the Environment, ex parte Greenpeace [1994] 4 All ER 352. Lack of certainty that the future development would proceed obviously cannot of itself preclude the obligation, since some degree of uncertainty must always exist.

3A.7 Moreover, the significant environmental effects of the RCF which must be assessed by virtue of Articles 1(1) & 3 of the Directive & Schedule 3(2) of the UK Regulations include "indirect" effects, and also by virtue of Annex III Note (1) & Schedule 3(3) respectively include "secondary", "cumulative" & "long-term" effects. For the RCF these must include the effects associated with the DWR. Nirex concedes that it is material to consider both the rationality of the site selection procedure which led to the investigation of Sellafield as a potential repository site, and the sufficiency of the "promise" of the site for a repository inasmuch as there may be planning objections to the RCF proposal. Whilst Article 5(1) stipulates both that the information be relevant to this stage of the consent procedure & to the specific characteristics of the project and that it be reasonable to require the developer to compile the information, nevertheless some information plainly exists in this instance because Nirex has broadly assessed some of the environmental effects of the

repository in the course of both its site selection process and its Sellafield confirmation exercise to date.

3A.8 In the UK the appropriate consent procedure must be the land use planning process, as the one which entitles the developer to proceed with the project [Article 1(2) of the Directive], rather than the regulatory approvals which are no longer concerned with site selection. If such an existing UK procedure cannot completely fulfil the aims of the Directive, then another procedure must be established to attain such compliance [Article 2(2)]. To delay the production of the relevant information which Nirex has already compiled until the planning application for the DWR is made would be to fail to take the environmental effects into account at the earliest possible stage, contrary to the Directive; and it would conflict with the high priority consistently given by the EEC to the preventive protection of the environment, and the principle of effectiveness. The suggestion is not, however, that there should straightaway be a fully detailed assessment of the environmental impact of the potential DWR at Sellafield. All that is necessary at this juncture to satisfy Article 5 is broadly the level of environmental impact information requisite for the identification or rejection of candidate DWR sites.

3A.9 Cumbria adds that the potential length of the RCF & other Sellafield-specific work from 1989 to 2009 would also make it extremely difficult for Nirex to start again somewhere else. Setting aside the claim that the RCF is part of the DWR project, nevertheless at the end of a very lengthy & costly investigation process the approach of planners towards the issue of the location of the DWR would be necessarily affected by what had gone before. Much of the science is novel; and the overall programme is taking much longer than expected in 1988-1991. Yet Nirex is already asserting that scientific comparisons cannot be made with other sites because so much more is known about this one than any other.

3A.10 It is wholly appropriate, and in accordance with both the advice in PPG23 and the judgement of the Court of Appeal in Gateshead MBC v Secretary of State for the Environment & Northumbrian Water Group plc [1995] JPL 432, for the planning system to seek to control the location of a development which has safety implications. In reality, it would be far too late to examine the relative safety of the location of the repository for the first time at the repository inquiry. It is not something which can be left to the regulators, for site selection is no longer their concern at any stage; and at present there is no formal regulatory regime at all.

3A.11 Nirex responds [including COR/101B] to all the submissions by pointing out that its work on the DWR is following a contingent, staged programme. As part of that programme, the function of the RCF would be to carry out searches & tests of the BVG near Sellafield. This would be similar to oil & gas exploration work, the planning merits of which are considered without regard to any hypothetical future development. A decision has not yet been made whether to proceed with a DWR at Sellafield, and would not be made earlier than about halfway through Phase 1 of the RCF. Although it was originally envisaged that such searches & tests could be carried out after planning permission had been granted for the DWR, it was concluded in 1992 that firmer interpretations of the hydrogeology were needed before a successful application could be made, and so the RCF was clearly separated from the DWR development as a discrete stage in the contingent programme. It now constitutes

preparatory investigation for the DWR project, and not part of that project itself. Neither the scientific necessity to site the RCF at the putative best DWR location nor the prudent avoidance of duplication of shafts & galleries can be regarded as reversing this severance.

3A.12 The estimated RCF costs of £195M excluding interest & inflation are only about 11% of the total development & construction costs on the same basis for a DWR commissioned at Sellafield in 2012 [NRX/12/16 & NRX/12/18, Table 4.1]. Also projected RCF costs represent merely about 13.6% of projected expenditure from 1 April 1995 to first waste emplacement. This relatively low proportion of expenditure cannot constitute any degree of commitment to an eventual repository at Sellafield, since Nirex would not persist with this site if it were shown at any time to have insufficient promise: and other options might have to be pursued in any event because of the emergence of intractable practical problems at Sellafield such as excessive cost or intolerable working conditions. RCFs cannot be proposed elsewhere in the UK for the very reason that insufficient preliminary work has been done to support them. Nirex's reasons for gradually concentrating on Sellafield have been well publicised, and endorsed at each stage by the UK Government. On the other hand, granting permission for the RCF could not conceivably commit the authorities themselves to permitting a subsequent repository development, since the applications would raise quite different issues.

3A.13 The RCF is itself a project within the definition of Article 1(1) of the Directive. It cannot be part of an installation solely designed for the final disposal of radioactive waste, since the description of the development does not entail the emplacement of any radioactive waste at all. The opposing parties have effectively recognised the weakness of their submissions on this point by suggesting without corroboration that the meaning of "project" in the Directive is ambiguous. All the actual cases in respect of which they cite legal opinions concerned the segmentation of overall projects such as roads, and not an investigatory project prior to a possible construction scheme as in this appeal. Moreover they have not referred to any authoritative, binding judgements in support of their arguments.

3A.14 In any event, it is a fundamental error, in Nirex's judgement, to argue that the effects of a repository would be the indirect effects of an RCF. Implementing a permission for an RCF would not enable the development of a DWR to take place, for that would require its own planning permission as well as authorisations from the regulators. It must follow that the effects of a repository are not part of the effects of an RCF, indirect or otherwise.

3A.15 The repository project itself is relevant to the determination of the RCF application only in the course of either considering the rationality of the preliminary site selection or applying a robust test of the sufficiency of the promise of the preferred site. In terms of Article 5(1)(a) of the Directive, information about the environmental effects of a possible DWR is not relevant to this stage of the consent procedure, which is concerned solely with permission to obtain data on the geological & hydrogeological characteristics of the BVG & overlying strata at Longlands Farm. This is not an inquiry into applications for permission & authorisations for a DWR, nor into the environmental effects or safety of a repository at Sellafield, nor into an alternative site for a repository. For example, the post-closure radiological safety information is preliminary & incomplete because of the very lack of information from an RCF. The earliest stage in the consent procedure at which that could be supplied would be on the application for planning permission for a DWR, accompanied by a PCSR & a DSA. Even then, radiological safety would be for the regulators and not the

planning authorities; but that would be the obvious stage at which to consider the environmental effects of the repository, in accordance with SP Policy 57.

3A.16 Similarly it would be unreasonable in terms of Article 5(1)(b) to require Nirex to compile such information at this stage. The planning authorities cannot have the benefit of the expert comments of the regulators on the selection of the PRZ until the latter make their contribution to the repository inquiry. The current conceptual design process at Sellafield is not generating any environmental information. Assessing at this stage the environmental effects of a repository at alternative sites is out of the question. According to the other side's own argument, such effects would be relevant only as the indirect effects of the RCF, and yet there is no alternative proposal for an RCF, either at Sellafield or elsewhere.

3A.2  
3A.12  
3A.17 My opinions on this set of legal issues are preceded by noting that further judicial pronouncements after the close of the inquiry may have a bearing on them. Subject to any such judgements, I consider that the question of the kind of commitment to the DWR which is represented by the RCF must essentially be one of degree. This degree would inevitably vary over time due to various factors, not all of which would be under the developer's control. Therefore consideration of the kind of commitment involved may well be relevant to the planning merits, but will not of itself resolve the legal arguments, in my view.

3A.11  
2B.15  
2B.16  
3A.18 However, the basic fact is that the RCF would constitute a crucial examination of the potential of this location for a DWR. There is obviously an intrinsic physical link between the RCF and the DWR, and this cannot be ignored just because the RCF might be wound up without being followed by a DWR. On the hydrocarbon analogy suggested by Nirex, the RCF would be much more akin to an appraisal well than an exploration well - hence the relevance of the long-term suitability of the site. The RCF's Phase 1 would certainly be confirmative work preparing for a particular DWR as generally agreed, but Phases 2 & 3 could well be part of the design enterprise. They would include applied experiments as well as rock tests. I consider that the High Court would be bound to hold that such links constitute a substantial land use connection, as a simple matter of UK domestic law.

1.2  
2B.6  
3A.19 In the European context, the first question raised by the debate over the transposition of the Directive's concept of "project" into "development" as defined by UK planning law is whether the development described in the current application would comprise a project in its own right. In my opinion it would not be a discrete project, for a reason which seems plain to me although not explicitly put in the submissions. This is that the RCF development could only be utilised in conjunction with the RCF, RCM & PRZ boreholes which have already been permitted. Thus it would be the development plus at least those local boreholes which would constitute the core of the RCF project. This suggests that an assessment of the inter-relationship of developments may need to look back as well as forward.

2B.5  
3A.20 More generally, I respectfully agree with the cited judicial indications, despite their not being binding precedents, that one project can be part of another project. Projects need not be mutually exclusive; and a "contingent programme" could itself be a "project". In this case, at the basic level there is clearly a series of overlapping projects. Looking back in the Sellafield context, there is a functional overlap between the regional boreholes and the cluster of local boreholes which are part of the RCF project. Then looking forward to the desired



progress with the RCF, Phase 1 would be primarily the last part of the confirmative project, whereas Phases 2 & 3 would be primarily parts of the design stage of the DWR project.

2B.3  
2B.1 3A.21 I consider that the overlapping nature of this series of projects constitutes another land use relationship which cannot be ignored as a matter of law. The RCF project may be more striking than previous developments in this series because of its larger scale. But the DWR, of which the RCF is hoped to be the precursor, would be larger still. Therefore the relative size of the RCF would not introduce discontinuity into the series, but instead would tend to confirm the appositeness to this situation of the judicial dicta. Those dicta necessarily imply that the language of the Directive & Regulations can be construed so as to take some of the environmental effects of the larger overall project into account.

3A.22 The phrase most obviously appropriate to such an interpretation is "indirect effects". In terms of meaning, a subsequent development or project could indeed be an intermediary through which the original development might have an indirect environmental effect. Of course any specific effect would have to be identified in every particular instance. But I cannot see that the domestic legal requirement to obtain separate approvals for the subsequent development necessarily precludes that development from being such an intermediary. It was this very type of situation, of a series of consents, that the judicial dicta addressed.

3A.18 3A.23 In my view there would be 2 main indirect relationships. The RCF could confirm the potential location of the DWR, which would have some obvious environmental effects if constructed: and the RCF & DWR might have appreciable combined impacts on particular environmental features. The potential relevance is not further limited, in my judgement, by some rule of UK law on materiality. Given the obvious land use connection between the DWR and the RCF, the law cannot pick & choose some RCF planning issues as the only ones to which the DWR can be material. To do that would be to introduce a legal test of necessity, which the Courts have expressly eschewed in questions of materiality; and so it would blur the distinction between such legal issues of materiality and the planning judgements as to the weight to be given to the various considerations. Whilst there might be a final conclusion on the merits that the only RCF planning issue really affected by the DWR is that of site suitability, there cannot be a legal short cut to that conclusion which arbitrarily ignores the potential DWR in the evaluation of every other RCF planning issue.

3A.19  
2B.16  
3A.15  
3A.19  
3A.7  
3A.1 3A.24 Thus the relationship between the RCF and the DWR is relevant as a matter of UK law to this stage of the consent procedure, namely the planning application for permission to develop the main part of the RCF project. The specific characteristics of this development are not merely the collection of geological & hydrogeological data to prepare a DSR & PCSR for the regulators: they include the subsequent evaluation of that data for DWR design purposes. The fact that some environmental information cannot be compiled yet is not a reason for failing to bring forward that which can be compiled now. The earliest possible stage for taking the RCF's environmental effects into account has already passed, for that was when the application for the borehole part of the RCF project was considered; and there should be no further delay. It is plain from the evidence to the inquiry that work has already been done both on the environmental effects of a DWR and on designing a DWR at this location. Therefore I consider that it would be reasonable to require some broad assessment of prospective effects of the DWR. Whether that should include alternatives is discussed in the next Chapter.

### **3B. ALTERNATIVES & AVAILABILITY OF INFORMATION**

**3B.1 Cumbria, Copeland, the Irish Government, Patricia McKenna MEP & Mr J Fitzsimons MEP, Greenpeace, NSCNFLA, FOLD & Ms J Sutcliffe and some written representations** submit that, on the basis of facts already agreed by Nirex, alternative sites for the DWR must as a matter of law be considered in connection with the RCF application, and that Nirex must supply & summarise more information about these alternatives than it has done so far. Some of them emphasise Nirex's acknowledgement that any proposed DWR must now be preceded by an RCF or similar investigation as a matter of good practice. There is thus a generic link between alternative sites for an RCF and alternative sites for a DWR, as well as the specific intrinsic link between this RCF and the overall DWR project.

**3B.2** Annex III(2) of Directive 85/337/EEC specifies as part of the information to be supplied by the developer, inasmuch as it is relevant and its compilation may reasonably be required, "Where appropriate, an outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking into account the environmental effects". Whilst the phrase "where appropriate" introduces an element of discretion, it is essential to understand that there are limits to the exercise of that discretion.

**3B.3** The leading English court judgements on the relevance of alternative sites, such as those referred to in para.3.15 of PPG23, were made before the Directive came into force. Moreover, although a number of propositions were formulated in such judgements, they were expressly stated not to be exhaustive. The basic points must be that the existence of alternative sites is capable of being a material planning consideration: and that, in combination with safety as another consideration, the existence of a safer alternative site for this potentially hazardous development must be a proper ground for refusing planning permission. There is no rule of law that radiological safety in particular is not a material consideration.

**3B.4** The first & last of Oliver LJ's 4 indicative criteria of the appropriateness of site comparability, set out in Greater London Council v Secretary of State for the Environment & LDDC (1985) 52 P&CR 158, at p.172, would be met, in that there is a clear public advantage in the RCF proposals, but there could only ever be a very limited number of permissions for an RCF. A predicted failure by the proposed DWR site to meet the risk target would be an adverse effect as required by the 2nd criterion, whereas an alternative site predicted to meet the target would not have that effect & so meet the 3rd criterion. SP Policy 57 would in any event require due consideration to be given to alternative locations at the repository inquiry, and expediency indicates that such matters should be examined now.

**3B.5** Looking next at the examination of alternatives in the international context, the practice is at the heart of environmental impact assessment in the latter's birthplace, the USA. Also the Rio Declaration & Agenda 21 call for such assessment to extend beyond the project level to policies & programmes (eg Agenda, para.8.5(b)). Taking assessments beyond the project level in this way must involve consideration of the possible alternatives to any specific project within the policy or programme in question. Yet these higher order assessments are seen as integral parts of the strategies towards sustainable development to which both the EU & the UK have formally subscribed.

3B.6 Moreover, Article 7 of Directive 85/337/EEC requires the environmental information to be supplied to a neighbouring Member State when there are likely to be significant transboundary effects: and Appendix II of the Espoo Convention requires an assessment with such effects to include a description, where appropriate, of reasonable alternatives (eg locational or technological) to the proposed activity and also the no-action alternative. The language of the Directive and of the UK Regulations does not expressly confine "alternatives" to alternative sites, and so generally other basic options should indeed be considered too. Given the inextricable link between the choice of location for the RCF and the suitability of a site for a DWR, the relevant alternatives in this case include repository options & alternative disposal processes. Neither the Directive nor the Regulations exempt consideration of alternatives just because they have been discarded as a matter of Government policy. No exceptional exemption of this project in whole or in part from the provisions of the Directive has been made by the UK Government under Article 2(3).

3B.7 In the particular field of radiological protection, the provisions of Articles 6(a) & (b) and 13 of the amended Directive 80/836/Euratom, as reflected in the Court judgements of EC Commission v Belgium [1992] 2 CMLR 22 & the Greenpeace case (already cited 3A.6 above), require both prior justification of an activity involving exposure to ionising radiation and optimisation of protection. Neither of these requirements can be met if alternatives are not expressly considered.

3B.8 With regard to the relevance & reasonableness requirements under Article 5(1) of Directive 85/337/EEC, the UK Government, in for example para.3.16 of PPG 23, regards an outline discussion of main alternatives as normally requisite in an ES. The work programme which has led Nirex to make the application for the RCF has necessarily entailed consideration of alternative processes and sites at earlier stages of the programme. If this consideration had not taken place, the RCF application itself would not have been made. So logically it must be relevant and reasonable to obtain information on those alternatives now. The Directive requires them to be taken into account at the earliest possible stage in all the technical planning & decision-making processes. The supply of the information cannot lawfully be delayed until the time of the full repository inquiry, with the attendant risks of the information becoming either stale, lost or rationalised to fit subsequent events.

3B.9 Due partly to the manner in which the Directive's requirements have been transposed in the Regulations, there appears to be a legal view that the supply of information on alternatives in an ES is entirely within the developer's discretion. Indeed this view seems to be implicit in some UK Government publications. However, the obligations imposed by the Directive are not directly on developers but on Member States, with an overriding obligation under Article 2 to adopt all measures necessary to ensure that projects likely to have significant environmental effects are subjected to an assessment. It follows that any discretion under the Directive is to be exercised by or on behalf of the State, and not the developer. Moreover, it must be exercised in accordance with the spirit of the Directive. The proposed removal of the discretion by Article 1(7) of the Agreed Common Position on Amendments to the Directive [GOV/139, p.6, substitute Article 5(3)] does not imply that at present the discretion can be exercised arbitrarily.

3B.10 A closer reading of the UK Regulations results in a similar interpretation. Although information on the main alternatives is specified in Schedule 3(3)(d) only as further

information which an ES "may" include by way of explanation or amplification, Regulation 21 empowers the relevant authorities to require any further information mentioned in Schedule 3(3) so long as the developer could provide it and it is reasonably required.

3B.11 In this instance Cumbria as the local planning authority required by letter of 3 October 1994 [COR/104, Appendix D, p.93] additional detailed material concerning the reasoning for Nirex's decision to focus attention on Sellafield, in accordance with Regulation 21 (albeit there was an erroneous reference to para.2(d) of Schedule 3, instead of para.3(d)). Passages in the letter made it clear that Cumbria was concerned particularly about other locations nationally which may provide a better prospect of limiting radiological risk, including a comparative investigation of a true BUSC (basement under sedimentary cover) site. As an emanation of the UK State, Cumbria thus exercised the discretion under the Directive to decide that the supply of information on alternatives was appropriate. It is now too late to mount a High Court challenge against the validity of that exercise of discretion.

3B.12 Nirex's reply of 22 November [idem, p.95 & COR/101A] expressly acknowledged that Cumbria's request was made under Regulation 21, even though it did not accept that the requirement was material or proper. The reply was received on 23 November, and was copied to all consultees, being treated as submitted in response to the formal request [COR/104, para.5.3.12], in time for the Extraordinary Council Meeting which determined the application on 20 December. The 5th Reason for Refusal stated that Cumbria was not satisfied that a rational basis for focusing detailed investigation solely on Sellafield had been demonstrated. Para.3.3.2 of Cumbria's Statement of Case gave notice that the authority would continue to argue for full presentation & release of the site selection exercise documentation. Thus it was made clear that the local planning authority maintained the view that the further information supplied on alternatives had been inadequate.

3B.13 If adequate information on alternatives is not supplied, it is not possible to grasp fully the baselines from which environmental impact is being measured or mitigation assessed. Planning permission should not be granted for the RCF until after these deficiencies have been made good. The adjoining Lake District National Park is a very significant environmental feature obviously at risk of adverse impacts from the development of the appeal site. Sufficient information should, for example, be provided about alternative sites to enable comparisons to be made with the significance of the features at risk near those. Also, because of the intrinsic link between them, the impacts to be considered are those of the DWR as well as of the RCF. Moreover, the comparison obviously cannot be confined to non-radiological impacts, since the most fundamental assessment is of the prospects of limiting radiological risk.

3B.14 So far as disclosure is concerned, the balance of the public interest must lie in identifying the main alternative locations which have been studied by Nirex, rather than in declining to name them because of the disquiet this would cause amongst local people. This was the conclusion of the Rossi Committee [GOV/304, paras.235-9] and of the majority of the RWMAC/ACSNI Study Group [GOV/409, Chapter 6]. No limitation under Article 10 of the Directive has been suggested to this inquiry; and no direction has been made under Section 321 of the Town & Country Planning Act 1990. Risks of causing alarm & controversy are not accepted as reasons for withholding information in, for example, publicising alternative routes for trunk road schemes.

3B.15 Before planning permission can be granted for the RCF, information about the alternative sites must be supplied in a form which is comprehensible to the relevant authorities & to the public concerned and which makes Nirex's decision-making processes transparent, so as to comply with Articles 6 & 7 of the Directive & enable the public, the responsible authorities and the neighbouring State to make an informed assessment of the environmental impact. Genuine public participation is also required by Principle 10 of the Rio Declaration & Chapters 8, 10 & 23 of Agenda 21, to which both the EU & the UK are committed, following up Directive 90/313/EEC on Access to Environmental Information. The other locations must be fully identified so that the public & authorities can check, for example, the geology for themselves. Under UK law, consultation documents must not be misleading; and sufficient time & information must be provided for a genuine interchange. On the other hand, legal reliance cannot be placed, as in para.18 of DOE Circular 7/94, on the circulation of additional information in accordance with the Inquiries Procedure Rules, because this would manifestly not be an adequate notification & consultation of the public as required by Article 6(2) & (3) of Directive 85/337/EEC.

3B.16 The preferred site should be chosen as a result of the environmental assessment process, not before its application. In this case, there clearly were numbers of sites which could reasonably be classed as the main alternative sites - either the 12 which were carried forward for the final detailed study [COR/501, Section 6.6] or those 3-5 which Nirex has told this inquiry were subsequently short-listed for consideration by its Board.

3B.17 On no account can it be concluded that there is no alternative RCF site to the present one, because for example even at Sellafield Nirex has shifted its investigation from the site originally chosen by its Board to the current PRZ [NRX/12/11A]. Nirex cannot be allowed to argue that there is no conceivable alternative site when the nature of the programme is such that the choice of site is under Nirex's unique control. Moreover, in a case like this where a main objection is that the site is unsuitable, under UK law as enunciated in Trust House Forte Ltd v Secretary of State for the Environment & another (1986) 53 P&CR 293, the objectors do not have to identify specific alternative sites before the Secretary of State can uphold their objection.

3B.18 The Directive refers to an outline of the main alternatives because the developer will obviously have studied the preferred process & location more closely than the other options. It is therefore a spurious reason for failing to supply information on the alternatives that there is less information about them than the preferred option. In this instance, Nirex may only have borehole information of its own for Sellafield & Dounreay, but the BGS provided it with geological profiles of the other sites which were considered [COR/501, paras.6.5.6 & 6.5.10]. Nirex has carried out too some degree of environmental appraisal of the other sites [idem, para.6.6.4(b) & COR/101A, para.2.2.7], but it has also confirmed to this inquiry that all comparative environmental evaluation has ceased. All such information must now be supplied to Cumbria & the Secretary of State, and it must also be properly summarised in a non-technical manner and generally publicised.

3B.19 NSCNFLA & Ms Sutcliffe add that there is other vital information missing from Nirex's ES. The requisite assessment of effects on human beings must include consideration of the overlapping topics of accidents & emergencies and occupational health & safety, and yet this is not addressed at all in the ES [COR/101]. Ms Sutcliffe has also reviewed the

entire ES following 3 suggested approaches - minimum requirements & established best practice [SUT/1/1: Morris & Therivel], quality review [SUT/1/2: Lee & Colley], & key components (CPRE 1990). Broadly these have shown that the ES is good in parts but poor in the examination of the significance of impacts and in proposals for monitoring & mitigation measures.

3B.20 **Nirex** contends that most of these submissions have been based on the fundamental fallacy that the RCF would be part of the proposed DWR; whereas the true position was stated by Cumbria itself in its public consultation leaflet on the RCF application [COR/118, p.1], namely that the RCF is a research facility, and that it is not a repository application which is for determination now. Information on alternatives for the DWR is thus not material to the RCF application, and cannot be properly due under the UK Regulations. Moreover, it is not appropriate even to call for information on alternatives for the RCF, because in effect there are none.

3B.21 It is in the national interest to pursue the investigations at Longlands Farm until a decision can be made whether the site is suitable as a location for a DWR; and it is generally agreed that an RCF is a necessary part of such investigations. Only a favourable decision on the suitability of the site during implementation of the RCF would trigger the preparation of planning & authorisation applications for the DWR. The national interest in persisting with this locational investigation until such a stage has already been agreed by the Secretary of State in endorsing the concentration of detailed geological studies on Dounreay & Sellafield; and upheld, for example, by the Inspector who allowed the appeals for Regional Boreholes 8 & 9 in the National Park [COR/201, p.358, para.9.5]. This public benefit in continuing up to this decisive point means that there is logically no alternative to this RCF.

3B.22 The criteria laid down by Oliver LJ in 1985 [3B.4 above] were still being applied in 1994 by the Court of Appeal in Secretary of State for the Environment v P G Edwards & others (1995) 69 P&CR 607, well after Directive 85/337/EEC came into force. The 3rd criterion refers expressly to "the existence of an alternative site for the same project", as being relevant where there are clear planning objections to the proposed development. The project in this instance is the investigation & characterisation of the BVG & overlying sediments in this particular PRZ: and an RCF anywhere else would not achieve this. There is only a potential site for an RCF where an RCF is needed. But there is no need for an RCF elsewhere because no other PRZ is being investigated, and so the land use effects of a putative RCF at another location are immaterial. There cannot be a potential RCF elsewhere until sufficient borehole investigations & other surveys have been carried out to warrant establishing an alternative PRZ. The due consideration which would be given to a planning application for a repository under SP Policy 57 would be in accordance with the law & policy in force at that time, including of course the question whether Policy 57 itself was still extant. If the Policy & the Regulations were still extant, that would be the time to consider alternative sites for the DWR.

3B.23 Nirex considers that similarly questions of compliance with European or public international law, other than Directive 85/337/EEC, which effectively relate to the DWR should not be anticipated but left to the repository inquiry. In particular the amended Directive 80/836/Euratom cannot apply to the RCF because the RCF would not include any

activity involving exposure to ionising radiation. In the meantime Nirex should not be regarded as accepting that the various Conventions or Directives cited apply either at all or at least without significant qualifications not mentioned in the submissions made by the other side.

3B.24 In Nirex's view, the other parties are misunderstanding the circumstances in which safety considerations could become material to the planning application for the DWR. The advice in PPG23 on non-duplication of planning and regulatory functions applies equally well to radioactive waste management [GOV/107, para.1.5]. Paras.1.34 & 3.19 of the PPG state that planning authorities should not seek to substitute their own judgement on pollution control issues or interpretation of detailed risk assessment of releases into the environment for those of the relevant expert & statutory authority. The judgement of the Court of Appeal in the Gateshead case (already cited 3A.10 above) made it clear, at [1995] JPL, pp.439/440, that the planning authority should follow the regulator and refuse permission on safety grounds only where a refusal would also be the only proper course for the regulator on the authorisation application.

3B.25 Thus radiological safety would be a matter for the regulators, who by the time of the repository inquiry would have considered the DSA & PCSR. The Secretary of State, as planning authority, would very probably not be concerned with the cogency of the safety case unless satisfied that an authorisation would inevitably be refused. The planning safety test surely cannot be more stringent at this RCF stage, when there is no formal advice from the regulators at all [COR/101C], and planning authorities lack the requisite expertise. The planning system should not deprive the developer of the opportunity to put his case to the regulators. The judgement whether on balance to accept a safety case for a site predicted not to meet the risk target is to be made by the regulators: and there is no UK policy to refuse an authorisation for a site predicted to meet the target just because another site might have the potential for a lower risk.

3B.26 Concentrating instead, as Nirex contends should be done, on the RCF's direct planning issues, Nirex considers that it has provided full information on its reasons for choosing to develop the proposed RCF as a further step in its investigation of the Sellafield BVG. This discharges its obligations on the issues of the rationality of its site selection procedure and the sufficiency of the "promise" of the Longlands Farm site - the only 2 material issues on which alternative sites have a bearing. In the context of the first issue, it has led evidence of its assessment in 1988 of the comparative radiological safety for a DWR offered by 12 other sites, and thus supplied all the information needed by Cumbria & the objectors on, for example, the potential for lower levels of post-closure safety risk. But if it succeeds in establishing the promise under the 2nd issue because of the very substantial investigations already carried out at Sellafield, then in its submission a refusal of permission for the RCF on the ground of the potential of other sites would be irrational, because the refusal would be based on much more limited knowledge of those sites than of the PRZ.

3B.27 Other information on alternative sites is not reasonably required to give proper consideration to the likely environmental effects of the RCF in the terms of Regulation 21(1)(b), and so the existence of alternative sites is not generally a material consideration at this stage. The reality is that only 2 of the other parties have referred to the land use planning effects of either an RCF or a DWR at alternative sites. The rest are concerned only

with geology & radiological safety. Whilst the locations of 3 of the other 12 sites studied by way of detailed decision analysis [COR/501, Section 6.6] are now publicly known to be Sellafield Works, Pelham House School & Dounreay, naming any of the other potential sites would raise public alarm in the areas of such sites. This alarm would actually be heightened by naming them before the decision on the location of the DWR had been made. It is clear from the responses [COR/204] to the 1987 consultation exercise [COR/203] that there would inevitably be substantial local objection to a DWR at any such site. It would be irresponsible to raise such alarm.

3B.28 The objectors have nevertheless been seeking to turn this RCF inquiry into a pseudo-repository inquiry. Of course issues of the potential radiological safety of a DWR at alternative sites are likely to be raised at the DWR inquiry proper. But radiological safety issues would then be for the regulators under the authorisation application, and they would not be concerned with the possibility of achieving a lower risk than  $10^{-6}$  at an alternative site. Given that these issues would be matters for the regulators then, they cannot be matters for the planning authority now. Moreover there is the predominant acquiescence by the other parties that the non-radiological effects of a DWR at alternative sites are immaterial to consideration of the RCF application.

3B.29 Accordingly there is no valid reason for the Secretary of State to take the quite exceptional & very serious step of formally requiring further information under Regulation 21 following his receipt of the Inspector's report on this inquiry. Cumbria did not respond to Nirex's reply [COR/104, Appendix D, p.95 & COR/101A] to its original Regulation 21 requirement [COR/104, Appendix D, p.93] in terms which disputed the sufficiency of the supplied information, nor did it request more information. Instead it determined the application rather than suspend its determination under Regulation 21(7). It cannot now complain of the insufficiency of environmental information. The Inspector's preliminary view at the first pre-inquiry meeting was not to ask for any more information on alternative sites [INQ/4, PIM on 15-5-95, p.6]; and he has not expressed a change of view since. Nor has the Secretary of State seen fit to comply with NSCNFLA's pre-inquiry request to require further information under Regulation 21.

3B.30 If the Secretary of State nevertheless concludes that it is appropriate to require further information on the main alternative sites for an RCF, Nirex has not carried out physical investigations at any site other than Sellafield & Dounreay. Therefore the requirement should be confined to information on the non-radiological environmental effects of providing an RCF at Dounreay.

3A.24 3B.31 My opinions on this set of legal issues start by recalling my conclusion that the relationship between the RCF and the DWR is relevant as a matter of law. Then I have to address further arguments some of which are rather circular, in my view. Moreover the leading High Court judgements on the relevance of alternative sites do not distinguish as sharply between the concepts of materiality, reasonableness, policy & determinative weight as, for example, recent judgements on the relevance of planning obligations.

3B.32 Nevertheless it must be prudent to apply Oliver LJ's 4 general criteria to the case in hand as a first step. To avoid initial confusion, the criteria should be applied directly to the



3B.21

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RCF, and not to the DWR as some submissions suggested. There is a clear public advantage in establishing the RCF as a necessary step in the national programme for the disposal of radioactive waste. The environmental information already supplied [COR/101] shows that there would nevertheless be at the least visual intrusion and an increase in traffic levels. Given the special nature of the DWR programme & the preparation required, it is plain that there will only ever be a very limited number of permissions for this kind of RCF in the UK. Thus the 1st, 2nd & 4th criteria are obviously fulfilled.

3B.33 Nirex claims that the 3rd criterion is not met, in that there are no alternative sites because this development's only purpose is to investigate the very rocks in which it would be constructed. But I consider it plain from the ES that this is not strictly correct. The ES shows that the purpose of the RCF is to gain direct access somewhere to the extensive area of rock that is potentially suitable as a host for the disposal vaults of a deep repository, but which has been chosen partly because it is near Sellafield and is available to Nirex [COR/101, p.10, para.1.36]. Within this large area the precise location of the shafts has been dictated partly by environmental considerations [idem, paras.1.37-8]: and furthermore, flexibility is to be retained in planning the underground layout to access particular features in the rock mass [idem, paras.1.69-71].

3B.34 Consequently it is clear from the environmental information already supplied that choices related to geology, proximity & availability have been made in identifying this PRZ; and that choices relating to geology & environmental impact are being made in the location & design of the RCF within the PRZ. In my view, Nirex's argument about uniqueness would only have been valid if the RCF development were to be strictly confined to observations of a precise area of rock predicted to be pre-eminently suitable for the DWR. Instead, options are obviously being exercised both on the accessibility of various areas of rock and on experiments & design work to be carried out in the facility.

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3B.35 The real position is that the first, and maybe only, RCF for the national DWR could be designed in a different way at a different potential repository location: and a narrow developer's view of the singularity of a project was not accepted at the UK level in the Trusthouse Forte case, and was criticised at the EU level in the Bad Naturshutz case (already cited 3A.5 above). The obvious fact that preparations have not been made elsewhere does not mean that an RCF could not be established there. Consequently I consider that Oliver LJ's 3rd criterion is also met, and that even on a narrow view of the UK law it would be material to examine comparable sites. Given the basic purpose of the RCF and the delineation of its development site as the entire PRZ, those comparable sites would be other potential repository locations. In other words, alternative sites for the RCF are by their very nature alternative sites for the DWR.

3B.36 I do not see any transposition difficulty relevant to this case in particular & alternative sites in general between Annex III(2) of Directive 85/337/EEC & Schedule 3(3)(d) of SI1988:1199 as amended, albeit that it is intriguing that "outline" is in parenthesis in the Regulations but not in the Directive. I agree that ultimate responsibility for the decision whether it is appropriate to supply this information on alternatives must rest with the State and not with the developer. I also accept that, whether it is put as expedient to do so in terms of the English planning system or as required by the Preamble to the Directive, it is right to examine this information sooner rather than later. Changes since closure of the

inquiry to the Agreed Common Position on Amendments to the Directive do not seem to me to have affected these points. On this view, I do not consider it essential to look at the wider context of international law in relation to alternative sites as such.

3B.37 Nirex has not argued in terms that there is a rule of law making any potential radiological harm resulting from development immaterial to land use planning, in contrast to the materiality of the potential harm from any other form of pollution. Whilst there is indeed a distinction in a different sense, in that there is a separate system of pollution control for radioactive substances, I am not aware that this distinction has any relevance to legal issues of materiality in planning law.

3B.38 Although the language of PPG23 is in parts couched in terms of material considerations, it is of course setting out policy guidance and not giving legal advice. The guidance on the non-duplication of planning and regulatory functions is agreed to apply to radioactive waste management. It includes advice that one of the considerations on which the planning system is likely to focus is location, including the reasons for selecting the chosen site itself (para.1.33): that planning authorities may conclude that the wider impact of potential releases on the development and use of land is unacceptable despite the potential grant of an authorisation or licence (para.1.36): and that a development likely to satisfy pollution control requirements may still be considered to present an unacceptable risk in planning terms, because of social, economic or environmental factors incorporated in that risk (para.3.18). Such advice actually follows the decision in the Gateshead case relied on by Nirex (para.1.3).

3B.39 This means to me that, contrary to Nirex's understanding, it is national policy for a developer's case on social & economic factors to be put to the planning authority as well as to the regulator; and that it is left open to the authority to strike a different balance than the regulator between those factors and the risk. What the policy advises the authority not to do is to substitute its own detailed risk assessment for the regulator's. But the authority can also put environmental factors into the balance; and indeed site selection is a matter for it alone. Therefore, on present law & policy, the comparative radiological safety offered by alternative sites could well be a live planning issue at the repository inquiry. I also feel that there is some force in the argument that, if, as apparently intended, the regulatory regime does not review site selection, then the planning system will have to do so to comply with Euratom justification requirements.

3B.7

3B.40 In any event, Nirex seems to accept that comparable radiological safety is at least material to 2 of the issues on RCF site selection. These issues have been framed by Nirex from some of the wording in the 5th & 6th Reasons for Refusal. But the implicit point which the other parties are making is that, so long as Cumbria's approach was basically reasonable, it would have been open to the authority to have raised other issues on the generally material matter of site selection. It is now open to the Secretary of State in his turn to do so, if thus persuaded by the submissions of other parties: and the latter rely also on the need to comply with basic procedural law. The submissions of Nirex, on the other hand, tend to squeeze any wider consideration of alternative sites out of the planning process altogether. Yet it is plainly wrong under EU & UK law, in my view, to suggest that an authority cannot rely on an alternative site simply because less information is available about it.

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COR/101  
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3B.41 The weight to be attached to adverse environmental effects does not depend on the number of parties who refer to them, but on the nature of the information to be supplied and the cogency of any comments upon it. A stronger point is that Nirex apparently has not started to conceive of an RCF at any other site, and therefore finds it difficult to envisage the effects. But it has assessed the Longlands Farm RCF in great detail, and has analysed the other sites, and so should be capable of broadly contemplating the major effects of a typical RCF at those sites, in a manner similar to that which it has done for a DWR itself. There is also my conclusion that the obvious environmental effects of the DWR would be indirect effects of the RCF. Moreover there is no legal reason for distinguishing, as Nirex does, the effects of ionising radiation from other environmental effects.

3B.42 Comparison of the potential radiological safety offered by the various locations is also relevant to the planning balance, to see for example whether proportionately greater safety would offset the direct & indirect adverse effects of the Longlands Farm RCF, including effects through the DWR as an intermediary. It follows that, again contrary to Nirex's understanding, it is appropriate for the planning authority to look broadly at the relative radiological protection offered by various sites before the regulators look in detail at the protection offered by the chosen site. Indeed that is, in my view, the logical approach which accords with the Preamble to the Directive. In expressing concern about the expertise of a planning authority to do this, Nirex is tending to overlook the policy that the authority should assume that the regulatory regime will operate effectively.

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3B.43 In this case, the planning authority understandably required, albeit with a referencing error, further information on the developer's choice of location having regard to better prospects of limiting radiological risk elsewhere. The prospects of limiting radiological risk relate directly to the RCF, since one of its main functions is to assess the ability of the rocks under investigation to limit such risks. Whilst I am uncomfortable with the use of the word "detailed" in Cumbria's requirement when the Directive expressly refers to an "outline", I consider that the information supplied in response was certainly no more than an outline, compared with the information which we now know Nirex has compiled.

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3B.44 For some reason, Nirex believes that Cumbria was satisfied with the response, whereas the formal documents issued by Cumbria showed that it was dissatisfied. Also there had been sufficient time between receipt of the information which Nirex did supply and the date of the determination by Cumbria to amount to a suspension period complying with Regulation 21(7). I can only reconcile their respective positions by surmising that Nirex has been surprised by the way in which Cumbria's attitude towards the application has shifted during the inquiry stages. As I understand Cumbria's final view, this is that Nirex indeed did not supply all the information required, but that the further evidence given by Nirex has in any event convinced the authority that the application should be refused outright on its merits. On the other hand, a number of the other parties who share Cumbria's legal views are nevertheless relying more on the procedural point that insufficient information has been supplied. My opinions have to address this procedural point so as not to prejudice the merits.

3B.45 In fact, my views on the requisite legal requirements have been changed by the various submissions made in the course of the inquiry. On reflection, I accept that it is not possible for the environmental authorities & public concerned to express an informed opinion on the direct & indirect environmental effects and benefits of the RCF unless they are given

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outline profiles, including locations, of the analysed alternative sites, so that they can make their own judgements of the appropriateness of the developer's choice. This I now believe to be an overriding requirement notwithstanding the inevitable alarm it would raise in the vicinities of the alternative locations. I am reinforced in this belief by the realisation that this case is concerned with the potential safety of sites over millions of years, in comparison with which the period of public alarm should be fleeting.

3B.46 In line with para.44 of Circular 15/88, I do not regard the application as currently invalid because of this omission in the environmental information; but I consider that permission should not be granted for the RCF before the outline profiles have been supplied, summarised, publicised & commented on. If the inquiry is to be re-opened for this purpose, I draw attention to the submission (para.3B.15) that the arrangements described in para.18 of Circular 7/94 do not adequately transpose the notification & consultation requirements of the Directive.

3B.47 On the other hand, I disagree with the other parties that another omission in relation to the Directive & other international obligations is in failing to address other disposal options & processes. In my view, the ES contains adequate information as at the time of its preparation on the choice of the deep disposal option [COR/101, paras.1.8-21].

3B.48 Finally, I make no general comment on the overall critique of the ES, since it does not seem to me to be essentially a matter of law: but I am concerned at the specific major omissions that have been pointed out. Accidents & emergencies can conceivably cause serious environmental effects; and whilst a number of the foreseeable events are covered in respective Chapters of the ES there seems to be no specific treatment of, for example, fires & explosions. Also I consider that the generalised commitments to health & safety [idem, p.44, paras.2.185-190] do not constitute an adequate assessment of the possible impact on human beings on the development site itself. These omissions are of obvious effects from the development; and, whilst most of the possible impacts would be subject to some kind of regulatory regime, the legal scheme of the Regulations as I understand it depends on planning permission being withheld until such basic failures are rectified.

### 3C. MARINE DISCHARGES

**3C.1 The Irish Government, Patricia McKenna MEP & Mr J Fitzsimons MEP** emphasise that the PRZ is close to the Irish Sea and to nuclear installations, the discharges from which have made the Sea exceptionally radioactive. The Irish Government & people have made many representations in the past about this contamination [eg IRL/1/2]; and their transboundary interest in this Nirex application is direct. For instance, under the fishery arrangements agreed between the UK & Irish Governments, Irish vessels exercise the right to fish to within 6 nautical miles of a long stretch of the British coast including Sellafield. Also, along the Irish coast opposite - and in some places as little as 70 nautical miles away - are 50 significant communities, including Dublin [IRL/1/1, Map 1], with a year-round population of about 1.5M people and many holiday visitors.

3C.2 Scientific & public concern is based on past experience. There have been routine & accidental discharges into the Irish Sea from Sellafield since the early 1950s. Many of the radionuclides are deposited on the sea bed in the north-eastern Irish Sea. Others are carried by the currents to be eventually deposited in the western Irish Sea. There is also a potential long-term problem, currently indicated by <sup>137</sup>Cs concentrations, in the muddy sediments between the Isle of Man and Dundalk Bay [idem, Map 2]. All these facts are acknowledged by MAFF's Aquatic Environmental Monitoring Report No.32 of 1992 [pp.8, 15-21, 50-51]. Although there have been reductions in radioactive effluent from Sellafield in recent years, the Irish authorities continue to monitor the health risks to the Irish people: and consider that any further addition to the long-lived radionuclide inventory of the Irish Sea should be avoided. Thus Irish interests are entitled to consideration both according to the precautionary principle in the light of the scientific uncertainties and because of the real public concern & apprehension about the health risks from artificial sources of radiation.

3C.3 The Irish Government points out that part of Nirex's Science Programme to establish the suitability of this site to host the DWR is the development of an assessment of the post-closure safety performance of a repository located there [COR/522, Preface, 1st para.]. An essential part of this is the preliminary analysis of the groundwater pathway for such a DWR. Nirex now cites this analysis as indicating that the site continues to hold good promise of suitability. Yet the steady-state radionuclide transport calculations for the base case of this analysis predict an eventual radionuclide discharge into the biosphere mainly in a region from about 100 m offshore to about a kilometre offshore [idem, Vol.3, p.2.12]. Reliance in this manner on a predicted marine outlet would be a deliberate use of the sea as the recipient of a radioactive discharge.

3C.4 Nirex does not seem to appreciate that this deliberate discharge to sea from a permanent DWR would nowadays be in breach of international law. Whilst the extent of the Irish Sea may well diminish over time, it might also increase. Although Nirex does claim that the amounts of radioactivity involved would be minute [eg NRX/15/34], this is on the basis of very preliminary & narrow assumptions which Nirex concedes could be wrong and which do not so far allow for credible catastrophic events such as earthquakes or glacial melting. Moreover the actual amount of contamination involved is irrelevant in European law.

3C.5 Notwithstanding Nirex's argument that this inquiry is concerned merely with an RCF project, of course its predictions are of contamination from a potential radioactive waste disposal facility. The Irish Government & Patricia McKenna submit that the predictions & other calculations constitute general data relating to a plan for the disposal of radioactive waste which the UK Government should have provided to the European Commission under Article 37 of the Euratom Treaty, so that the Commission could determine whether the implementation of the plan is liable to result in the radioactive contamination of the water (or soil or airspace) of Ireland as a fellow Member State. The ECJ held in Saarland & Others v Minister of Industry, Posts & the Telecommunications & Tourism & Others Case 187/87: [1988] ECR 5013 that the purpose of Article 37 is to forestall any possibility of transboundary contamination. There is an obvious possibility in this case of transport of contamination across the Irish Sea.

3C.6 Moreover the advance justification & optimisation required under Articles 6 & 13 of the Directive 80/836/Euratom (see 3B.7 above) must apply to the protection of all of the population of the EU which is at risk, and not just the population of the Member State where the activity is taking place. As para.62 of Cm 2919 acknowledges, such justification & optimisation should be carried out before major commitments of money & effort have been made. Yet there has not been any examination so far in this case either of the reasons for the plan to cause effects on the marine environment, or of the environmental economic & social effects in Ireland. The grant of planning permission for the RCF cannot be contemplated until these failures have been put right.

3C.7 The position under public international law is even more restrictive, in the Irish Government's submission. The UK is a party to the 1958 Geneva Convention on the High Seas which provides for every State to take measures to prevent pollution of the seas from the dumping of radioactive waste. This is reflected & expanded in Article 194(2) of the 1982 Convention on the Law of the Sea, which is broadly considered to set out customary law, and is expected shortly to be binding on the UK. The dumping of radioactive waste at sea is also banned by Article IV(I)(a) of the 1972 London Dumping Convention, as extended by Conference Resolutions of 1983, 1985 & 1993. Both the UK & Ireland are parties to this Convention.

3C.8 In turn, Article 3(a) of Annex II to the 1992 OSPAR Convention prohibits the dumping of low & intermediate level radioactive substances, including wastes. Although the UK has not yet ratified this Convention, para.15 of Cm 2919 states that its provisions are being applied to all UK waters: and whilst the UK might obtain an exemption from the dumping ban after 25 years, this would only be on production of scientific studies to show lack of hazards or harm. The Preamble to the Convention specifically recognises the inherent worth of the marine environment of the North-East Atlantic, which of course includes the Irish Sea. The Preamble also endorses a sustainable approach to the marine ecosystem, whilst other provisions require application of the precautionary principle (Article 2(2)(a)); the taking of all possible steps to prevent & eliminate pollution from land-based sources (Article 3 & Annex 1); and, to that end, the use of best available techniques & best environmental practice.

3C.9 These provisions will replace similar ones currently in the 1974 Convention on the Prevention of Pollution from Land-Based Sources, to which the UK & Ireland are parties.

Article 5(1) of this specifically refers to the adoption of measures to forestall and, as appropriate, eliminate pollution of the maritime area from land-based sources by radioactive substances, including wastes. By virtue of Recommendation 88/5 of PARCOM, the best available technology is to be applied to minimise and, as appropriate, eliminate any pollution caused by radioactive discharges from all nuclear industries into the marine environment.

3C.10 The Irish Government considers that the stringent restrictions in particular on radioactive pollution of the sea from land-based sources mean that the permanent & irretrievable deep disposal of radioactive waste in a manner which is predicted to result in discharges to the sea cannot comply with international law. If Nirex were to go so far as to argue that such a maritime location is the only possible one, that would actually reinforce the general legal arguments against this method of disposal altogether.

3C.11 This matter is clarified by paragraph 22.5(c) of Agenda 21, which the UK & Ireland have supported without reservation, and to which the Irish Government attaches particular importance in this context. States should not promote or allow, amongst other things, the disposal of ILW & LLW near the marine environment, unless scientific evidence which is consistent with international principles & guidelines shows that the disposal poses no unacceptable risk to people & the marine environment or does not interfere with other legitimate uses of the sea.

3C.12 The paragraph effectively lays down a presumption against a radioactive waste repository near the sea. A proponent such as Nirex has to meet 4 requirements, in the Irish Government's submission. Firstly, there must be some scientific evidence to show the suitability of the site. Secondly, it must be shown that there is not a more suitable site away from the marine environment. Thirdly, there must be proof that there would not be an unacceptable risk to the marine environment. Fourthly, the paragraph expressly calls for appropriate use of the concept of the precautionary principle.

3C.13 The Irish Government considers that insufficient evidence has been produced to meet the first requirement. As to the second & third requirements, Nirex has not really addressed them at all, tending to regard proximity to the sea as an advantage of the current PRZ rather than as a drawback which has to be justified. Finally, it has not appreciated that application of the precautionary principle at this stage of its project means that the RCF must not be near the sea, because the principle essentially implies that potential sites away from the sea must first be fully investigated & rejected before a maritime location can be seriously considered. The precautionary principle must always apply to a DWR project because such a project is manifestly subject to considerable scientific uncertainty, with potentially serious risks. And there is no indication whatsoever that Nirex approached its site selection exercise on the basis of a presumption against maritime locations.

3C.14 **Nirex** naturally makes no response in respect of any policy or political considerations which might arise out of the Irish submissions, since these are matters for the UK Government. It reiterates, however, that it has not made a decision to build a repository at Sellafield; and that the RCF development itself would not result in any exposures to radiation. Erudite though the Irish Government's legal submissions on marine discharges may be, they all fail on the basic preliminary point that the RCF proposal is not part of a DWR

proposal. The submissions should not be considered, and so do not need to be answered, before a repository planning application has been made. This view again cannot be taken as an acceptance that in any event the Conventions & Directives do apply in the manner submitted by the Irish Government.

3C.15 The development of an assessment of the post-closure safety performance is, as the Irish Government acknowledges, a preliminary one. It is part of the acquisition of information required before Nirex could become confident of constructing a DWR in safety and at an acceptable cost. Before deciding to make a repository planning application, it is necessary to know whether a post-closure safety assessment would probably satisfy the regulators that there would be no impediment to eventual licensing & authorisation. All that can be said for the time being is that a satisfactory outcome is possible, but not certain.

3C.16 In any event, the preliminary information shows the Irish concerns to be scientifically unwarranted, in Nirex's view. The total exposure from current Sellafield discharges is about 0.2% of that received by the critical group in Ireland from all radiation sources [NRX/15/34, para.11]. The base case probabilistic analysis indicates the peak risk to an individual human being through a marine discharge as about 3 orders of magnitude below the UK Government's risk target [COR/522, Vol.3, Table 6.18, Fig.6.6 & para.9.1(g)]. That human being would be living on the British mainland, and the risk to persons living on the Irish part of the continental shelf would be even less. For instance, the peak risk to the latter from <sup>129</sup>I would be less than 2 millionths of the radiation dose received from all sources by people living in Ireland today [NRX/15/34, para.12].

3C.17 As to the relative significance of maritime locations, Nirex notes that an inland repository site would eventually lead to discharges to sea. For rivers & the air would eventually carry to the sea some of the long-lived radionuclides which would have originally been discharged terrestrially but are the key determinants of risk.

3C.1 3C.18 In my opinion, the shared use of the Irish Sea and the history of radioactive  
3C.2 discharges into it give the people of Ireland a legitimate interest in a proposal for a  
radioactive waste repository near the coast. The argument that it is premature to inform their  
Government of the Sellafield DWR programme because the decision has not yet been made  
3C.14 to go ahead with the DWR itself is, to my mind, a repeat of the reasoning about relevance  
& alternatives. I consider that it is right to involve them at least to the extent that it is proper  
3B.45 to review now the choice of potential repository locations.

3C.16 3C.19 In contemplating discharges from such locations over 10<sup>8</sup> years, it is not enough to  
3C.4 consider the transport of radionuclides by the very slow movement of groundwater through  
3C.2 rock. For it is evident both that over such a period there would be some risk of a breach of  
containment by natural catastrophic events, and that the sea is a relatively quick transporter  
of radioactivity. There is a palpable possibility of radioactive contamination of the fishing  
& territorial waters of Ireland, and within the EU this should trigger transboundary  
consultation regardless of the currently predicted amounts involved.

3C.20 Accepting the point about the relevance of any consequences of the DWR programme for the neighbouring Member State potentially widens the geographical spread of information



that may have to be considered at this stage. However, I do not consider that it necessarily increases the depth of information that it is reasonable to require, for it cannot be right to insist upon more knowledge about the predicted impact on Ireland than upon the UK. On the other hand, another major contention in the Irish submissions is that the spread should include the potential effect on the intervening marine environment, which has been wrongly overlooked.

2B.12 3C.21 Several of the provisions of public international law cited in the submissions relate to the dumping of waste at sea. But the repository concept now being pursued near Sellafield is to dispose of the waste deep in the land. My attention has not been drawn to any special definition of dumping at sea, and I would not regard the present Sellafield concept as entailing such dumping just because it is foreseen that some of the radioactivity from the waste might end up in the sea as a result of natural processes. But this does not mean that this foresight can be ignored altogether, because there are also provisions of international law which relate to radioactivity entering the sea from land-based sources.

3C.3 3C.22 On this aspect, it seems to me that the thrusts of the 1974 (as extended by PARCOM) & 1992 Conventions and paragraph 22.5(c) of Agenda 21, to all of which the UK apparently subscribes, are very similar. Whilst Nirex points to the possibility of some radioactivity reaching the sea from any land-based repository, a site near the sea must put the marine environment at significantly greater risk of pollution by radioactivity than an inland site, on the simple basis of proximity. Although I consider some of the submissions of the Irish Government to relate more to the weight of the evidence than to the law, in my judgement the coupling by international law of a special protection of the sea with the precautionary principle has inevitable implications for considering the location of a DWR.

3A.15 3C.23 These implications are that a location near the sea, as in this case, must be specifically justified as such in terms of need & impact; and that particular attention must be paid to the potential effects on the marine environment, including users of the sea, as such and not just as part of a pathway to the intake of radioactivity by inhabitants of the land. These points should at the least be considered when determining the issues of the rationality of the site procedure and the promise of the PRZ, which Nirex accepts as germane to the appeal. They may also have implications for other issues when taken together with my conclusion that there is an obvious link between the RCF and the DWR which domestic law would be bound to acknowledge.

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#### 4A. CONFORMITY WITH STATUTORY DEVELOPMENT PLAN

4A.1 **Nirex** points out that sustainability is the underlying objective of not only SP Policy 1 but also the rest of the Structure Plan [COR/303, p.14, para.2.5], and that several of the other parties concede that the RCF would have a sustainable purpose. It is the concept of sustainable development which enables a balance to be struck in the interests of the people of Cumbria as a whole between economic growth and the environment. The benefits of securing a solution to the long term management of ILW stored at Sellafield are obvious to all except those who query Government policy. Much of that waste is also locally generated. It would accord with sustainability to resolve the problems and dispose of the waste in Cumbria if practicable.

4A.2 The accordance with sustainability contributes greatly towards the RCF's conformity with the 10 broad strategic policies in the Structure Plan, in Nirex's view. It is of particular relevance to Policy 2, as are the RCF's siting outside the National Park, thereby avoiding any direct physical effect; the lack of harm to any other feature of national importance or the scenic beauty or natural resources of the locality; and the slightness of the impact on the amenity of local residents & visitors. Also Nirex considers that a development like the RCF which is fully justified by reference to Government policy and the Science Programme cannot be regarded as fundamentally inappropriate in terms of Policy 2. Furthermore, as already pointed out in the legal submissions [para.3A.11] and as accepted by the Secretary of State for Scotland in the case of investigations at Dounreay [NRX/11/3, p.4, para.11], the significant planning issues can only be concerned with the immediate environmental impacts of this particular investigatory phase, with its maximum length of 13 years [2B.9 above].

4A.3 As to the other broad policies in the Structure Plan, Policy 5 was not referred to in the Reasons for Refusal, and the alleged impact on the Lake District National Park can be considered in more detail in the context of Policy 11. Policies 8 & 9 are the other elements of the Structure Plan strategy which are of most direct relevance to the appeal proposal [not referred to in COR/101, Table 3.1.2 or COR/301, but mentioned specifically in evidence].

4A.4 Moving on to the more specific Structure Plan policies, Nirex regards the central question under them as whether the development would comply with SP Policy 54 by satisfying its 4 criteria. Cumbria concedes, and indeed in Nirex's view there is no dispute at all, that the 2nd & 3rd criteria would be met - the proposed scheme would be carried out in such a manner as to cause the least practicable harm; and direct & indirect adverse impacts during construction & operation would be minimised.

4A.5 The features of international or national conservation importance possibly at risk of being harmed in contravention of the 4th criterion are the National Park and other designated areas of particular landscape significance. But the RCF would be sited outside all of these; and Nirex's detailed evidence on the extent & degree of visibility of the proposal from its surroundings, and on the appearance & character of the landscape, shows that the National Park would not be harmed. Hence there would be compliance with the 4th criterion too.

4A.6 The 1st criterion requires more detailed analysis, in Nirex's judgement. Although any harm or risks to the local or wider environment have to be clearly outweighed by the sum of

benefits, the extent of the harm & risks has first to be established definitively. For the less the harm that would be caused then the less the benefits that have to be demonstrated. In this sense the balance which is to be struck is a relative one, as is made clear in the wording of the Secretary of State's Matter 6 (para.1.5 above).

4A.7 Nirex considers that the detailed environmental evidence shows that the adverse environmental effects of the RCF would be temporary or otherwise limited. Hence the benefits required to clearly outweigh them would be not very large, and in the final analysis they are more than ample. Para.4.61 of the SP's Explanatory Memorandum [COR/303, p.52] does require the benefits to include the national or regional reason for the development, and the principal reason of national significance is of course the need to obtain information not otherwise available on the potential to make a post-closure safety case for a DWR here. The factors which are important in determining the suitability of the site in this way are predictions of groundwater flow & dilution; the potential for natural & induced changes to create significant new pathways for groundwater flow; and the local parameters for repository design. Decisions could not be made about these without the information to be gained from the RCF.

4A.8 Although the concentration of investigations on this site does have to be justified, it is only in National Parks & AONBs that Policy 54 requires all reasonable alternative locations to have been explored & shown to be unacceptable. Nirex considers that it does not have to justify at this inquiry the merits either of its choice of about 500 sites to consider initially or of their sequential sieving down to a concentration on Dounreay & Sellafield. Instead its first test under Policy 54 is merely to show the reasonableness or rationality of the procedure which was utilised to do this. There is no policy requirement to demonstrate to the planning authority or the regulators that its preferred site has the best potential to achieve the lowest risk performance. Whilst it did comply in the 1988-9 site selection exercise with the requirement of the Green Book not to ignore a clearly better option for limiting radiological risks [GOV/302, para.5.4], that requirement is now obsolete.

4A.9 As to a second test under Policy 54, the scientific evidence shows that the site continues to hold good promise as a DWR location. Whilst eminent bodies such as RWMAC, Nirex's Review Panel & the Royal Society Study Group have occasionally raised particular points about aspects of the Science Programme, they all agree that the RCF is a necessary part of the Programme, and have commended the high quality of much of the scientific work to date.

4A.10 Thus Nirex is clear & confident on the purpose of, and need for, the RCF, whereas Cumbria has been confused about an appropriate test of the strength of the case for going ahead with the development. Its witnesses have used different phrases varying widely in their import, and by no means always corresponding with the wording of the 6th Reason for Refusal. They have also tended to gloss over the point accepted by the Inspector in the Regional Boreholes 8 & 9 appeal [COR/201, p.358, para.9.5], that it is in the national interest to pursue the geological investigations at this site to the extent that is necessary to either rule it out or to verify that a cogent safety case can be produced. In consequence, the proper test can only be whether it is already apparent that the regulator would be bound to refuse an authorisation for a DWR on this site.

4A.11 To put this test in the one set of Cumbria's own words which is appropriate, it is whether there is overwhelming evidence to date that would appear to rule out the Sellafield area as a repository location [COR/104, p.133]. The application, on the other hand, of any test that puts the onus on the developer to show a reasonable, robust or convincing prospect of making a safety case would wrongly involve the planning authority in pre-judging the decision of the regulator, contrary to the Court of Appeal's judgement in the Gateshead case [para.3B.24 above] and paras.1.34 & 3.19 of PPG23. So would a test whether there were significant doubts that a safety case could achieve the  $10^{-6}$  design target.

4A.12 No party has suggested that there is a material consideration which indicates that this appeal should be determined otherwise than in accordance with SP Policy 54. Therefore Nirex presumes that this second test of continued promise will be regarded as part of the process of reasoning involved in applying the Policy. If for some reason the test were regarded as a separate consideration from SP Policy 54, it would of course still be constrained by the views of the Court of Appeal and by national planning & radioactive waste management policies. Moreover, if so separated, the benefits under Policy 54 would be even more clearcut, for the self-evident national interest would become unfettered by any reference to the present promise of the site. In any event, it must also be borne in mind that this national interest would not be the only benefit, for Nirex's detailed evidence on the socio-economic effects of the development shows that there would be a socio-economic benefit too.

4A.13 One or two parties have contended that SP Policy 57 applies to the RCF application as well as Policy 54. This is not apparently the position of Cumbria, which merely contends that it is relevant to anticipate now the applicability of Policy 57 at the repository application stage. With regard to the basic contention, the RCF is plainly not a "development concerned with the ... disposal of nuclear waste". The word "concerned" no more covers this phase of the investigation of the location's potential than it covers the boreholes. Paras.4.70 & 4.71 of the Explanatory Memorandum make it clear that Cumbria intends the Policy to apply to further major developments associated with Sellafield or radioactive waste disposal after determination of the RCF appeal. The Secretary of State also had a hand in the wording of Policy 57; and if either he or Cumbria had intended Policy 57 to apply to the RCF, they would have said so explicitly.

4A.14 So far as anticipating the applicability of Policy 57 at the DWR application stage is concerned, the present intention is to show that a DWR in this PRZ would achieve in full the regulatory risk target of  $10^{-6}/y$ , and that best practicable means would be adopted. According to para.78 of Cm 2919 [GOV/208], no further reductions in risk should then be sought. Even if the estimated risk were above the target, the detailed assessment of the appropriate level of safety and of the proportionality of the costs of achieving further improvements in safety would be for the regulators to carry out. Therefore there would probably be no role for the planning system in evaluating safety considerations even at that stage. The consideration of alternative locations which would be "due" could only be something similar to that being given now, but with the benefit of more information about the PRZ.

4A.15 Turning back to other specific SP policies, Nirex considers that Policy 11 relates particularly to developments sited within the National Park. In a call-in decision reference PNW/5166/21/73 of 11 March 1992, concerning a proposed wind farm at Kirkby Moor in Furness [NRX/11/5], the Secretary of State concluded that the proposed development, albeit

close to the National Park & in similar countryside, would not directly affect the Park's appearance & character even though it would be readily seen from the Park [idem, para.5]. It was further concluded that, although the development's appearance would be regarded as alien by some, such harm as might be caused by its visual impact was outweighed by the national need for alternative, cleaner sources of energy. Nirex points out that the wind farm, although outside the Park, was nevertheless sited in a designated landscape area, unlike the RCF. The degree of visual impact of the RCF would be much less than that of the wind farm; and so in the light of the decision on the latter, which was not challenged in the High Court, it is not possible to conclude that the RCF would have a significant & detrimental effect on the appearance or character of the National Park.

4A.16 Although Cumbria & the National Park Authority disagree with the reasoning in the Kirkby Moor decision, they do accept that some distinction must be made between developments inside and outside the Park boundary. Cumbria also concedes that in policy terms there is no justification for the concept of some kind of buffer outside the boundary to protect the Park from intrusive development. Given the extent of visibility of the RCF proposal, its likely degree & length of intrusion, and the nature of any contrast between the development & its surroundings, it does not warrant refusal under Policy 11, in Nirex's view.

4A.17 There would be no significant impact on features of the Park especially defined on the Section 3 Conservation Map; and there have been much more intrusive developments near this boundary of the Park, such as opencast coal mining & the expansion of the Sellafield Works. Indeed the RCF/RCM/PRZ Borehole development itself has been described by the former County Planning Officer as having a greater short term visual impact than the RCF.

4A.18 With regard to SP Policies 13 & 25, Nirex relies on the point that the RCF would not be inherently inappropriate development. Whilst the first part of Policy 13 assumes that appropriate development should be steered alongside existing settlements, the very nature of the RCF means that it would not be suitable for a location immediately adjoining a settlement. Although it would not be required to meet local infrastructure needs, it has to be sited in the open countryside as do analogous mining operations. Cumbria concedes that the PRZ is the location at which the investigations should go ahead if they are to continue at all near Sellafield.

4A.19 Despite the site being technically in the open countryside, there are a number of buildings & tall structures nearby; and Cumbria also accepts that everything that could reasonably be done to minimise impacts has been proposed. It is not practicable with a temporary development like a mine fully to achieve the aim of Policy 25, of enhancing the quality of the existing environment; and this is actually acknowledged in the relevant paragraph of the Explanatory Memorandum, which opens with the words "Wherever possible..." [COR/303, p.28, para.3.35].

4A.20 Other Structure Plan policies considered by Nirex to be relevant but agreed by Cumbria not necessarily to lead to a conflict are Policies 16, 17, 21, 22, 24, 26, 36 & 70. Detailed evidence under the Secretary of State's Matters 4 & 5 (para.1.5 above) has been submitted (and summarised in Section 5) which shows conformity with those policies. In particular, and as other parties acknowledge, there is no longer the potential conflict with Policy 17 envisaged by the ES [COR/101, Table 3.1.2 & para.3.5.88].

4A.21 With regard to the policies of the adopted Mid Copeland Local Plan which are still in conformity with the extant Structure Plan, Nirex considers it not altogether proper to seek to apply Policy 6I to a temporary development akin to mining. The relevant reasoned justification refers only to residential development [COR/305, p.40, para.6.15]. In Nirex's view, it is debatable whether Copeland's wish to make the external appearance of the heapsteads look like those of traditional mines would diminish the visibility of the structures. Attention would certainly be drawn to the moving parts, perhaps thereby making observers more aware of the operations rather than less.

4A.22 As for Policy 6J, it is generally agreed that the character & setting of Sally Hill, the nearest listed building [para.2B.8 above], would not be detrimentally affected. The trees & woodland on the site would be substantially retained, and the minority affected would generally be replanted or reinforced [para.2B.18]: and BNFL as landowner has entered into a planning obligation to manage the woodland for 15 years [NRX/11/18], all thereby ensuring compliance with Policy 6Q. Finally, in accordance with Policy 6R, no important archaeological sites would be affected; and ample opportunity has been, & would be, given for archaeological recording & research.

4A.23 **Cumbria** considers that the first main issue which arises under the statutory development plan encompasses SP Policies 2, 5, 11, 13 & 25 and LP Policy 6I and is covered by the first 3 Reasons for Refusal. This issue is also of concern to many of those making **written representations** [eg WR/ACC/1, NTR/2 & SPC/1]. The policies seek to protect the countryside & the National Park from inappropriate development and visual intrusion. The area containing the appeal site is predominantly rural and open, with highly localised man-made features, albeit that the Sellafield Works is visible well beyond the coastal fringe and into parts of the fells. The visual impact of the RCF development would arise from its substantial scale in the landscape; the height, shape & size of its various buildings & structures; the surface & underground excavations; and the impact of lighting & general activity. Although the design & the revised landscaping scheme represent the best that can be achieved, they would do little to reduce the overall visual impact.

4A.24 The flat platform, cuttings & bunds would contrast with the undulating nature of their setting; and the large industrial-type buildings would not be in keeping with the rural landscape. The development would be visible from a number of points at close range & further afield. It would be seen both from lower ground to the south & south-west and from higher ground to the north-east & south-east within the National Park.

4A.25 The RCF would be inappropriate in terms of Policy 2 because it would be visually incompatible with the nearby National Park. The County Council & the National Park Authority have led evidence to show that the adverse visual impact would be significant from inside the Park as well as outside. Parts of the development would be visible from undeveloped open countryside in the Park, including some stretches of land identified on the Section 3 Conservation Map. Consequently the RCF would damage the character, special qualities & setting of the Park, and detract from the public's enjoyment of it, contrary to Policies 2, 5 & 11. The Kirkby Moor wind farm call-in decision [NRX/11/5] can no longer support Nirex's claim to the contrary. The reasoning to justify the disagreement with the Inspector's conclusions in that case was illogical in holding that the wind farm would not

directly affect the Park's appearance & character, as is evident to all now that the development has been carried out: and in any event the up-to-date development plan makes it plain that large scale renewable energy proposals can affect the Park without lying within it [COR/303, pp.53-4].

4A.26 SP Policies 13 & 25 and LP Policy 6I are not cast expressly in terms of inappropriate development. The siting, scale & design of the RCF would plainly not be well related to existing developed areas of countryside. For as Nirex accepts, the RCF would be in undeveloped open countryside, and yet not required to meet local infrastructure needs. Therefore it would be contrary to Policy 13. Similarly it would be an alien development in its rural setting, rising above its peripheral screening, and looking out of keeping by virtue of its size, shape & type of construction materials. Consequently it would conflict with both SP 25 & LP 6I.

4A.27 Thus, in the view of Cumbria & others such as the Ramblers Association & Seascale PC (which nevertheless supports the RCF on scientific grounds) [WR/SPC/1 & RAM/1], the development would cause visual harm to 2 interests of acknowledged importance & protected by the development plan, namely the National Park and the other open countryside. This means that the RCF has to be justified by need, as were the RCF/RCM/PRZ Boreholes; and this consideration takes the assessment directly on to Policy 54, with its first criterion that the sum of the development's benefits be shown to clearly outweigh the harm or any risks to the wider environment. Cumbria considers that in this case the criterion entails Nirex showing to the satisfaction of the Secretary of State that this RCF needs to be provided in the national interest. If Nirex fails because the Secretary of State concludes that Longlands Farm is not a sensible place on which to focus investigations, then Policy 54(i) would indicate upholding the last 3 Reasons for Refusal [para.1.5 above].

4A.28 Policy 57 is also critical to consideration of the appeal, in Cumbria's judgement. The first criterion of that Policy has recently been imposed by the Secretary of State, and so can be taken to represent his current policy. It would require a full repository application to address the issues of alternative locations and the suitability of the site. But due to the nature of Nirex's programme the RCF would represent a substantial commitment to proposing a DWR on this site (for the reasons reported in paras.3A.9-10 above), as is also argued in very many of the written representations. Therefore it would not be sensible planning to leave Policy 57 completely out of account until the DWR application stage. It should be a current issue whether Nirex's site selection process indicates that it has a good chance of meeting criterion 57(i). The insistence that Nirex can continue to focus on Sellafield, regardless of the inevitable environmental impact, until Nirex itself decides to rule Sellafield out actually reinforces Cumbria's commitment argument.

4A.29 There are no particular forms of words for specific tests to meet the first criteria of Policies 54 & 57. But the basic question now must be whether Nirex's decision in 1989 to focus on Sellafield & Dounreay in preference to proceeding with more robust geologies (BUSC sites) can be approved by the planning system. The 1989 endorsements of Nirex's decision by RWMAC & the Secretary of State were certainly not land-use planning judgements. Moreover the decision should be reviewed in the light of subsequent realisation that investigations of the preferred site will be much lengthier & costlier than envisaged in 1989. There is also the matter of the weight which the planning system should allow to be

attached to Nirex's penultimate site discriminator of "local support", as a short-term political consideration and not a long-term planning one.

4A.30 Whilst Cumbria is not trying to set a design target lower than the regulatory one, nor claiming that the PRZ would definitely fail to meet the latter target, the review of site selection for the DWR is now solely a function of the planning authority. As that authority, Cumbria is raising very substantial doubts whether a safety case could be made, and pointing to some fundamentally unsatisfactory features of the site in comparison with what is known about some others. Given the harm that the RCF would cause, and the environmental risks it would create, further investigations should first be carried out at a more promising site in geological & radiological terms, to check whether incurring the harm, risks, time & costs of an RCF at Longlands Farm would probably be worthwhile.

4A.31 Cumbria considers that it would be in both the public and Nirex's interest to draw back from Sellafield in this way for the time being. Even if a PCSA were eventually produced indicating that a DWR at this site should meet the regulatory design target, planning permission for the DWR could still be refused if it were not shown that due consideration had been given to alternative locations.

4A.32 It would be even more difficult for Nirex if the planning inquiry were reviewing the choice of this location after it had transpired that a DWR was predicted not to meet the design target, but the regulators had concluded that nevertheless an appropriate level of safety was assured, with further safety improvements achievable only at disproportionate cost. Any planning authority, considering a case which involved the rejection of more robust geologies merely because of the absence of local support, would be bound to conclude that the site selection process was flawed, and that to approve the application would be contrary to the principles of sustainability.

4A.33 As to other relevant policies in the development plan, whilst the RCF need not conflict with them to an extent which would warrant refusal, this is subject to the acceptability of the requisite planning conditions & obligations or other statutory controls. There are outstanding differences with Nirex over achieving conformity in particular with Policy 17 in respect of the protection of nature conservation interests; Policy 21 in connection with the control of noise; and Policies 22 & 24 in respect of the water environment (considered in Chapters 5D, 5E & 7A of this report).

4A.34 Copeland has assessed the proposal partly against the non-land use policies in the adopted Mid Copeland Local Plan (see para.2C.18 above); but, of the land use policies in the statutory development plan, it considers LP Policy 6I and SP Policies 21, 25, 54 & 57 to be the most relevant.

4A.35 Following Nirex in treating Policy 54 as central to the planning issues, Copeland makes several points about the balance of benefits and harm/risks under criterion (i). It is not national policy that there should only be one RCF at a single site: this is Nirex's decision. Although it is Government policy that there should be a DWR, this does not of itself increase the weight which should be given to the need for candidate DWR sites to be investigated, especially since Nirex prefers to be treated as a corporate developer rather than



a public body. The need for the facility should not, in any event, be assumed to be particularly pressing, for estimates of ILW volumes for disposal have recently been scaled down: and BNFL has a clear strategy for interim storage [CBC/1/2].

4A.36 Copeland has consistently held & expounded the view that, in seeking to dispose of nuclear waste, safety should be paramount. On this basis, permission should not be granted for the RCF unless it can be shown now that all the necessary consents for a DWR at this location are likely to be forthcoming subject only to the RCF providing satisfactory data. However, Copeland considers the currently proposed RCF science programme to be inadequate for this purpose. Also the need to progress towards a DWR has not been shown to justify this specific application for an RCF: investigations should continue on a broader front.

4A.37 Particular exception is taken by Copeland to Nirex's choice of Sellafield as one of 2 locations to concentrate upon as a result of a subjective judgement about a measure of local support for nuclear activities [COR/501, p.51, para.6.7.11]. This judgement seems to have been based mainly on a misreading of local authority responses to a consultation exercise on radioactive waste disposal [NRX/12/2, pp.1-8], not a systematic survey of public opinion. Moreover, Copeland's reply expressly said that local support is secondary to finding the "best" site [idem, p.1], and yet Nirex reversed this priority. Copeland's comment had been made particularly because it was feared that a dependence on civil nuclear activities might heavily influence local judgements about the acceptability of a disposal facility. Nirex's error of judgement is symptomatic of a flawed site selection exercise. Taking Cumbria's point that DWR application would probably be assessed against SP 57 (superseding LP 6C), Nirex has certainly not shown that it has given proper consideration to alternative sites.

4A.38 Furthermore, Copeland does not accept that criteria (ii) & (iii) of SP 54 would be met. This becomes clear when particular aspects of the development are assessed against specific policies of the development plan or agreed material considerations. SP 21 prohibits development which exposes the public to noise nuisance. Yet there is a grave risk of unacceptable levels of noise disturbance, especially at night; and Nirex will not agree to the conditions required to avoid this. There would also be a wide-ranging & significantly adverse impact upon local views & visual amenity, contrary to SP 25. The proposal would not have regard to traditional building design nor to the use of local materials, as required by LP 6I. Thus the scheme would not be carried out in a manner which would cause the least practicable harm, nor would adverse impacts be minimised. Contrary to Nirex's claim, the net socio-economic effects would be particularly adverse.

4A.39 Of the other parties, **Greenpeace** contends that it is plain from the scientific evidence that Nirex is uncertain whether the RCF would be in the best location for a DWR within the PRZ. It has a circular problem in that according to its own programme it cannot be sure that it has optimised the location until it has at least obtained the results of the RCF investigations. Yet those investigations might prejudice the radiological safety potential of the optimum location - a point also made by **FOE** [WR/FOE/2, S.3]. Therefore Nirex is not proposing to carry out the scheme in the manner which would cause the least practicable harm to the host environment, contrary to SP 54(ii) and the principles of sustainability.

4A.40 **FOE Cumbria & Mr Balogh** consider that SP 57 applies directly to the RCF. The plain & ordinary meaning of the words "concerned with" in the Policy is "relating to"; and the RCF would be concerned with investigating the suitability of the site for the final disposal of nuclear waste. Also, although the current intention is not to emplace any waste in the RCF, if the RCF were successful it would become part of the DWR. The RCF proposal conflicts with SP 57(ii), (iii) & (iv), in that, as also pointed out in some of the written representations, its safety & environmental consequences have not been fully examined and shown to be acceptable; adequate road infrastructure does not exist, nor is it being provided; and there would be an adverse socio-economic impact on West Cumbria. FOE Cumbria also suggest that SP Policy 63 is material to the infrastructure issue: and that Policies 60 & 62 are also relevant since it is proposed to treat most of the excavation spoil as waste to be disposed of on site.

4A.41 **FOLD** take issue with Nirex on the relationship between the development plan and the protection of the setting of the National Park. It has been nationally recognised since the Hobhouse Report of 1947 that the boundary of a National Park should not be regarded as a sharp barrier between amenity & recreational values within and disregard of such values without. The national indicative criteria in the Annex to Circular 7/94 of whether wind generators would be likely to have significant effects on the environment include locations within or likely to have significant environmental effects on a National Park. The Lake District National Park Authority is proposing to change para.1.11 of its Local Plan to make clear its view that SP Policies 2, 5 & 54 afford protection to the Park from inappropriate development around its periphery [COR/310, p.3].

4A.42 In FOLD's view the RCF would indeed have an unacceptable impact upon the Park due to its wide-ranging visual effects; the lighting, noise & additional traffic; and the damage to the amenity value of the local footpath network, as claimed too by the Ramblers Association [WR/RAM/1]. FOLD also consider that the development would have an unacceptable impact on an important area of open countryside by reason of its location, scale & design, contrary to SP Policies 13 & 25. The clear conflict with Policy 13 is enough in itself to require Nirex to show that it has fully considered alternative sites if permission is to be granted. Finally, FOLD's judgement is that the landscaping & screening measures would do little to mitigate the adverse effects, and might emphasise the development's presence, contrary to SP 54 (iii).

4A.43 My conclusions on the conformity of the proposals with the principles of sustainability as incorporated in the development plan are that, as the proposals are for a development which is more national than local in character, so they should comply with the overall requirements which have been drawn together in SP Policy 54. The conformity of the basic DWR concept with sustainability principles has of course been settled nationally in Cm 2919.

2C.14

4A.44 The second part of Policy 2 implicitly relates only to development within the relevant area of conservation importance, in this case the Lake District National Park, but the first part is framed to protect, amongst other things, the County's scenic beauty overall. In my view, this must apply to any site in a setting of some scenic beauty, which may or may not include part of the National Park. I consider that inappropriate development means in such

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a context development that would look out of place: and I am not aware of any provision of national policy which makes an exception to this for an RCF or a DWR. Moreover, I have already concluded that, as a matter of law, the material considerations in this appeal are not confined to the immediate environmental impacts of the development now applied for. The RCF, RCM & PRZ boreholes previously permitted are part of the RCF project: and a broad assessment of prospective effects of the DWR would also be reasonable.

4A.45 Although Policy 5 was not mentioned in the Reasons for Refusal, it was specified in para.2.1.3 of Cumbria's Statement of Case, and Nirex concurs that it is relevant. My view is that as a broad strategic policy its main value to this appeal lies in its indication of the basic elements of the National Park which make the Park an especially important interest to be protected by the planning system.

4A.46 Policies 8 & 9 were introduced into the inquiry by Nirex itself despite a lack of reference to them in either the Reasons for Refusal or the Statements of Case, but I agree that they are relevant. SP 8 provides some strategic background to the socio-economic issues discussed in Chapter 5B, whilst SP 9 does the same for the transport infrastructure issues covered in 5C.

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4A.47 Turning to Policy 54 as the development plan's basic application of the principles of sustainability to projects such as this, I am surprised by Nirex's ultimate misapprehension of the cases against it on criteria (ii) & (iii). It seems to have been unduly lulled by Cumbria's part acquiescence. For to the extent that there are disagreements with Cumbria over the imposition of controls to alleviate harm or mitigate impacts there is implicitly a claim of potential failure to comply with the criteria. Moreover, there are some other parties which directly allege conflict with the criteria. There are also parties such as **Gosforth, Mr Spendlove & Ms Skinner** who do not relate their cases to the criteria but in effect suggest contraventions of them.

4A.5

4A.48 Criterion (iv) of Policy 54 includes a specific provision for development within National Parks, but its general provision relates to harm to any areas or features of international or national conservation importance. Nirex accepts that this includes potential transboundary harm to the Lake District National Park from the RCF. I note in passing that areas of national conservation importance are defined by the Structure Plan [COR/303, p.14, Footnote to Policy 2] as including such areas of nature conservation importance as are defined by PPG9. The Site Designation Table in the PPG of course makes all notified SSSIs sites of at least national importance. The Natterjack Toad habitat downstream of the appeal site is a potential SSSI, and therefore a potential area of national conservation importance in terms of Policy 54 (iv).

2C.19

4A.49 It is criterion (i) of Policy 54 which has been the subject of the most detailed submissions about the application of the Policy. Some of the submissions have been over elaborate and too rigid, in my view. The wording of the criterion is very clear, and it obviously encompasses a wide-ranging balancing exercise. On the one side can be national & regional benefits as well as local ones, and on the other there can be harm or risks to the wider environment as well as the local environment. Thus, as a matter of up-to-date development plan policy, as well as of law, consideration of the appeal cannot be confined solely to the local impact of the RCF.

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4A.50 I agree entirely with Nirex that the balancing exercise is a relative one: the less the harm and the fewer the risks shown, the smaller the benefits required manifestly to outweigh them. Also it is obvious from the start that there is potentially an appreciable benefit, namely the implementation of a key stage in national radioactive waste management policy. However, relativity applies to both sides of the balance, and the developer cannot arbitrarily set its own thresholds of the type or degree of benefit beyond which it is said the balance is bound to be in the development's favour. I have already concluded that, as matters of law, it would be material to this appeal to examine comparable sites; and the examination should take place sooner rather than later; and the planning authority was right to require further information on the developer's choice of location. It therefore seems to me to be of little consequence that the Policy does not explicitly require such an examination in this case.

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4A.51 Moreover, I have also concluded that, as matters of national planning policy, the planning authority can examine the reasons for selecting the chosen site: the authority can also determine that a development likely to satisfy pollution control requirements may nevertheless present an unacceptable risk in planning terms: and consequently a comparison of the potential radiological safety offered by the various locations is also relevant to the planning balance. Whilst it would be going too far in a relative balancing exercise to declare that safety is paramount, it seems to me legitimate for the planning authority to conclude that the social, economic & environmental contexts suggest that greater, or even, the greatest, weight should be attached to safety factors. On the other hand, my view is that a developer can expect its own social or economic reasons for selecting a site also to be regarded as material when issues of need & alternative sites are being considered.

4A.52 In short, I do not consider that there should be set tests or formulae for applying Policy 54. Also, since the basic issue itself is whether the development would accord with the development plan, there is no general presumption on this issue in favour of the development. Whilst there is an initial onus in the debates between the parties on those who put forward the view that the development should not be allowed, the burden of the argument on any particular matter can thereafter swing to & fro. In this case, a final conclusion on conformity with SP 54(i) can be reached only after all the factors properly sought to be put into the balance by the various parties have been examined.

4A.53 Personally I regard the words "concerned with" in Policy 57 as vague & therefore ambiguous when only the first clause of the Policy is read. However, the wider context of the subsequent wording of the Policy's criteria, especially (ii) & (vii), suggests that a narrow meaning, of installations actually containing nuclear waste, is intended: and any lingering doubts about inapplicability to the RCF are resolved by the use of the phrase "future BNFL & Nirex proposals" in the first sentence of para.4.72 of the Explanatory Memorandum [COR/303, p.55]. Cumbria nevertheless claims that it is expedient to look at criterion 57(i) now, but I consider that it is a needless complication to argue that part of an admittedly inapplicable development plan policy is actually relevant. In this instance the law & national planning policy effectively provide already that due consideration should be given to alternative locations.

4A.54 Looking now at particular claims of harm, my experience is that the Hobhouse Report's view about the merely gradating effect of the delineation of National Park boundaries is generally accepted. Having viewed the Kirkby Moor wind farm from various

vantage points inside, & against the background of, the Park, my judgement is that it is an example of the visual harm which can be caused to the fringe of the Park by taking an unorthodox view that development outside the boundary cannot directly affect the appearance & character of the Park. Whilst some significance must of course be attached to the transitional effect of crossing the policy boundary, its line should not be treated like a kind of artificial blindfold.

4A.55 The scenic beauty & recreational value of the Lake District National Park are of course interests of internationally acknowledged importance, which Policy 5 would firmly protect & enhance. Policy 11 is not confined in terms to development inside the Landscapes of National Importance, and opposes change to the present characteristics & qualities of such Landscapes. Even if it were thought that technically the Policy is not directly applicable to development outside the Park, in my judgement the Park's characteristics & qualities should still be taken into account in assessing the basic merits of whether this area of international importance would actually be harmed by nearby development. On the other hand, I do accept that regard should also be had to existing intrusions into the setting of the development.

GB.12 4A.56 In relation to Policy 13, the site is in the undeveloped open countryside as defined by the Explanatory Memorandum [COR/303, p.23, para.3.16]. I do not consider the RCF to be of a type of development that inevitably has to be in the open countryside. The pitheads of traditional deep mines are to be found within & on the edges of developed areas as well as in the countryside. The site would probably have been within the Sellafield Works complex if the BVG there had proved more accessible. The location of the PRZ has been determined solely by the accessibility of an area of rock potentially suitable to host the DWR. Accordingly the justification for the departure from Policy 13 falls back on the degree of benefit to be obtained from a further, intrusive investigation of this rock.

2B.4 4A.57 Even if the essentially transitional nature of some of the development applied for really means that the aim for enhancement in the first part of Policy 25 cannot be met, it cannot be used in my view as an excuse for an unnecessarily poor standard of design. It is still reasonable to require the development to try and comply with the middle part of the Policy, and be in keeping with the local landscape character, well integrated with the existing pattern of farmland & woodland, and in keeping with the local vernacular tradition where appropriate. On the other hand, I do not consider that Local Plan Policy 6I is also applicable, since the reasoned justification is part of a local plan, and para.6.15 makes it clear to me that the Policy relates to residential development.

2B.5 4A.58 Generally, I agree that the other statutory development plan policies mentioned by Nirex and other parties are applicable. But I do not see the need to come to any preliminary conclusions on the proposals' conformity with these others at this stage, save to note that compliance with SP 17 would depend very much on the view taken on the adequacy of the mitigation measures proposed to protect the important nature conservation interests at risk.

## **4B. CONFORMITY WITH RETAINED & EMERGING POLICIES**

**4B.1 Nirex** makes no particular submission to the inquiry concerning the transitional development control policies which have been retained from the 1988 Structure Plan as now more appropriate to local plans; and turns instead to the emerging local plans themselves. The key policies in the 1988 Plan which were applicable to the RCF so far as Nirex was concerned were C1 & C6, but these have now been replaced by SP 13 & 54.

**4B.2** From the pre-replacement standpoint, the ES assesses retained Policy C5 as in support of the development, whilst 1988 Policies C20, F4 & M1 are assessed as not in conflict [COR/101, p.55, Table 3.1.1, cf table appended to COR/301]. Policies T17 & T21 are not identified as material to the development at all by the ES. Only Policy P6 is both assessed by the ES as potentially in conflict with the development and still identified by Cumbria as a transitional development control policy. The ES does not specify the points of potential conflict, but the implications are that they would be the visual impact of the spoil disposal area [2B.14] and its effect on adjoining land uses, by virtue of factors b. & c. in Policy P6 [COR/301, p.7].

**4B.3** In turning to the emerging Copeland Local Plan, Nirex considers Policies DEV 1 & ENV 33 as of principal relevance [2C.26-7]. Whilst the appeal site is beyond any town or village development limits defined by DEV 1, the RCF development is clearly within the 6th set of developments permitted by the Policy to be carried out outside those limits, because it would be development in relation to the nuclear industry. This LP exemption is seen by Nirex as reinforcing its argument that the RCF would not be inherently inappropriate development in the countryside [4A.18].

**4B.4** ENV 33 is the most significant of all the relevant LP Policies, in Nirex's view [NRX/11/11, para.1.30-1], because it supports the principle of this very appeal development. Its 6 criteria, as recommended to be modified, would be met. This is shown in Nirex's detailed evidence on the planning merits (summarised in Section 6 of this report in respect of the first 3 criteria and in Section 5 in relation to the last 3).

**4B.5** As to the cross-references in the 4th & 5th criteria of ENV 33 to other LP Policies, the development's conformity with DEV 4 & IMP 1 [4A.28-9] is demonstrated mainly in those parts of Nirex's case which relate to the lack of any long-term, adverse socio-economic impact [Ca.5B]. Briefly, there is no demonstrable planning objection on which to base a requirement for an obligation [NRX/11/11, para.1.19]; and also Copeland's suggestions for inclusion in the planning agreement are unreasonable, inappropriate & irrelevant.

**4B.6** DEV 3 [2C.30] is regarded by Nirex as another significant LP Policy in that it seeks to give local effect to the requirements of SP 25 [2C.12]. The general objective of the Policy to respect the character of the surroundings & contribute to a strong sense of place must be subject, in Nirex's judgement, to practicability in terms of safety & the functions of the proposed development. Whereas, in relation to this objective & the 1st principle of the Policy, Copeland wishes the upper parts of the shafts' winding gear to remain exposed in traditional mining fashion, Cumbria as the planning authority prefers them to be clad and has now agreed a revised colour scheme [COR/113, Scheme A]. Nirex considers this to be the

better design approach because Copeland's concept might tend to draw more attention to the presence of an industrial-type activity in the locality. But it would be open to the Secretary of State to agree with Copeland, and exclude from the grant of permission the external design of the upper sections of the headgear & hopper, reserving it for subsequent approval.

4B.7 As to the 6th principle of Policy DEV 3, Cumbria concedes that there would be no conflict with Policies TSP 5-8 [2C.31], because the level of traffic anticipated would not have an unacceptable impact on the local highway network, nor require the provision of footways or road widening for pedestrians or cyclists. It also agrees that a link road between Sellafield and the Surface Site would have an adverse visual impact. Moreover it accepts that the development would not be of a sufficient size to make a rail link practicable in terms of Policy TSP 13 [2C.32].

4B.8 Cumbria also agrees that the proposals, subject to agreed conditions, would be consistent with LP Policies SVC 1 & 5 [2C.34] and ENV 11, 13, 14, 15, 26, 27, 51 & 52 [2C.36-41]. Apart from DEV 3, the only emerging LP Policies which the ES assesses as potentially in conflict with the RCF proposals are ENV 5 & 23 [COR/101, p.56, Table 3.1.2]. The implications are that the main concerns are landscape impact of the spoil disposal and the effects of that & other activities on the habitats of badgers & perhaps natterjack toads. The mitigation measures for these are considered in Chapters 5A & 5E of this report.

4B.9 In relation to the National Park Conservation Map and Policy NE 5 of the deposited National Park Local Plan [2C.42], Nirex does not accept that the appeal development would significantly harm the character or appearance of any part of the National Park.

4B.10 Turning to the Consultation Draft of the Minerals & Waste Local Plan [2C.43], Nirex emphasises the obsolescence of Appendix 1 due to the drafting having preceded the publication of the 2 White Papers. On the other hand, it claims that Draft Policy 43 is in line with its view that the planning merits of mineral exploration proposals are confined to their immediate impact, and are not concerned with the potential for subsequent appraisal & production development [COR/311, para.5.20.1, last sentence]. Moreover, the spoil disposal arrangements of the RCF proposals accord fully with Draft Policy 51, because there would obviously be net benefits in disposing of the spoil on the PRZ adjacent to the Surface Site rather than transporting it to an existing landfill site.

4B.11 **Cumbria**, like Nirex, makes no specific submissions concerning the transitional development control policies, nor for its part about LP Policies DEV 1, 3 & 4.

4B.12 It does submit that the most important criterion of LP Policy ENV 33 as recommended to be modified is the 2nd. The RCF proposal must demonstrate at this stage that further investigations of the suitability of the Sellafield site for an ultimate repository via the RCF are justified. Although Nirex points out that in recommending this wording the Local Plan Inspector specifically rejected a reference to alternative locations as anticipating a DWR proposal, the Inspector nevertheless stated that the recommended wording should not inhibit consideration of all matters relevant to this issue at the RCF inquiry. Cumbria's case is that Nirex has failed to show that further investigations of the Sellafield site are justified at this stage. On the other hand, Cumbria has concluded on balance that there would not be

sufficiently adverse social & economic impacts as to warrant seeking a planning agreement under the 5th criterion of ENV 33 & Policy IMP 1.

4B.13 In the case of Policies ENV 1-5 [2C.35], Cumbria notes the possible effects on the potential SSSI down Newmill Beck & its population of natterjack toads, and also the loss of an area used by badgers for foraging. However English Nature & the Cumbria Wildlife Trust have not objected to the proposals [COR/107, pp.101 & 155]. Although English Nature is concerned about the risk to the potential SSSI of changes to the water quality & flow in the Beck, strict monitoring & enforcement by the EA of the extant water discharge consents for the development would provide adequate protection.

4B.14 In relation to Policy ENV 29 [2C.39], there is an outstanding disagreement with Nirex over controlling hours of operation. It is also important to appreciate that, although Cumbria does not claim that there would be insuperable difficulties in complying with the environmental & transportation policies in the Local Plan as recommended to be modified, it does consider that the increases in traffic, noise & dust would contribute to the loss of rural character & the overall adverse impact of the proposals.

4B.15 Moreover, it does submit on behalf of the National Park Authority [CCC/3/2] that some of the mountain, moor, heath & coast delineated by the Conservation Map in the National Park Plan would be visually affected by the appeal development. Similarly, the Proposals Map of the deposited National Park Local Plan [COR/309] defines as parts of the Quieter Areas subject to Policy NE 5 some stretches of the western fells from which portions of the RCF superstructure would be seen [CCC/3/1, Figs.2 & 3a]. Again on behalf of the Authority, Cumbria submits that the RCF would also visually intrude into these Areas.

4B.16 Copeland points out that Nirex does not merely accept but indeed urges that considerable weight should now be attached to the version of LP Policy ENV 33 which is recommended by the Inspector. Nirex understandably takes this line because the Policy supports the principle of the RCF, but the fundamental point is that most of the specific criteria of the Policy are not met by the appeal proposals. FOE Cumbria add that the conflicts with the criteria of ENV 33 amount in themselves to a strong case for dismissing the appeal.

4B.17 The proposals are not justified by relation to the proposed repository site, because that site has not been chosen by a process which regarded safety as paramount, contrary to the 1st & 2nd criteria. In relation to the 3rd criterion, Copeland also has serious reservations about the scope of the activities to be undertaken in the RCF, particularly the lack of practical tests of the engineered & near-field barriers despite the national policy option of retrievability [GOV/208, paras.99 & 100]. The crucial 4th criterion would very plainly not be met, since the landscape & traffic impacts would be unacceptable; and the Borough's environmental, social & economic resources would all be prejudiced, contrary to the new Policy DEV 4.

4B.18 Nirex has spurned Copeland's suggestions of matters to be covered by a planning agreement, but those suggestions are founded on Policy IMP 1, by seeking to address adverse social & economic costs & effects and to positively encourage investment. It is not for the local authority to go further, and Nirex is in breach of the 5th criterion by failing to bring



forward draft obligations to overcome those clear planning objections to its proposals which cannot be met simply by the imposition of conditions.

4B.19 As for Policy DEV 3, to which also considerable weight should be attached, Copeland is not complaining about the functional nature of the RCF's superstructure but, with the full support of **FOLD**, about the admitted failure to obtain skilled design advice on its external appearance. Nirex has taken professional advice merely about the colour scheme after the start of the inquiry. Also it concedes that views of just parts of the headgear could have moderate to substantial adverse visual impacts, even against a background of the Sellafield Works. Yet traditional local mining headgear is characteristically open [CBC/1/16], not enclosed as in this case. Moreover, the most visible parts of the operational buildings would have flat roofs, and their walls would be clad by plastic-coated, profiled metal sheets. They would be wholly inconsistent with the rural vernacular of pitched roofs & stone or brick walls.

4B.20 Whilst Copeland & FOLD are not insisting that the operational buildings should slavishly replicate the vernacular, the submitted external details would do nothing to assist the buildings to harmonise with the locality. They are part of the application, and cannot be varied or excluded by the Secretary of State. **Cllr DWT Gray** contrasts Nirex's approach with that in Sweden, where the surface facilities at the Äspö Hard Rock Laboratory have been sympathetically designed to match their rural surroundings [GRY/1/4].

4B.21 Having assessed the appeal proposals against the other relevant policies in its emerging Local Plan, Copeland considers that they would conflict with 2 others as well as ENV 33, IMP 1 and DEV 3 & 4. These are TSP 6, because the detailed traffic evidence shows that the relevant stretches of the A595(T) are not to an appropriate standard of road, and Nirex has declined to undertake to improve them; and ENV 29, since Nirex refuses to amend its proposed working arrangements, or accept conditions, to bring the noise generated by the development down to acceptable levels. There would also be a conflict with the spirit of TSP 7, because of the lack of provision for cyclists & pedestrians on the A595(T), albeit the Policy itself applies only to on-site provision.

4B.22 There would arguably be a conflict with EMP 11 [2C.33], for this would be a relatively large-scale, employment-related development outside established or designated employment areas. On the other hand, the already approved conversion of the Longlands Farmhouse [CBC/1/15] accords with EMP 17 [2C.33]. In the case of ENV 5, it is recognised that the development could affect species protected by law, but the mitigation measures proposed should secure adequate amelioration.

4B.1  
4B.11  
2C.22-5  
4B.23 **I conclude** from the representations that no party attaches particular weight to the transitional development control policies retained from the 1988 Structure Plan. They do not seem to me to differ significantly from the policies in the emerging local plans in their approach to any interest of acknowledged importance. Therefore, like the parties, I have concentrated on the emerging policies.

4A.56  
4B.24 My view is that there is an accord between SP Policy 13 and LP Policy DEV 1 as to whether the appeal site is located in the open countryside. The second sentence of para.2.3.2

COR/306 of the Local Plan's reasoned justification, which it is not proposed to modify, describes the land outside the defined limits of the classified settlements as large areas of open countryside & undeveloped coast with scattered hamlets & farmsteads. Later in the paragraph the RCF is implicitly referred to as a large project which does not fit neatly into a traditional settlement pattern. The nearest settlement to the appeal site which is defined in an emerging local plan is of course the village of Gosforth, but as that is about 400 m away on the eastern side of the A595(T) it is in the National Park, and so delimited by Policy NE 2 of the deposited Park Local Plan [COR/309, Inset Map 7].

2B.1  
2B.2  
2C.14  
4B.16  
4B.5  
4B.25 Thus ENV 33 supports the RCF in principle as within one of the exceptional categories of development permitted outside settlement limits. However the RCF proposals are expected to satisfy all 6 of the Policy's criteria. Although these substantially overlap the requirements of SP 54 and encapsulate a number of the major issues on the planning merits, they are not merely indicators or options providing a flexible framework for the RCF, but amount to a set of preconditions which Copeland & others claim have not been met. Other material considerations have of course to be taken into account too; and in particular ENV 33.5 & Policy IMP 1 would only bite if substantial planning objections incapable of being overcome by conditions are identified. But it has already been established at this stage that no planning obligation at all is in fact being offered, over & above the agreement already entered into by BNFL for the management of its local woodlands for 15 years from the start of the RCF [NRX/11/18].

COR/111,  
pp.13-4  
4B.6  
4A.19  
2B.10  
5A.11  
4B.6  
4B.26 In considering the design of the development in accordance with LP Policy DEV 3, it seems to me that Nirex is relying primarily on its landscape architecture to show respect for the character of the surrounding area. The external appearance of the superstructures is being excused on general utilitarian grounds from the criticisms of looking out of place, as well as because of the temporary nature of the development. The cladding of the upper headgear & hopper is an integral design feature of the full, original application, and a focal point of the visual assessment in the ES. To require the omission of the cladding would, in my judgement, amount to an unacceptably major alteration of the application, without adequate information on the appearance of the structures which would be exposed, whereas the details submitted during the inquiry are merely mitigating the appearance of the cladding.

4B.22  
COR/102,  
p.52  
4B.27 The road traffic impact is to be considered under SP Policy 36 & LP ENV 33.4 as well as DEV 3.6 & TSP 6, and it is not appropriate to come to any preliminary conclusions on that impact at this stage. The same is true of noise control under SP Policy 21 & LP Policy ENV 29. On the other hand, I consider that the applicability of EMP 11 can be ruled out at once, since I do not accept that the RCF would be employment-related development in the normal sense of industrial, business or kindred developments. However, there are still difficulties over nature conservation policies such as ENV 5. The precise measures for safeguarding the natterjack toads down Mill Beck have yet to be settled: whilst Cumbria & Copeland seem to have overlooked that English Nature's inference [COR/107, p.104, para.2)] that alternative badger foraging areas are guaranteed by the planning application is incorrect.

2C.42  
4B.15  
4B.28 The National Park Conservation Map and the designation of Quieter Areas by Policy NE 5 of the Park's deposited Local Plan amplify for me some of those characteristics & qualities of the Park which should be taken into account in assessing whether the Park would actually be harmed by the RCF.

4B.29 The consultation draft of the Minerals & Waste Local Plan can be accorded only limited weight, in my view, since it is at an early stage in the plan preparation process. In any event, I do not agree that Draft Policy 43 supports Nirex's claim of a lack of relationship between the RCF and the DWR. This is because, as I have already concluded, the RCF is akin to appraisal development, not mineral exploration. On the other hand, I do accept that the proposals for the disposal of spoil on site are in line with Draft Policy 51, since I note that para.6.4.37 of the draft reasoned justification defines landfill as including land-raising, which is what would be entailed in this case.

4B.10

3A.18

COR/311

## 5A. VISUAL IMPACT

5A.1 In this Chapter the visual impact of the development is considered in relation to the amended proposals [1.2], as described in COR/111 and summarised above [2B.9-18]. In the light of my legal conclusions on the nature of the project and its indirect effects [3A.19-24], the Chapter also touches on the effects of the RCF, RCM & PRZ boreholes [2B.6] and some possible effects of the DWR if it were constructed on this site. The site and surroundings are described in COR/112 & also summarised above [2B.1-8]. The preceding Chapters 2C, 4A & 4B have analysed the development plan & other policies which bear on this topic and the other planning merits.

5A.2 As to the DWR, the initial outline design in the late 1980s was for a railhead & a disposal location including support buildings & 4 shafts, with headworks 35-50 m high [SPD/1/1, p.3]. The first site-specific design for Sellafield was for waste receipt at a new marshalling yard next to Sellafield Works, and then overground & underground rail links broadly on the line of the current Service Corridor A [2B.3] to a surface site of about 40 ha [idem, pp.3-4]. This would have been in the southernmost part of the PRZ, between Sides Lane and the B5344 [2B.2 & 7], corresponding with the location simulated in the Nirex 95 post-closure performance assessment [COR/522, Vol.3, Fig.6.1]. There would have been 4 shafts, each with a 65 m high winding tower; a new access to the A595(T); and about 60 ha of landscaping to reduce visual impact. But a review identified objections relating to visual intrusion, proximity of operations to Gosforth, impact of & severance caused by the link, doubts about the trunk road access, lighting, & aesthetic design [COR/206].

5A.3 By 1991 there were 2 design options to deal with these problems. The preferred one was for virtually all buildings to be next to the Works, with twin drifts down to the DWR, and 2 ventilation shafts rising into buildings about 15 m high in a landscaped surface site of 4 ha accessed by road from Sellafield [SPD/1/1, pp.4 & 6]. The back-up option would also be much better than the initial design, but would not have the operational simplicity of the preferred option [idem, p.9], and has now been set aside by Nirex. It was for tunnels to be bored about 50 m below ground from the Works to a surface site of about 12 ha, again with the 2 ventilation shafts but also an 8.5 m diameter shaft for waste delivery, with partially buried headworks to keep superficial height down to 15 m [idem, p.9]. In 1993, the preferred design was re-examined to ensure that the RCF would be compatible with the DWR [SPD/1/5, p.49]: and it was announced that much more design development had taken place, with a special design team recently appointed [idem].

5A.4 The RCF/RCM/PRZ boreholes development currently in operation on the PRZ [COR/101, Fig.3.1.1] has altered the appeal site's landform and appearance and is clearly visible [idem, para.3.10.2]. The then County Planning Officer expressed the view that the short term visual impact of the boreholes development on the countryside would be greater than that of any subsequent RCF or DWR [COR/201, p.246]. The developments are of up to 3 years duration from the time of commencement, plus a maximum of 4 years' post-drilling testing, and are subject to landscaping and restoration conditions [idem, pp.217 & 229]. However, some of the boreholes have yet to be drilled; and the sites of 4 of the boreholes would be incorporated into the RCF Platform, whilst the sites of 2 others would be retained as part of the Surface Site [COR/112, para.6.13].

5A.5 The methodology of Cumbria's 1992 Assessment of County Landscapes [COR/304] in support of the Structure Plan was based on the Countryside Commission's 1987 guidelines. The Assessment included the appeal site within the Main Coastal Strip of North Copeland, extending inland from Sellafield, and comprising a lower and less distinctive coastal landscape than the Coastal Cliffs & Hills to the north-west [idem, p.32, para.3.5 & Plan P246/2-0002, Sheet 5]. The Sellafield complex and associated developments are found to detract from many views. Attractive blocks of deciduous woodland to some extent mitigate the general impression of a rather intensively managed bland landscape, comprising predominantly flat or undulating agricultural land divided into large rectangular fields with shelter belts or hedges. The Strip does not project the distinctive character which would justify landscape designation.

5A.6 The Landscape Assessment in the ES [COR/101, Ca.10] was preceded by a Visual Assessment in the "Sellafield Baseline Information Report" 1990 [COR/701, Ca.5]. The methodology of the latter was based on a combination of the Countryside Commission approach and the Visual Resources techniques of the US Bureau of Land Management. Its findings were helpfully summarised in 1993 by Nirex Report 375 [COR/702], which also set out principles for mitigation in the landscape design of both an RCF and DWR on the appeal site [idem, Appendix 1].

5A.7 According to the Baseline Report [COR/701, p.112, Map 20], the PRZ falls within its Landscape Character Zone 16 (Lingbank/Longlands), which straddles the A595(T) between the Calder Valley and Gosforth [NRX/2/3, Fig.4.1]. The scenic quality of the Zone, & most of the 46 others in the study area, is assessed as containing a combination of some outstanding features and some that are fairly common to the region [COR/701, paras.5.3.15 & 5.4.2 & Map 24]. The human sensitivity level to changes in the landscape of the Zone, and its potential visibility in its surroundings, is rated as medium [idem, paras.5.4.5-12 & Maps 25-6], again like most other zones.

5A.8 The final stage of the Baseline Report's assessment technique is to assign its zones to one of 5 Management Classes [idem, p.111, Table 5.3.1]. These categorise the acceptable degrees of change which are warranted by the basic landscape elements of the zone, placing the most disturbed landscapes in Class 5 and the best conserved ones in Class 1. Zone 16 was initially placed in Class 4 by the standard methodology [idem, Table 5.4.1 & Map 27], but modification of the original, largely quantitative method, by adding all available judgemental information, led to a revision [idem, Map 28].

5A.9 The portion of the Zone which is in the National Park was upgraded to Class 2 [idem, para.5.5.7], whilst most of the rest & of the PRZ was upgraded to Class 3 [idem, para.5.5.9] because it is adjacent to the Park and includes the attractive Lingbank Plantation [COR/101, Fig.3.5.1 & COR/112, para.6.6]. The consequence was that the site is in an area classed as intrinsically not outstanding yet important in terms of its context [COR/701, p.120, Class 3], which could support some change & development, but changes in form, line, colour & texture of a development should remain subordinate to the existing landscape [idem, para.5.6.3]. The strip of Zone 16 to the south-west of the PRZ remains in Class 4 because it is less attractive & visible, and overlooks the Sellafield Works.

5A.10 The Landscape Quality section of the ES [COR/101, paras.3.10.54-5] emphasises that the average scenic quality of Longlands Farm & Lingbank Plantation is of slightly greater landscape value than that of areas to the south & west. This is said to be because of its attractive topographic features, the visual variety & structure provided by the woodland blocks, and the screening of views of Sellafield by some of those blocks. The situation of the area adjacent to the National Park is noted as an additional factor.

5A.11 The ES sets out Nirex's assessment of the RCF development as at the time of the application. The main differences in visual terms between the amended application now being considered [NRX/2/3, Fig.5.2] and the development which was the subject of the ES are due to the views of MAFF on planting trees on temporary soil mounds, and to the extra depth of excavation and resultant spoil [2B.14] which is a contingency for less promising geology at the 650 m bOD horizon [2B.13]. Additional matters of detail have also been negotiated during the inquiry and are addressed further in Chapter 7A. These relate to the colours of the external elevations of the headgear and buildings [COR/113, s.2]; security fencing & lighting [2B.11 & NRX/1/5]; and landscape planting & management [NRX/11/18 & COR/113, s.8]. Re-routing of the electricity supply is also proposed [COR/113, Condition 4 & Drg. No.008008D].

5A.12 The extent of potential visibility of the RCF is illustrated by Visual Envelope Maps (VEMs) in the ES and in other documents submitted by Nirex and Cumbria, but they are generally based upon topography and so are only indicative. None of the VEMs account for hedgerows, trees or walls and buildings. Nirex's VEMs in the ES [COR/101, Figs.3.10.20-27] and in NRX/2/3 [idem, Fig.6.2] use the highest structures at the Sellafield Works (piles and stacks) for reference and also take account of the screening effect of large blocks of woodland. Cumbria's VEMs relate either to a height in the middle of the 4 cooling towers at Sellafield [CCC/2/1, Fig.4a] or to the southern pair of towers [CCC/3/1, Figs.3-3b]. They do not take account of the higher piles & stacks at the Sellafield Works (some 30 m or so higher than the towers), so reducing Cumbria's VEM coverage of Sellafield in relation to the RCF.

5A.13 It is agreed that the proposals would cause some visual intrusion [COR/101, para.3.10.3]. Changes would be made in the landscape within the appeal site related to landform, vegetation cover and built structures [idem, paras.3.10.101-5]. The extensive earthworks associated with the creation of the Platform Site and bunds would affect topography, as would the excavated spoil through creation of a new landform. Some 15 trees and some 450 m of hedgerow and scrub within the valley would be removed; and hard-standings, buildings, cranes, shafts and access roads would be introduced into the landscape of the Surface Site.

5A.14 The development would be potentially visible to residents & the public from points in a wide arc around the site, including roads & other public rights of way both in the National Park and on the coast [idem, Tables 3.10.1-5 & Figs.3.10.19-38]. Significant developments & modern structures, especially the Sellafield Works [NRX/2/3, Fig.4.2], share some of the fields of view. The network of rights of way near the PRZ according to the 1989 Definitive Map is shown on Fig.3.12.1 of the ES. The shaft headgear buildings are estimated to be potentially visible from about half of the land area within 1.5 km of the centre of the Platform Site and less than a quarter of the land area from 1.5 to 5 km

[COR/101, para.3.10.6]. Photomontages in the ES indicate some of the anticipated impact [idem, Figs.3.10.7-18, viewpoint plan Fig.3.10.19, but NB Figs.3.10.12-3 are not from a realistic public viewpoint]. Nirex's subsequent analysis of the ES's assessment indicates that there would be a range of slight to substantial visual effects on a variety of properties [NRX/2/3, Table & Fig.6.1].

5A.15 However, because the topography falls away from the A595(T) to the platform site and towards the coast [see sections in COR/101, Figs.3.10.2-5 & map Fig.3.10.34], the appeal site is not very visible from the A595(T). When travelling south or north on this road, the site appears briefly on approaching the site access; and while passing the access the Sellafield Works is also in view. Otherwise along this road, the site is only visible from a limited number of viewpoints for short distances. In addition, the retention of Longlands Farmhouse would help to screen views of the development itself generally from the east.

5A.16 The freeze drilling rigs (25 m), if they are required [2B.12], and the tower crane (35 m) are assessed to contrast strongly, due to their scale and appearance, with their surroundings for the relatively short period they are needed [idem, para.3.10.66]. The lower longer-term buildings would also stand out because of their simple geometric shape, larger scale and the texture of the cladding materials used [idem, para.3.10.67, but see COR/113, s.2]. Lighting would contrast the Platform Site with its unlit surroundings except when seen with an illuminated area behind (eg the Sellafield Works) [COR/101, para.3.10.69]. The landscaping proposals illustrated in the ES [idem, Figs.2.11-16], and since revised [NRX/2/3, Fig.5.2] are designed to screen & integrate the development and improve its setting's landscape character & visual amenity. RCF/RCM/PRZ Borehole planting has already commenced.

5A.17 Notwithstanding its location immediately on the other side of the A595(T) from the appeal site, the setting of Sally Hill (listed Grade II) is assessed to be unaffected because the topography [COR/101, Fig.3.10.2] would result in only the top of the tower crane, if anything, being visible over hedges [idem, Table 3.10.6]. Other listed buildings would also be unaffected. Whilst there would be inter-visibility with the Scheduled Ancient Monument at Seascale Stone Circle to the south-west [idem, Fig.3.11.1], the Monument is regarded as too distant at 2.7 km for its setting to be affected. No party to the inquiry has demurred from these judgements.

5A.18 The conclusion in the ES concerning landscape quality in relation to the National Park is that the development would affect the Park, due to the visibility mainly of the shaft headgear from within the Park, and its appearance in views from the Park [idem, paras.3.10.88-91]. But, whilst the impact on the landscape in which the development itself would lie is assessed as significant albeit temporary, the impact on the Park is assessed as small. The overall effects of the development on landscape amenity are consequently considered to be minor due to the limited effect on the Park and the average value of the area directly affected.

5A.19 **Nirex** claims that the form and siting of the RCF would be appropriate to the function which it is intended to fulfil. Its proposals have located and designed the development to minimise visual intrusion by cut & fill; by minimising structure height; by optimising

screening by the landform; by sympathetic shaping of spoil and by the subdued use of lighting [idem, paras.3.10.4 & 10]. The texture and colour of its cladding would also help the headgear to blend into the background.

5A.20 Furthermore, open headgear as advocated by Copeland would be technically possible, if thought preferable despite the proposals being designed in accordance with modern mining practice. Fencing has been reduced by 20% in response to comments by Gosforth & Cllr Gray [NRX/1/5, Fig.2]. Minimal light spillage would be assured by the proposed low level of operational lighting of 20-50 lux needed to illuminate the Surface Site for vehicles and pedestrians. Temporary lighting would be shielded from Sides Bungalow by trees on the boundary of its curtilage and intervening topography and vegetation during the period between dusk and 1900 hours for the 12 months it would be needed. Cumbria accepts that the proposed detailed schemes are the best that could be achieved in the circumstances, including the details of the design of the structures [NRX/11/12 & 14].

5A.21 The phased landscaping proposals [NRX/2/3, Fig.5.2] would provide screening around the development, and facilitate its integration with the existing landscape and surrounding vegetation structure. Most of the small valley in the PRZ would be retained throughout the development. The landscape character and visual amenity of the local area would be improved through the creation of some 4.85 ha of new indigenous broadleaved woodlands and the strengthening of hedgerows. Mitigation of potential effects on local fauna and provision of habitats for flora and fauna would also be achieved (see Chapter 5E). The visual effects of the development would be reduced as planting matures. Following restoration, the long term effects of the development on the landscape would be insignificant [COR/101, para.3.10.9], with the spoil heap taking the locally familiar shape of a drumlin (ovoid hillock formed by glaciation).

5A.22 Nirex claims that no party suggests an alternative to the appeal site for the proposed investigation of the BVG at Sellafield. Mr Spendlove's alternative proposals for the RCF shafts and surface works within the site would have significant practical and scientific disadvantages. He has in the first place confused the 15 m height of the permanent ventilation shaft headgear in the preferred DWR design option with the height of its temporary construction headgear, which would be in the same 25-30 m range as the RCF's. Then his alternative shafts would not be squarely within the volume of rock which has been preliminarily characterised in COR/524, and which would be monitored by the already approved boreholes. Furthermore, his preferred location would entail construction through up to 22 m of unconsolidated ground.

5A.23 His alternative locations & platform heights could well result in a greater impact upon the surroundings than the appeal proposals, in Nirex's view. In particular, Mr Spendlove does not appear to have taken into account the visual impact of his own artificial slopes, such as the red rock-bolted sandstones; nor the points that, if the RCF proceeds beyond Phase 1, his scheme would cause a long delay and produce more spoil than the present proposals. Cumbria, in contrast, accepts the chosen level of the platform site as striking the best balance between utilising the local topography to assist in screening the development and mitigating the local environmental disruption caused by cut & fill.



5A.24 Thus Nirex considers that the RCF could be accommodated by the landscape without significant adverse effect. It would not directly impinge on the Lake District National Park, and no party has specified any alleged detriment to the present character, appearance, qualities or distinctive features of the Park. The landscape quality of the area immediately surrounding the RCF is not high. It does not lie within any designated landscape area, nor does it merit "County Landscape" status. It is within the very wide area over which the Sellafield Works exerts a strong visual influence, as Cumbria accepts [NRX/2/3, Fig.6.2 & CCC/2/1, Fig.5a]. There are other modern man-made structures, in addition to settlements, in this area [NRX/2/3, Fig.4.2]. On the other hand, there would be sufficient separation between the RCF and the Sellafield Works to avoid a cumulative impact.

5A.25 Cumbria also concedes that the land within the National Park just east of the A595(T) in the vicinity of the PRZ is broadly similar in character to the land to the west of the road. That stretch of the Park is not identified as an area which the Park authority feels it is particularly important to conserve under the provisions of the Wildlife & Countryside Act 1981 [COR/309, Fig.2]; neither does it, taken in isolation, exhibit all the special characteristics which lead to National Park designation. Cumbria also accepts that the really distinct change in the character of the local countryside is where the undulating farm & estate lands give way to moorland and fell near Hurlbarrow [NRX/2/3, Fig.4.1].

5A.26 The immediate context of the activities on the appeal site would be a landscape of merely average value. Also they would be obscured from most public viewpoints in the National Park, and from travellers along the A595(T) - the main transport corridor - except at the site entrance. Although the spoil disposal area would be seen from the inside of the bend in the Newton Manor drive [2B.7-8], the drive is a private road [NRX/11/8, para.2.1], and the activities are unlikely to have an adverse impact if they are not seen from any public vantage point. Nirex considers that, although the earthworks of the boreholes in and around the Platform Site give rise to some visual intrusion depending on the stage of development and proximity of view, this impact is not significant in the context of the character of the existing landscape. Yet the former County Planning Officer foresaw the RCF/RCM/PRZ borehole development as being more obtrusive than the RCF in the short term.

5A.27 The RCF would not be seen from many local viewpoints, and it must be borne in mind that Nirex's VEMs constitute a worst case analysis. The tallest RCF structure, the tower crane, would only be on site for 11 months and the others for less than 12 years. Visual impact of the RCF would normally be limited to that caused by the top of the shaft headgear and the hopper, because of the visual containment by the topography, Farm buildings and the Boreholes screen planting. Should it be concluded that there would be some residual intrusion notwithstanding the landscaping and restoration schemes, which have now been agreed with Cumbria [COR/113, Conditions 28a-b & 29 & NRX/11/18], Nirex considers that such effects could be further ameliorated by additional design work.

5A.28 Cumbria concedes that a number of views of the RCF from the coastal strip, and at close range in the National Park, would be contained and intermittent. The viewpoints within a radius of 2 km of the site which Cumbria feels are important extend to only 30% of a circle. Only the upper part of the RCF structures would be visible from the National Park and Cumbria admits that this part of the Park is not frequented by large numbers of people. Furthermore, Cumbria also accepts that walkers in the National Park would usually see the

RCF together with the Sellafield Works. Nirex submits that the predominance of Sellafield in the visual context for the RCF is demonstrated by its VEMs [NRX/2/3, Fig.6.2] and by the more detailed analysis of fields of view from viewpoints identified in the ES [NRX/2/1]. It regards Cumbria's use of a field of view of only 50° as unrealistically blinkered.

5A.29 The limited extent of views is illustrated by Cumbria's own photomontages CCC/2/2, Figs.S1-S3 (near Moss Wood, near Tarn How & near Hurlbarrow Farm - superseding idem, Figs.4c-e) even though these photomontages still suffer from some technical shortcomings [NRX/2/2]. In the first (S1) the view would be limited to the South Shaft headgear, a small proportion of the North Shaft headgear and a glimpse of the hopper. The lower buildings would not be seen. The second view (S2) would be limited to one shaft, the top of the winder house and the hopper, with the lower buildings and conveyor unseen. The third view (S3) would show only the shafts and hopper merging with the background. The lack of rigour in Cumbria's analysis is exemplified by its reliance upon ES photomontages 3.10.12-13 from Sides Lane, which are not taken from normal eye level where the high hedges would obscure views.

5A.30 The only views of the National Park which would include the RCF would be from the south-west. They would be limited to the tops of the taller structures and screened from many viewpoints. Some views, such as that from Brownbank [COR/101, Fig.3.10.11], would have a background not confined to the National Park. The only settlement affected would be the village of Seascale, along its eastern edge [idem, Fig.3.10.7]. Although the view of the Park from parts of Seascale Golf Course & the public footpath alongside it would also be affected, the effect would be ameliorated to some degree by the distances involved [idem, Fig.3.10.14]; and their visual amenity would not be harmed given the wider landscape setting of the Golf Course.

5A.31 It is generally accepted by the other parties that the development would not adversely affect the visual setting of Sally Hill or any other heritage site. Although Mr Balogh refers to the proposed Hadrian's Wall Military Zone [BLG/1/10], English Heritage does not positively recommend in its Draft Management Plan that any of the Cumbrian coast between Maryport & Ravenglass be defined as part of the Zone [idem, para.5.4.1 & coloured green on NRX/11/10]. This is because there are only sporadic Roman sites along this stretch of coastline [BLG/1/10, para.5.3.6, last bullet point]. Some land down this coast is tentatively identified [coloured orange on the map] as possibly part of a wider Zone which would include visual settings, but even then the nearest part of this to the RCF would be as far away as Seascale Stone Circle, which as an individual feature is agreed to be too distant from the RCF to be affected.

5A.32 Nirex consequently denies that the adverse impact of the RCF development upon the countryside surrounding the appeal site or, bearing in mind the Kirkby Moor appeal decision [4A.15-16], the character of the National Park, would be significant. There would be no long term diminution in the quality of the landscape but an enhancement as a result of this scheme. Visually intrusive effects and localised physical change would be either temporary or would in the long term be offset by the beneficial effects of new woodlands and enriched vegetation cover in and around the appeal site.

5A.33 **Cumbria** regards the visual impact of the RCF as being demonstrably harmful to both local viewpoints and those in the adjacent National Park. A similar view was also taken on the applications for the RCF/RCM/PRZ Boreholes, and they were granted permissions of a very temporary nature only because it was accepted at that stage that there was still important information to be obtained, and in the light of appeal decisions for Boreholes 8, 8a, 9 and 9a [COR/201, pp.248-9 & 343-375]. The basic points remain that the countryside is to be protected for its own sake as a matter of national policy, and the natural beauty of the National Park needs to be preserved & enhanced and its enjoyment promoted in conformity with statute.

5A.34 The RCF would be an incongruous new industrial development set in open countryside, some of which is of high quality as found by Nirex's own Baseline Report [5A.9], and within which Nirex concedes there would be some significant visual effects [NRX/2/3, Table 6.1]. The local topography and the landscaping measures would have only limited screening effects. The RCF may be regarded as temporary but would be preceded by obvious construction activity such as a tall tower crane and periods of intense lighting. It would last for some 15 to 20 years as a discrete project including boreholes & restoration, and this would be a relatively long time. The construction lighting, at 300 lux on 20 m columns and switched on up to 1900 hours on weekdays for a construction period of up to 2 years, could even be powerful enough to be intrusive to Sides Lane Bungalow.

5A.35 Taking views from properties as indicators, within 1.7 km of the RCF there would be a range of slight & moderate impacts, and in some places substantial ones [idem, Table 6.1 again]. The RCF would be seen against the skyline from some viewpoints. For example from the Seven Acres Caravan Site & Brownbank [COR/101, Figs.3.10.10-11]; from near Moss Wood, near Tarn How & near Hurlbarrow Farm and on the bridleway near the Seven Acres Caravan Site [CCC/2/2, Figs.S1-S3 & 4f]; from the Red Admiral before tree screening obscures the open view [COR/101, Figs.3.10.8-9]; and from Sides Lane [idem, Fig.3.10.13] even with an allowance for a lower, and more realistic, height of eye.

5A.36 Other viewpoints show the RCF against the Fells in the National Park, notably from the outskirts of Seascale [idem, Figs.3.10.7 & 14]. The significant visual presence of the Sellafield Works would not make the RCF more acceptable in such a context. The RCF would be perceived from Seascale as an independent industrial development with the Park as its backdrop; and would also be seen separately from Sellafield at points to the north in the Park, such as at Ponsonby [idem, Fig.3.10.17]. When viewed from the Park in the same scene as the Sellafield Works, as at High Boonwood [CCC/3/1, Fig.3a, viewpoint 1], the RCF would be regarded as an extension of the Sellafield development, thereby exacerbating the impact, not alleviating it.

5A.37 The RCF would be an alien development [CCC/2/1, Fig.3a] visible over a wide area [idem, Fig.4a] and intruding into the important "buffer zone" between Sellafield and the National Park. The local area is popular with visitors wishing to see the many sites of interest. Recreational users of the National Park would observe the significant impact of the RCF during walks in what is designated as a "Quieter Area" in the Deposit Local Plan [COR/309, para.2.10 & CCC/3/1, Fig.2]. Walkers would stop occasionally to look about, especially on hills. Footpaths, bridleways and lanes are a feature of the area to the north-east of the appeal site, and users would observe the adverse impact of the development just as do

the occupiers of various dwellings in the locality [eg NRX/2/3, Table 6.1 Nos.38 (Ponsonby Old Hall), 39 (Sella View), 40 (Gibb Hill), 41 (Gibb Hill Farm) & COR/101, Fig.3.10.17].

5A.38 A typical circular walk starting at Gosforth [CCC/3/1, Fig.3a, viewpoints 1 to 11 and photomontages CCC/2/1, Figs. 4f & 4h] illustrates the frequent and clear views of the RCF which would be potentially visible. Motorists would also see the development [eg CCC/3/1, Fig.3a, viewpoints 3 & 4]. Not only would the RCF be prominent from the Park and elsewhere, but it would also lack affinity with the predominantly rural scene. This would be emphasised by the tall structures, spoil dumping and substantial lighting characteristic of industrial and mining operations. Cumbria, joined by Copeland, FOLD, the Ramblers Association [WR/RAM/1] and other objectors, emphasise the importance of the fringes of the National Park to its character and enjoyment, notwithstanding the different approach in the Kirby Moor appeal decision.

5A.39 The substantial degree of intrusion can be estimated in relation to the drilling rig of similar height to the RCF (about 30 m) on the site as seen from north of Hurlbarrow Farm [CCC/3/4 - taken near location 6 on CCC/3/1, Fig.3a] and again at In Fell [CCC/3/5 - taken at location 9 on CCC/3/1, Fig.3a]. This can be verified during the accompanied site inspection, when a crane is located on the South Shaft site & raised to the same height as that proposed for the RCF headgear.

5A.40 Potential visibility of the RCF in the National Park extends beyond 8 km [CCC/3/1, Fig.3], and in some areas where Sellafield's cooling towers are not visible [idem, Fig.3b]. This is so even allowing for woodland cover not included in the visual envelope modelling [eg Seven Acres Caravan Site - CCC/2/1, Fig.4f]. The visual impact would be mitigated by distance and by haze, mist or rain, but better visibility normally coincides with greater use of the National Park for recreation. Photomontage CCC/2/1, Fig 4g, for example, demonstrates a clearer distant view than COR/101, Fig.13.10.18. The widespread impact on the National Park would clearly be contrary to the policies already considered, and constitute demonstrable harm to an interest of internationally acknowledged importance. The overall visual effects are the principal ingredient of the environmental harm which would be caused by the RCF, in Cumbria's judgement.

5A.41 Copeland emphasises the differing visual impacts from the separate phases of the RCF development namely, about 4 years for construction, 6 years operational, and 2½ years restoration. Nirex accepts that overall these would be wholly different in scale to any previous borehole. During the construction phase the tower crane (some 35 m high) would be on site for about 11 months, and potentially visible over 56% of the locality between 1 km and 5 km of the site. Construction headgear between 25 m and 30 m high would be on site for about 39 months. Nirex concedes that a major alteration would be made to the shape of the landscape of the valley form. The tree and hedgerow loss there [5A.13] should be set off against Nirex's proposal to plant new woodland.

5A.42 The operational headgear buildings (29.2 m high) & winder houses could be in place for some 9 years. They would have a substantial extent of potential visibility [5A.14] both outside & inside the National Park, in countryside which is overwhelmingly rural in character & sensitive to visually harmful development. The significant and wide-ranging adverse

impact upon local views and upon local visual amenity would be contrary to national policy as well as Structure Plan & emerging Local Plan policies. Although Nirex has claimed that the RCF proposals would not cause any visual obstruction, it does now concede that the roadside planting to screen the associated borehole development will block the open view south-westwards from the Red Admiral Hotel [COR/101, Figs.3.10.8-9]. That is one of the public viewpoints within the National Park nearest to the development. On the other hand, as Nirex further concedes, the existing woodland and topography are a natural barrier between Sellafield Works and the Surface Site, with the consequences that the Works do not detract from the landscape quality of the Site and would be visually separate from the RCF.

5A.43 As for the external appearance of the RCF structures, the detailed design proposals agreed with Cumbria [NRX/11/12] are still unsatisfactory so far as Copeland is concerned, and do not accord with LP policies. The most visible parts of the operational buildings, with flat roofs and clad with plastic coated profiled metal sheets, would not reflect local vernacular trends in form & construction, contrary to Nirex's own design principles for permanent buildings on the appeal site [COR/702, Appendix 1, 7th bullet point]. The RCF would look like a substantial alien development, failing to fulfil Nirex's own desire to achieve the maximum degree of harmony within the landscape.

5A.44 Gosforth, adopting the evidence of Mr Spendlove (see below), and supported by Councillor D W T Gray in his own right, is of the view that the proposals exceed what is strictly necessary for the RCF and considers that they incorporate requirements for development of the DWR. Car parking and office space are cases in point. The impact of both the RCF and DWR should be considered at this stage.

5A.45 Experience with the borehole developments has shown local people the harmful effects of lighting. Boreholes were introduced into a rural agricultural area where little or no light pollution existed in contrast to the glare at the distant and distinguishable Sellafield Works. Lighting from the proposals would add to the present intrusive effects, especially if switched on throughout the night. The borehole development on the PRZ has also led to the recently constructed access from the A595(T) giving an industrial air to the site entrance, in contrast to the countryside setting which the appeal site shares with Gosforth village. The village is regarded as a "gateway" to some of the most beautiful western valleys of the Lake District.

5A.46 Gosforth & Cllr Gray believe that the mitigation measures would only have a limited effect from surrounding viewpoints, including the well used network of rights of way between Gosforth and Seascale. The headgear would be very prominent locally, emphasised by the industrial box-like design of buildings and structures and the tall illuminated security fencing, which would contrast with the rural character of their surroundings. The potential impact of the fencing and proliferation of obtrusive signs can be gauged from existing nuclear industry installations in the locality [GRY/1/2]. The proposals do not compare favourably with the sympathetic environmental approach taken in Sweden for the Äspö project [GRY/1/4].

5A.47 The extensive levelled platform (4 ha) would require considerable excavation and seems excessive. Gosforth's witnesses and Mrs Lowery can personally testify that Newton Manor drive has been used as a public right of way without challenge for several decades, and the extensive spoil disposal area would be visible from this. In the absence of the

internal transport link to Sellafield envisaged by the preferred DWR design option [5A.3], the A595(T) access to the site would attract additional activity near Gosforth and the National Park instead of towards the Sellafield Works. Gosforth regards it as important that details should be the subject of any formal planning approval. Although the proposals are said to be temporary, the term is lengthy for such a degree of harm, especially considering the time for the site to be fully restored to agricultural use.

5A.48 The Shop Stewards, on the other hand, support Nirex, and particularly on the visual impact issues. Although the proposed structures would have some visual effect at close quarters, they would be insignificant from within the National Park. There has been a dramatic increase in visitors to North Copeland over the last 15 years, especially to the Sellafield Visitors Centre [NRX/2/3, Fig.4.2] and on the Coast-to-Coast Walk from St Bees to Ravenscar. The visual impact of the RCF must be assessed against the large numbers of projects permitted at the Sellafield Works during the same period [CBC/1/1], by contrast with which the RCF would pale into insignificance. If there is concern about the visibility of developments on the coastal strip from the higher ground in the National Park, the permitted opencast coal workings over a 10-13 km stretch between Keekle & Workington have had a far greater local impact before restoration.

5A.49 Seascale Parish Council also supports the RCF proposals, but on scientific grounds, whereas it considers that visual intrusion would be inevitable. The RCF structures would impinge on presently undisturbed views of the Lakeland Fells from Seascale; and from this aspect the long-term landscaping measures would actually hide pleasant features from view rather than screen unattractive ones.

5A.50 FOLD, also supported by the Ramblers Association (Lake District Area) and the Council for National Parks, and representing the CPRE and YHA, do not see a special environmental designation of the PRZ as a prerequisite for a cogent case of objection on grounds of landscape impact. They point out that the landscape is continuous and varied rather than a patchwork of specially designated areas. Quantitative landscape assessment, as advocated by Nirex, is misleading; and structures like overhead power lines, although detracting, do not undermine the value of the PRZ setting.

5A.51 They see the proposals as being an entirely separate development in the landscape from the Sellafield Works, even though connected by such power lines; and the existence of the Works does not justify any further disfigurement. On the contrary, because of the high value of the general landscape to visitors and residents using public rights of way for recreation, especially in the National Park, there is a greater sensitivity to significant development of the sort proposed. Once the eye is caught by such a development, it is difficult to prevent the eye straying to it at every opportunity and to escape the perception of a less attractive scene.

5A.52 The scale and nature of the proposals, described by Nirex as similar to a modern industrial design typical of coalfields, would be extremely damaging. Security fencing, lighting and additional activity would add to the intrusion despite Nirex's efforts at reduction. Nirex concedes that the cumulative effect of the programme of temporary

boreholes has been significant in the landscape, and yet these proposals would be much worse. FOLD are not convinced that the significant changes to the landform and landscape character through the proposed earthworks cannot be reduced by exploration of other siting options.

5A.53 In addition, there has been no environmental assessment of the effects of quarrying the limestone for backfill. Neither has there been an objective appraisal of the transitionally unprepossessing appearance of the new planting whilst it is sheathed in plastic tubes, nor of the permanent change in character of the local landscape. Furthermore, the submitted restoration scheme is based on the premise that the RCF would be unsuccessful from the scientific point of view. Nirex actually claims to consider success to be the more likely outcome, in which case the next development stage would probably not be restoration but transition to the surface site of the DWR [5A.3]. Yet no assessment of the visual & other effects of this has been submitted.

5A.54 Mr N R Spendlove, supported by Gosforth, South Lakeland District Council [WR/SLC/1], Blawith & Subberthwaite Parish Council [WR/BSP/1] & 2 other parish councils in South Lakeland, proposes that only one shaft needs to be sunk to achieve the data for the first decision point on whether to proceed to a DWR or abandon this PRZ. Alternative locations for the RCF shafts and alternative schemes for the surface works would be feasible and less intrusive in the landscape. Extending the Platform Site into the valley to the west [SPD/1/7, Fig.4.1, item 8 & Fig.4.4] would allow the operational headgears installed after construction to be no more than 15 m above ground level instead of 29.2 m. They could also be more sensitively clad [idem, Figs.4.6 & 4.8].

5A.55 The single shaft would suffice for what would effectively be Phase 1 of the RCF scientific programme [2B.15]. This proposition leads directly to the realisation that the superstructure in the present proposals would be grossly excessive for the scenario in which the decision to abandon the PRZ is taken during Phase 1. Ample office & research accommodation to support this Phase could be provided in Longlands Farmhouse & at Nirex's Cumbrian headquarters, which are only 4.8 km south-east away down the A595(T) at Greengarth, just before the village of Holmrook [NRX/2/3, Fig.4.1]. The upper floor of the proposed office block [COR/102B/008022C] would not then be required. The 1,120 m<sup>2</sup> car park of 324 spaces is also seen to be largely unnecessary, and does not need to be provided on the Platform Site in any event.

5A.56 Also, operational headgears, heap-stead buildings, main extractor fan ducts and fan house, and the North Shaft disposal hopper and conveyor would never be built if the site were to be found unsuitable during the single shaft sinking stage. Whilst there would be a delay & some extra cost before sinking the second shaft if it were decided in due course to proceed with Phases 2 & 3, the risk of considerably extending the period of environmental damage by going on to use the redundant RCF structures for generic research or DWR purposes without a full re-appraisal would be avoided.

5A.57 Mr Spendlove suggests 3 options for minimising impact during the sinking of the first (South) shaft [idem, Figs.4.2-4.7]. Option 1, creating a new platform at 68 m aOD, would cut into the existing drilling platform to sink the South Shaft at the RCF3 Borehole position [idem, Figs.4.2-4]. This option would obscure the development from all but 2 of the

dwellings otherwise affected in Nirex's survey [NRX/2/3, Fig.6.1]. Soil stripping and total rock and spoil excavation would be greatly reduced from about 5 ha to about 0.8 ha and from about 86,000 m<sup>3</sup> to about 50,000 m<sup>3</sup> respectively. The valley to the west would be used for an access road instead of being filled to a depth of about 14 m in the Nirex proposals.

5A.58 Option 2 would achieve sunken access to Borehole RCF3 by excavation from the south-west but without cutting away the whole shaft platform, and by siting the winder house on it, resulting in about 25,000 m<sup>3</sup> of spoil [idem, Figs.4.5-6]. Option 3 would re-site the South Shaft some 130 m to the south-west, where minimal excavation would be required to construct a shaft platform at low level [idem, Fig.4.7]. Contrary to Nirex's criticism, it would only be Option 3 which did not sink into the volume of rock which Nirex has been readying itself to characterise. All 3 of the options could comply with basic safety requirements. If it were decided to sink a second shaft, there would no particular benefit in its being only 50 m away from the first, as Nirex currently proposes; and indeed Mr Spendlove sees more benefits in a greater separation distance.

5A.59 FOE Cumbria and other parties, plus many written representations [eg WR/O/32, WR/P/126, WR/FOE/18] also maintain a visual impact objection. Mrs M S K Higham particularly emphasises the unique inter-relationship of the landscape of the Fells with the coastal region, and the views of the Isle of Man beyond. Mr S Balogh draws attention to the need to take account of the impact on the setting of the Hadrian's Wall Military Zone set out in the Draft Management Plan [BLG/1/10], including long distance views towards the Wall or associated fortifications down the coast [idem, para.5.2.2]. Mr J Fitzsimons MEP points out the value of the scenic beauty of the Lake District National Park to international tourism.

5A.7  
2B.4  
2B.2  
5A.25  
5A.45  
5A.60 My conclusions on the visual impact of the development stem from an initial judgement that the landscape character of the PRZ is fairly reflected by the assessment in the Sellafield Baseline Information Report. The PRZ, and particularly the Surface Site, are located in an area of relatively uncluttered open countryside adjacent to the designated National Park. There is a continuum in the relatively open landscape across the A595(T), as the Baseline Report observes. But this means to me that there is an inter-dependence between managing the landscape of the PRZ and enhancing the beauty & promoting the enjoyment of the Park. It does not mean that this fringe of the Park is less important than usual. I also accept that the location is additionally sensitive because it is close to Gosforth village which forms a focal point for visitors gaining access to the western Lake District.

5A.5  
5A.9  
2B.4  
5A.61 The County Council's Assessment of County Landscapes was designed to serve a different purpose from the Baseline Report and ES, namely to select specially distinctive areas for designation outside the National Park. The omission of the PRZ from such designation as a result of that Assessment's broad-brush approach does not detract from the conclusions of the Baseline Report's & ES's more localised & detailed analyses, in my view. The setting of the PRZ is important because the PRZ is of a scenic character similar to that of the contiguous edge of a designated landscape of at least national importance. The site itself also contains topographic features which are attractive in their own right, notably the woodland and the small & secluded valley.



5A.48 5A.62 As some parties have pointed out, there is also a much broader perspective, in the  
5A.59 sweep of the view down from the fells, across the fairly narrow coastal strip, and out to sea.  
Although I accept that there are much larger developments in this general scene, especially  
5A.9 the opencast coal zone and the Sellafield Works, the former is well to the north, and the latter  
5A.10 is visually distinct from the PRZ at the local level, as the Baseline Report & ES themselves  
3A.19 note. On the other hand, the RCF development would not be so small-scale as to be trivial  
5A.21 in comparison. This is particularly so in the context of the RCF/RCM/PRZ Borehole  
developments being part of the same project, and of the contingent provision for the RCF to  
be followed by the DWR.

5A.12 5A.63 In examining the impact of the present proposals, the VEMs submitted by Nirex and  
Cumbria give useful indications of the extent of potential visibility of the RCF structures in  
5A.34-5 relation to the Sellafield Works, bearing in mind the differences in the way the VEMs have  
5A.14 been processed. Nirex accepts that a number of residents spread around the locality would  
5A.28 see the RCF; and it is clear that, potentially, the RCF would be intermittently visible over  
5A.14 a very wide area, but not to the same extent as the Sellafield Works. The relationship of the  
rights-of-way network to properties is such that the general public would obviously experience  
similar visual effects. In short, the RCF would not obtrusively pervade its environs, but it  
would frequently be disconcertingly noticeable, in my judgement.

5A.39 5A.64 My site inspections, some of them with the benefit of a crane on the spot of the  
proposed South Shaft, broadly confirmed that the VEMS fairly indicate in their different ways  
the extremes of visibility, both existing & potential. My general observations on views from  
the higher ground, a couple of kilometres or more away from the appeal site, are that the first  
inclination is to look out to sea, especially on a clear day: that, if it is visible, the eye is then  
drawn by the Sellafield Works: but that, even where the appeal site & the Works are  
virtually aligned in the field of view, it is almost always clear that their locations are well  
5A.24 separated. Consequently I have concluded that the upper structures of the RCF would be  
5A.18 intermittently seen from some distance away in the National Park as distinct, modern  
5A.20 protrusions beside the Park's fringe.

5A.30 5A.65 Looking at the site basically from the opposite direction, near the coast at Seascale to  
5A.36 the south-west, there would in my view be a similar perception, save that the structures  
would be seen against the impressive background of the lower, western fells which are mainly  
in the National Park. This would be the scene from the extensive amenity space of the  
Seascale Golf Course and the well-used public footpath beside it. Although the Sellafield  
Works is close by there, it lies just west of north, and the viewer really needs to turn away  
from the prospect of the fells to take in the Works. There are similar, albeit discontinuous,  
5A.35 impressions on the B5344 from Seascale towards Gosforth, until the RCF would become a  
COR/101, skyline feature, in which form it would be seen on Footpath 409011 from Moss Wood to  
Fig.3.12.1 Fleming Hall. However, the path is obviously little used; and then vegetation largely  
5A.29 obscures views of the Surface Site from Byway 409309 along Sides Lane itself.

5A.26 5A.66 I also agree with Nirex that there would be relatively few views of the development  
5A.15 from the A595(T). However, there would be enough for some travellers from the south-east  
to appreciate that they were approaching some modern development in the countryside before  
2B.7 Sellafield, in my judgement. Also the Surface Site's access from the road is an obvious  
5A.45 works entrance. To my mind the engineering works have left their mark there, and their

5A.35 incongruity has already harmed the character of the countryside flanking both sides of the  
5A.42 trunk road. The planting opposite the Red Admiral Hotel is also obscuring a view seawards  
from this point on the edge of the National Park where people naturally tend to congregate.  
It is not a justification that the access & planting have been provided in association with the  
borehole developments, since I have concluded that those developments are part of the same  
project as the present proposals, and indeed the access & planting are relied on to serve &  
screen these proposals.

5A.13 5A.67 Moreover, the proposals would certainly cause visual harm to their immediate setting,  
5A.18 as the ES concluded. Nirex has made little attempt to design in keeping with the local  
5A.20 vernacular tradition, relying rather on modern mining designs employed in other parts of the  
5A.16 country. This criticism applies to the buildings as well as the more prominent headworks, and  
5A.45-6 the consequence is that they would look palpably out of place, in my view. There would be  
5A.20 some inevitably adverse impact too from the lighting & the fencing.

5A.41 5A.68 Mr Spendlove's objection, adopted by Gosforth, is a reminder that the issue over the  
5A.57-8 interesting little valley is not whether it would be harmed, but what would be the feasible  
minimum extent of its harm. My broad conclusions on his alternatives are that they would  
have less visual impact than Phase 1 of the submitted project, but that if the enterprise  
proceeded to Phases 2 & 3, the implications of his approach would be more costly, time-  
5A.23 consuming & productive of spoil. Nirex's resistance to his step-by-step attitude does  
5A.20 emphasises the importance it attaches to the later, DWR design stages of the underground  
operations, in contrast to its lack of a direct riposte to his criticism of the sizes of the  
5A.55 temporary offices & car park. Whilst the relative seclusion of the buildings and their  
5A.26 curtilage from public view would mitigate their visual impact, I consider that it does not  
remove the basic objection that they would do visible harm to a rather pleasant piece of  
countryside.

5A.26 5A.69 Similar remarks apply to the spoil disposal area, which would be on a pasture close  
2B.14 to an attractive wood, and visible from a drive which the public use even though it is not on  
5A.47 the Definitive Map, in some conflict with SP 60 [2C.16]. Although it may be that the  
5A.21 additional planting proposed would add in due course to the wooded air of the northern part  
5A.53 of the PRZ, it might well contribute to the raw appearance of the development in the interim,  
and I do not accept that this rural spot is otherwise in need of visual enhancement. I also  
5A.52 share FOLD's scepticism that the quality of the permanently modified landform would be as  
good as that of the existing one. In short, I consider that the RCF development & activities  
would fail to remain subordinate to the existing landscape of the Surface Site & its immediate  
5A.9 surroundings, contrary to the Baseline Report's requirements for Management Class 3.

5A.29 5A.70 Nevertheless this kind of ground-level impact would not be apparent at a distance, and  
so the strength of the longer-range effects must be gauged in the light of the extent of  
visibility discussed above, the uninteresting appearance of the structures that would be visible,  
and Nirex's warranted criticisms of Cumbria's original photomontages. On the accompanied  
inspection, the viewpoint at Hooker Crag on Muncaster Fell [location 6 on CCC/3/1, Fig.3b  
& see Fig.2], about 8 km south-east of the Platform Site, was taken as representative of the  
2C.42 delineated features on the National Park's Conservation Map in that general direction from  
5A.40 the site. I have formed the impression that at such distances the RCF could be difficult to

discern and would not be dominant, although it would add an increment to the other developments seen on a clear day in the open countryside.

5A.71 The delineated moor & heath at Ponsonby Fell & Swainson Knott to the north-east of the appeal site would be closer at about 3.5-4 km; and, judging by the view from the footpath near the Farmery [location 8 on idem, Fig.3a] at the south-western tip of the delineated part of Swainson Knott, the headgear of the RCF should be readily discernible.

2C.42 5A.72 Coming to views at the 1-3 km range from within the National Park, the RCF's upper structures would be seen from publicly accessible points in the deposited Local Plan's designated Quieter Areas above Hurlbarrow [idem, locations 6 & 7] and on Bleng Fell [idem, location 4]. Whilst the latter would be a view against the background of the Sellafield Works, from the former in particular the RCF would be sufficiently distinct & prominent to materially detract from the landscape on its own account, in my judgement, even though seen against the coastal villages or the sea. There would also be a number of intermittent but clear & closer views around Ponsonby & Boonwood [idem, locations 1-3 & 9-11] from the National Park countryside similar to the PRZ, but placed by the Baseline Report in Management Class 2, where changes in any of the basic landscape elements should not be evident in the characteristic landscape. I consider that the RCF would also be intrusive in the landscape from these locations.

5A.25  
5A.9  
COR/701,  
p.120

5A.35 5A.73 A final location worthy of note is the bridleway leading north-eastwards off the A595(T) towards Gallows Hill on the low ridge beside the Seven Acres Caravan Site, and about 3 km south-east of the Platform Site [location 1 on CCC/3/1, Fig.3b]. This land is in the National Park and is placed by the Baseline Report in Management Class 2. The main structures of the RCF would be plainly seen on the skyline, whilst there are only intermittent views of the Sellafield Works further west.

COR/701,  
Map 28

4A.44 5A.60 5A.67 2C.5 5A.72-3 5A.28 5A.74 In relating these conclusions to the relevant policies, the strategic framework SP Policies 1-10 are not of course intended to be directly applicable to a specific application, even for major development. Nevertheless, I note in the context of the first part of Policy 2 that the site's setting is of some landscape sensitivity & importance, containing some attractive features; and yet that the development would not remain subordinate to the landscape, but cause visual harm to its setting & look out of place. As to Policy 5, the development would visibly impinge to some extent on some nearby land within the National Park which has attributes similar to the site & its immediate surroundings, and on other landscape within the Park the quiet enjoyment of which the emerging local plan seeks to promote.

2C.8 5A.70 5A.71 5A.37 5A.75 SP Policy 11 is concerned with managing the environment, and so is directly applicable to an individual development. The land in the Park to the south of the site which is identified on the Section 3 Conservation Map is too far away for its character to be affected, in my judgement. The land identified on the Map which is to the north-east of the site is closer, and I consider that the sight of the RCF could have a marginal effect on its character. More importantly, the RCF would visually intrude into some parts of the National Park to its east which are being identified by the emerging development plan for special protection of their quiet enjoyment. There would be similar intrusion into a stretch of

undeveloped open countryside in the Park, to the protection & enhancement of which particular regard is to be paid.

5A.67  
5A.65  
5A.76 The identified moor & heath, the quieter areas on the slopes, and the open countryside closer to the boundary are all characteristics & qualities of that part of the National Park which is near the site; and in my judgement the RCF's effects on them would harm the character of the Park. The harm would be accentuated by the failure to meet high standards of design. Moreover, the development would also be seen as a distinct, modern protrusion in views of the rising ground of the Park from towards the coast to the south-west. To my eyes, this would harm the appearance of the Park from this direction.

4A.55  
4A.54  
1.3  
5A.77 Consequently I consider that both the character & appearance of the Park would be harmed by the RCF. Even if Policy 11 is to be strictly construed as not to bite on a development site outside the Park, the provisions of it & Policies 2 & 5, plus the Conservation Map & the deposit Local Plan, indubitably spell out the features which constitute the local nature of this interest of acknowledged international importance. This interest does not abruptly become of no consequence just beyond its mapped boundary. The policies do not include any exception for temporary development. In making the judgements based on these factors that the character & appearance of the Park would be harmed, I have taken into account existing intrusions into the landscape, notably the Sellafield Works. Therefore the development would not accord with the combined provisions of SP Policies 2, 5 & 11, and the 2nd Reason for Refusal has been sustained.

2C.9  
4A.56  
5A.23  
5A.68  
5A.22  
5A.78 It is SP Policy 13 which relates to undesignated landscapes such as that of the development site itself. I have already concluded that the site is in the undeveloped open countryside, and that, since the development is not required to meet local infrastructure needs, a departure from the Policy is involved. But Policies 11 & 13 both require development also to be sited to minimise environmental impacts and meet high standards of design. Although the Platform level has been set to minimise the headgear's intrusion in the vertical plane, the Platform has still been placed in the horizontal plane where it would inevitably damage the pleasant small valley. This is not a visual compromise, but in order that Nirex may most readily characterise the particular volume of rock within the PRZ which it presently favours as a DWR location.

5A.21  
4A.19  
4B.6  
1.3  
5A.79 Again, whilst I agree with the consensus that the proposed landscaping is to a high standard, Nirex seeks to defend the external design of the structures on grounds of expediency only. The Policies do not recognise such grounds as an exception. The development would therefore be contrary to Policy 13 on all counts, and so the 1st Reason for Refusal has also been made out.

2C.12  
4A.57  
5A.68  
5A.55  
4B.26  
1.3  
5A.80 Nirex has similar difficulties in complying with SP Policy 25. It claims that it is impossible to fully achieve the enhancement aim of the first part. But, after allowing for that, there remain the points that the development would cause visible harm to a rather pleasant piece of countryside; introduce significant office & car parking development into a rural area; and fail to reflect local vernacular trends in structural form & construction. This last deficiency cannot legally be remedied by omitting a major part of the design, nor mitigated enough in practice by a revised colour scheme. Once more, there is no exception for temporary development in the Policy, and the 3rd Reason for Refusal has been sustained.

5A.17 5A.81 On the other hand, I concur with the judgements that the settings of Sally Hill & the  
Seascale Stone Circle, and other Listed Buildings & Ancient Monuments, would not be  
2C.12 affected, thereby complying with SP Policy 26 & Mid Copeland Local Plan Policies 6J & R.  
2C.20-1 Although the Stone Circle is close to one of the viewpoints from which I consider that the  
5A.76 appearance of the National Park would be harmed, the latter is because the backdrop of the  
Park would be close in the scene to the offending development, whereas the RCF would be  
at the limits of the Stone Circle's visual setting. For even stronger reasons, I do not accept  
5A.31 that the Draft Hadrian's Wall Military Zone would be affected. The designation that might  
5A.39 run down the coast from Maryport to Ravenglass would itself be a setting; and to implicitly  
BLG/1/10 argue for the existence of a setting for a possible setting is extremely tenuous, in my view.

2C.21 5A.82 Also it seems to me that the landscaping measures would just comply with the other  
relevant Mid Copeland Local Plan Policy - 6Q. Nevertheless the breaches of particular  
4A.43 development plan policies set out above have to be brought forward to the overall framework  
2C.14 of Policy 54. These breaches suggest that there are already emerging cases that the stipulated  
criteria are not met in all respects. In relation to criteria (ii) & (iii), it would have been  
practicable to cause less visual harm & to reduce the adverse visual impact even more, by  
carrying out a smaller development in the first place and by preparing a better external design  
of the structures. Nirex is unwilling to take these steps because of the cost & time penalties  
involved, in my judgement. In relation to criterion (iv), the Lake District feature of  
4A.48 conservation importance would be harmed, and so the value of the benefits of the RCF has  
to be shown to outweigh the value of the interest affected.

5A.5-10 5A.83 On this last point, I would rate the harm to the National Park as on a moderate scale,  
to reflect the development's location outside the Park, and the middling scenic beauty of the  
landscape affected. But it would still seem to me to amount to harm to the wider  
environment which has to be taken round to the general balancing exercise of criterion (i),  
together with the breaches of Policies 13 & 25. The relevant policies of the emerging  
4B.21 development plan also have to be considered. Despite agreed compliance with LP ENV 11  
5A.42 & 13, the overall impact of the development in relation to the landscape is not acceptable to  
2C.27 Copeland, for the reasons already given, and that is a conflict with criterion ENV 33.4. The  
2C.30 utilitarian & rootless type of external design conflicts with the principles of DEV 3.

5A.26 5A.84 This tension with the visual requirements of the statutory & emerging development  
plan is, if anything, exacerbated by consideration of the effects of related developments, in  
my view. Nirex has, to my mind, put forward completely the wrong approach towards the  
RCF/RCM/PRZ Boreholes. Instead of seeking to compare their impact unfavourably with  
that of the appeal development, it should have acknowledged that they are part of the same  
project the overall effects of which have to be taken into account. Although I disagree with  
5A.4 the implication that their visual effects are worse than those of the present proposals, their  
5A.45 various platforms in particular have badly broken up the natural landform for the time being;  
and their illuminated rigs can be intrusive. These 2 elements lengthen the potentially  
deleterious effects of the RCF project.

5A.2 5A.85 The first site-specific DWR design for the PRZ indicated that an RCF could be the  
forerunner of a repository development with a fairly massive visual impact. The proximity  
6B.89 of this to Gosforth is difficult to reconcile with the site search eliminator of entire local  
authority districts above a population density threshold. However, it seems that the impact

5A.3 problems of such a concept were recognised, and largely eliminated in the re-design. Assuming that the now preferred design option were located on the Platform Site after completion of the RCF, it seems to me that the reduction in respective scales would be significant enough so as not to permanently harm the character & appearance of the nearby National Park. I also note that the permanent buildings would reflect local vernacular trends.

5A.43  
4B.7  
5A.3  
SPD/1/1,  
p.6  
3A.1  
5A.86 Nevertheless it also appears that the development on the PRZ would be a permanently inappropriate one in the open countryside. There are in addition 2 important matters outstanding. The first one is a paradox over the internal road link between the development and the Sellafield Works, for Cumbria & Nirex have agreed for the purposes of the RCF that such a link would have an unacceptably adverse visual impact, whereas it is part of the DWR design concept. The second matter is that, whereas the preferred DWR design option includes spoil disposal by conveyor up a drift & thence off-site by rail, Nirex is reserving its position on the use of the RCF shafts for construction access. If that construction access were to include the disposal of considerable volumes of spoil, the visual & other impacts of the DWR at Longlands Farm might be significantly greater than I have assumed above.

SPD/1/1  
5A.87 Whatever the position about spoil disposal at Longlands Farm, the preferred design option would of course entail a large extension of the south-eastern part of the Sellafield Works.

## 5B. SOCIO-ECONOMIC IMPACT

5B.1 The Department of the Environment's 1989 Guide to Environmental Assessment Procedures does not specify socio-economic impact in its Appendix 4 checklist as a matter to be considered for inclusion in an environmental statement. However, the Lee & Colley 1992 quality review approach advises that a statement should estimate the significance that the projected impacts will have for society, in the form of both the affected community & society in general [SUT/1/2, p.46, paras.2.5 & 2.5.1]: and the Morris & Therivel 1995 minimum requirements & best established practice approach sets out as Criterion 5 the socio-economic characteristics of the development [SUT/1/1, 3rd page].

5B.2 Nirex has included a Chapter on Socio-Economics in its ES [COR/101, p.71], and no challenge to this inclusion has been brought to my attention. The 11th Preamble to Directive 85/337/EEC states that the effects of a project on the environment must be assessed in order, amongst things, to take account of concerns to protect human health, & to contribute by means of a better environment to the quality of life. The Directive & the UK Regulations list the factors that might be affected as including human beings, the inter-action between human beings & natural resources, & material assets. It seems to me that the socio-economic impact of a development project must be regarded as at least likely to have some indirect effects on such aspects of the environment.

5B.3 Even if socio-economic impact should not be treated as part of the effects of the project on the environment, I regard socio-economic factors as capable of being material planning considerations in any event.

5B.4 Nirex's discussion document [COR/203] initiating its 1987-8 DWR consultative exercise [6B.22-3] stated that several hundred jobs would be created during the DWR constructional period, and then an operational workforce of about 100 would be required [idem, p.14, para.4.1.1]. One of the main findings of the consultants' report on the consultation responses [COR/204] concerned socio-economics. The executive summary stated that potential detrimental local economic impact & blight through social stigma associated with the public perception of radioactive waste disposal were key concerns, especially in areas dependent on tourism, agriculture & fishing.

5B.5 After the decision was taken in July 1991 to concentrate further investigations at Sellafield [2A.10], Nirex published a booklet outlining both the site search [Ca.6B] and continuing research & development work [COR/205]. Section 5 on "Facilities Required" [idem, p.12] estimated that there would be up to 3,000 construction jobs and then 350-400 permanent operating staff, for what was in effect the first site-specific Sellafield DWR design [5A.2]. Section 8 on "The Next Steps" [idem, p.24] commented that there was little doubt that any development of the size of the construction & operation of the DWR would have a substantial impact on the local community. Nirex was committed to discussing ways in which it could be a good & conscientious neighbour. It wanted to bring as many benefits as it could to the local community and, at the same time, keep disturbance & inconvenience to a minimum.

5B.6 Since 1990 senior Nirex staff have periodically reported to the Sellafield Local Liaison Committee, which is chaired by a senior County Councillor & was established about 40 years ago as a consultative body on BNFL & UKAEA local operations. The formal Nirex Liaison Group was set up in 1991 at officer level & consists of representatives of Nirex, Cumbria, Copeland & the National Park authority [CCC/1/2]. It is Nirex's proposal that, if permission is granted for the RCF, a Joint Consultation Committee with local authority members should be set up [NRX/12/2, pp.36-8]. Nirex & Gosforth have already set up both a Local Liaison Group and a Technical Consultative Group. As a good neighbour, Nirex has contributed to the community of Gosforth by assisting with extensions to the school playground & church, and with the upkeep of the car park, public hall & playing field. Nirex also maintains a local educational sponsorship programme which in 1994-5 sponsored 3 university students in earth sciences.

5B.7 The ES establishes an economic baseline in terms of the use of the Surface Site and the key characteristics of the West Cumbrian economy. It concludes on the latter [COR/101, p.74, para.3.3.31] that the area's future economic prospects remain inextricably linked to the local nuclear industry in both its operation & future construction projects. Local employment prospects are not promising, with the possible exception of the tourism industry. The effects then assessed are on agricultural businesses, employment, housing & public services, tourism, and perceptions of the local area. The conclusions [idem, pp.79 & 80, paras.3.3.69 & 78-81] are that there would be no significant effect on agricultural activity or the viability of farm holdings (there no longer being any agricultural tenure of Longlands Farm): that the employment effects would be unambiguously positive, albeit small-scale in relation to previous construction projects in West Cumbria: that any adverse effect on housing & public services or tourism would be unlikely: and that, assuming that appropriate measures are taken to explain the nature of the development, any significant effect on local economic behaviour would be unlikely.

5B.8 The tourism assessment refers to a 1992 study carried out by consultants for the Cumbria Tourist Board [COR/408], & to a 1994 literature review of blight & nuclear facilities by Nirex's consultants [updated version COR/409]. The perceptions assessment relies largely on a 1993 report by Nirex's consultants on 2 surveys - a local survey of businesses & agencies in the vicinity of Sellafield, & a survey of development agencies in other parts of the country with major nuclear facilities [COR/402]. This survey report is an integral part of the evaluation of the social & economic impacts of the proposed DWR project [idem, para.1.1]. The ES comments that any local concerns arising from Nirex's investigation programme appear to relate to its effect in bringing development closer to residential properties & particularly Gosforth village. Further activities at Longlands Farm may reinforce these concerns, although the study findings suggest that the proposals are unlikely to have a significant effect on economic behaviour.

5B.9 Cumbria in turn has a 1993 consultants' study report on public perception & the nuclear industry in West Cumbria, based mainly on an expert review of socio-economic data and observations of focus groups [COR/401]. It has also arranged for opinion polls on the proposed Sellafield DWR in 3 waves - September 1991, November 1992 [COR/412], & November 1994 [COR/411]. Copeland received an 8% response to a written questionnaire which it circulated in 1991 [COR/403]. It has also conducted a 1992 professional opinion survey of local residents [COR/404]. There have been 2 further 1995 surveys to prepare for



the LP Inquiry - one of residents, with a wider remit of the socio-economic impact of BNFL's local activities as well as awareness of the RCF proposals [COR/407], and the other of businesses in the UK seeking industrial capacity & which have considered West Cumbria but have not so far decided to invest there [COR/410].

5B.10 Another group of consultants has carried out research for The West Cumbria Development Fund on the perceptions of individuals within groups of West Cumbria as a destination for leisure travel & inward investment. There are 2 versions of their report, published 7 months apart [COR/405 & 406]; and, with the agreement of Nirex & myself, FOE Cumbria have corresponded with the authors concerning the differences between the versions [COR/406A]. The same research group designed for the CBI a 1995 telephone survey by a leading market research company of 1,000 of the directors of the top 3,000 UK companies by turnover [NRX/10/10].

5B.11 **Nirex** has revised its ES estimate of RCF direct labour requirements [COR/101, p.71, paras.3.3.3-4] for the period 1996-2008 to about 1,260 person years, made up of 540 contractors' labour, 315 management/operations staff, & about 405 scientific staff. There would be an annual average of 97, with a peak requirement of 185 person years in 1999. Using the same multiplier for indirect & induced employment as the ES of 1.34 brings the total person years of employment provided by the RCF to 1,690. The area would benefit from more employment for local people, additional expenditure by in-migrants, and more contracts & work for local firms.

5B.12 Whilst Copeland & Gosforth suggest that the construction of Encapsulated Product & other Stores at Sellafield Works [CBC/1/1, Items 49 & 51] would provide equivalent employment & other benefits to the RCF, those stores would be additional to the DWR and not a substitute for it. There is no other query of Nirex's calculation of a positive employment effect for West Cumbria. Nirex's Model Code of Employee Relations for its contractors provides that their manpower should include, where reasonable & practicable, local personnel with relevant skills & experience or who can be suitably trained: and employment opportunities should be advertised locally. A steering group led by the Chair of the West Cumbria Development Agency has been set up to guide Nirex on local recruitment.

5B.13 There is no dispute over the capacity of local housing, education & health provision to meet the limited demands of people moving to the area as a result of the additional employment. Although there are suggestions that the advent of another nuclear facility would reduce residential property values, a supplementary study around Sellafield by Nirex's consultants [NRX/10/7, Section 3] concludes that any blighting effect in the immediate area must be highly localised and that any other blighting effect seems to be offset by the employment benefit associated with the facility [idem, p.18, para.4.3].

5B.14 Also in 1994 Cumbrian male wage rates were the highest in the Northern Region [NRX/10/1-3], and Nirex contends that high wage levels at Sellafield contributed significantly to this. The relatively stable & highly paid employment provides sustained spending power & hence substantial additional benefits to the community. Although construction employment at Sellafield has been run down severely in the last few years, and the local authorities

emphasise the predicted falls in general Sellafield employment over the period to 2010, the nuclear industry will remain the dominant local employer and every additional job should be all the more welcome against a background of declining opportunities.

5B.15 The statutory development plan for these parts of Copeland recognises the central role of the Sellafield Works in the local economy [eg COR/305, pp.5 & 7-9, paras.2.1-2 & 2.9-10, and NRX/10/5, p.6, para.2.1.4 (mis-printed as 2.2.4)]. Moreover, there has been inward investment related to the nuclear industry. Whilst the local authorities dwell on the lack of non-nuclear investment at the regional strategic employment site of The Westlakes Science & Technology Park on the south-eastern outskirts of Whitehaven [COR/306, p.72], the point is that the Park exists due to the presence of the nuclear industry. No other industry has induced a beneficial stimulus of this sort in Cumbria, and Copeland concedes the Park to be very important to the local economy in the long term.

5B.16 There is no substantive evidence that the RCF itself would influence people's perceptions and thereby have a detrimental effect on inward investment. The fact that BNFL has made contributions to local infrastructure & other provision in connection with its major developments at Sellafield [COR/401, Annex C] is not evidence of such effects; and Copeland admits that BNFL has consistently declined to incorporate such contributions in a planning agreement. Copeland's 1991 & 1992 surveys related to a DWR and not the RCF, and in any event found less than 50% of respondents completely opposed to a DWR [COR/403, Note 7] and 50% giving some support [COR/404, p.32, Section 8.3] respectively. As for Copeland's 1995 surveys, the business survey is basically unreliable due to its poor response rate & unsoundly small sample [COR/410, p.2]; whereas the residents survey is sensibly representative, and shows that 54% of respondents were unconcerned about an RCF at Longlands Farm [COR/407, p.vii]. This survey & Cumbria's 3rd wave poll [COR/411] show, in Nirex's view, a clear majority of residents favouring the RCF and a clear balance of opinion in support of the nuclear industry.

5B.17 Copeland is being very selective with the contents of Nirex's 1993 survey report [COR/402], despite accepting the surveys' methodologies. Any blight associated with the DWR can only occur if there is an adverse impact on the economy resulting from changes in people's behaviour & decisions, in turn resulting from perceptions of risk, image & stigma associated with nuclear facilities [idem, para.1.2]. As stated in para.3.18 of PPG23, perceptions of risk should not be material unless their land-use consequences can be clearly demonstrated. The few potential recruits to one company mentioned in the report [COR/402, para.3.15] who gave proximity to Sellafield as a reason for declining job offers also cited remoteness and poor career prospects & social facilities as other grounds for turning down the offers. The 2 economic development agencies which considered that the nuclear presence deterred companies & workers from moving into the area were actually the Economic Development Units of Copeland & its neighbouring district, Allerdale [idem, Table 4.2 & para.4.16]. They did not provide any evidence to support this assertion.

5B.18 Reliance cannot be placed, either, on the reported claim by the West Cumbria Development Agency to be aware of 2 cases where the proximity of Sellafield had been the deciding factor in companies choosing not to locate in West Cumbria [idem, para.4.38]. The Agency cannot now substantiate this claim [NRX/10/13]. The vacation of the Rowntree Mackintosh factory on the eastern edge of Egremont now referred to by the Agency was of

course a case of re-location away from West Cumbria, not of failing to move to the area. Nirex's consultants have spoken twice to the manager of this factory, who insists that the relocation was due to group rationalisation and not the presence of Sellafield. There is a similar account in the consultants' report of another company's explanation for moving away [COR/402, paras.3.23-4].

5B.19 There is no documentary corroboration of claims by Copeland about the closure of a sea-food processor and the deterrence of a brewery, of claims by FOE Cumbria about the closure of a dairy and effects on markets for fish, nor of a claim by Mr Catlin about the closure of a local school. On the other hand, Copeland's own Economic Development Unit is reported as seeing Sellafield as a positive factor in terms of its scientific expertise & the associated opportunities for technology transfer [idem, para.4.14]. It is also important to note, in Nirex's view, that its consultants' report concluded that the experience of other areas with nuclear facilities does not suggest that the nuclear presence has had any major impact on inward investment decisions [mis-printed as "discussions", idem, para.7.12]. Other factors, particularly location & accessibility, appear to be much more influential.

5B.20 Nirex considers that Copeland is being similarly selective with the information in the research reports for The West Cumbria Development Fund [COR/405 & 406]. The company decision makers questioned for the survey had chosen not to move to West Cumbria: there was no survey of companies which chose to move. Although Copeland considers the information presented in the interim version of the report as more favourable to its case, the perceived disadvantages that would be experienced by operating in West Cumbria were dominated by accessibility problems [COR/405, p.12 & Table 6 and NRX/10/12, Minute 2)]. In reality, there is no material difference of substance between the 2 versions of the report: and the final version concludes that Sellafield is not a significant deterrent to inward investment [COR/406, p.7]. This is corroborated by Nirex's own supplementary study on foreign direct investment [NRX/10/7, p.18] and by the CBI telephone survey [NRX/10/10, p.8].

5B.21 The report for the Development Fund actually envisages that Sellafield could be turned into a significant asset [COR/406, p.7]. So far as leisure travel is concerned, the vast majority of persons are no less likely to visit because of the presence of BNFL [idem, bottom of p.11]. Indeed 6% of respondents were more likely to visit to see the Sellafield Visitors Centre [idem, end of Section 2.2.2].

5B.22 The Äspö Hard Rock Laboratory in Sweden has been visited by Nirex's socio-economic consultant because the laboratory is similar to the RCF apart from being a generic research facility, and is also near a nuclear power station which is the country's location for the interim storage of spent fuel. The impact of the power station has been positive & significant in terms of providing highly paid & skilled employment, improving the local infrastructure, and enhancing educational standards, which is being taken forward by the Laboratory as a centre of excellence. Similar effects have been noted at Dounreay by the Scottish Office's Chief Reporter [NRX/10/8]. A recent paper [NRX/10/11] again confirms the same sorts of impacts by all 4 Swedish nuclear power plants, including positive visitor attraction & lack of effect on property values.

5B.23 Although Copeland relies on passages in the RWMAC/ACSNI Study Group's Report on Site Selection & Public Health Protection [GOV/409] commending consideration of compensation payments where net detriment arises, Nirex has seen no evidence that the RCF would have a net detrimental impact on the local economy. Perceptions are not always translated into behaviour, and Nirex's empirical evidence [5B.7 & 11-14] shows that on balance the impact of the RCF would be positive. There is no evidence that a non-nuclear but equally stable employer would provide a similar number of jobs if the RCF were turned down. Nor are there indications of any actual adverse impact by the presence of Sellafield on tourism. Indeed, English Tourist Board research suggests that holiday-takers do not think of adverse publicity for Sellafield or nuclear incidents in making holiday decisions [NRX/10/9].

5B.24 The argument that West Cumbria is too dependent on a dominant nuclear industry was rightly rejected in the Windscale Inquiry Report, in Nirex's view [NRX/10/4, p.76, para.14.24ii]. Consequently, it is clear to Nirex that the RCF would bring significant net economic benefits to the area, without imposing a strain on the social infrastructure. Whilst there may be some perceptions that the DWR as another nuclear facility would cause some harm, there is no reason to believe that this would translate into anything more than slight or fleeting blighting effects.

5B.25 These net benefits must be taken into account in the balancing exercise under SP Policy 54 [4A.6], whereas the development would conform with the emerging LP Policies ENV 33.4 [2C.27], DEV 4 & IMP 1 [4B.5]. There would be no adverse long-term effects on the Borough's social & economic resources, and so no need for a planning obligation to address such effects.

5B.26 The planning obligations suggested by Copeland are unnecessary, irrelevant & unreasonable. The liaison arrangements could not be appropriately included [GOV/138, para.9(a)]. There would be no need for the Nirex head office to be in West Cumbria for the RCF to go ahead; and indeed it would be premature to move before the location of the DWR is finally settled. The concentration of training & research in the local area would not be amenable to control by a legal agreement, and would be better discussed by the steering group [5B.13]. Copeland cannot relate the provision of social housing or community facilities to the RCF, because it concedes that the RCF would not add to the demand for social housing nor cause a deterioration in community facilities.

5B.27 **Cumbria** does not demur from Nirex's assessment of the impact on local housing, education & health provision, and notes the employment predictions. It does point out, however, that its opinion polls [COR/411 & 412] indicate mixed views about the nuclear industry generally and the RCF. There appear to be a substantial number of people in the County who have concerns of various kinds & to varying degrees about the Nirex proposals [see executive summary at rear of COR/411].

5B.28 As a result of its commissioned research into public perception, Cumbria takes issue strongly with the view that local support constitutes unequivocal approval of the nuclear industry based on a better understanding than average of its operations & processes. The background & qualitative research undertaken by its consultants [COR/401] has made it

appreciate that there is a general ambivalence towards the industry, reinforced by a "dependency syndrome", which makes many local people suppress their real feelings of concern. There is extensive local ignorance of Sellafield; and the acceptance of it and the accompanying risks is founded more on a fatalism about its dominant economic role & the lack of any realistic alternatives than on knowledge [idem, pp.2-3].

5B.29 Nevertheless Cumbria has noted Nirex's perceptions assessment report [COR/402]. It accepts that a direct connection between local people's feelings and social well-being & economic development has not been clearly demonstrated. Although overall it recognises concerns that further nuclear-related development may adversely affect external perceptions of Cumbria, it concludes that the harmful social & economic impacts do not amount to a individual reason for objection.

5B.30 Copeland is also concerned about the concept of local support. The report on the 1987-8 consultative process quoted in effect [COR/204, top of p.12] from the Council Leader's press statement welcoming BNFL's intention to initiate local discussions on radioactive waste disposal & management issues [NRX/12/1, p.4]. The report did not refer to the comment made later in the press statement that, whilst investment at Sellafield assists the local economy, the overriding issues are the health & safety of the local community and pollution of the environment. Nor did it recount Copeland's official response to the consultation [NRX/12/2, p.1], even though the consultants have confirmed receipt [NRX/12/9] of the response, which specifically commented at item 3 that local support is secondary to finding the "best" site. The response also commented at item 5 that the benefits to accrue to the local community should be assessed for the inquiry into the preferred site; and that such benefits should include the availability of resources for achieving social & economic objectives, and resolving problems arising from the location of such a controversial facility.

5B.31 The consultants did report to Nirex that impact & blight through stigma & perception were key concerns in areas especially dependent upon tourism, agriculture & fishing. Nirex itself refers to the Cumbria Tourist Board 1992 estimates [COR/408] of about 6,190 jobs directly dependent on tourism in West Cumbria (Copeland & Allerdale districts), and the 1991 Census of Population estimate of some 3,200 residents being employed in agriculture, forestry & fisheries. These compare with the 1991 Census of Employment data of about 5,600 workers in the construction industry and the BNFL 1991 Sellafield direct workforce of 7,550.

5B.32 There were 3,831 registered unemployed in the Whitehaven Travel To Work Area in April 1995, representing 12.5 % of the economically active excluding the self-employed, compared with 9.0% in Cumbria, 10.2% in the North West Region & 9.8% in Great Britain. BNFL itself projects that its total Sellafield workforce will have reduced to about 4,750 by the year 2010. This would be just over 14% of the Borough's predicted workforce, compared with the present 30%. Although Nirex has made much at this inquiry of the nuclear industry's funding of diversification, for example by establishing The Westlakes Science & Technology Park, Gosforth has demonstrated that employment there is still related to the nuclear industry. Furthermore the Challenge Fund bid to finance the extension to the Park, in which Nirex's consultants were involved, has failed.

5B.33 The benefit of the annual average of 97 jobs provided by the RCF has to be gauged in this context. The proportion of these to be filled by local recruits is largely speculative - Nirex's latest percentage ranges of local recruits vary between 5-20% for scientific work and 50-80% for site establishment. It is then a matter for further speculation as to how many of these local recruits would be transfers within the nuclear industry or even within Nirex. The gross socio-economic benefits are thus marginal at best. In Copeland's view they should be compared, as Gosforth has urged, with the 170 jobs over an average construction period of 3½ years for each Encapsulated Product Store at Sellafield, which have been planned on the basis of a worst case scenario assuming abandonment of the DWR project.

5B.34 Copeland points out that Nirex seems to be arguing that the adverse impact from the RCF would be outweighed by the general benefits from the nuclear industry. But the general, albeit declining, benefits will continue to be provided regardless of the RCF, and so cannot be put into the balance. Also Nirex is drawing a false distinction between perceptions and material impact. In the cases of deterrent effects upon tourism & inward investment, perceptions constitute the mechanism through which the impact is caused. In incinerator appeals such as decision ref. APP/F4410/A/89/126733 of 11 November 1991 [CBC/1/12], the perceived risk of socio-economic effects has been taken into account [idem, para.9].

5B.35 It is Copeland's contention that the grant of permission for the RCF would create or enhance negative perceptions of the area, so as to be likely to deter inward investment & tourism. Nirex itself emphasises the public controversy aroused at all 4 of the sites it was investigating for a shallow waste repository in 1986. Yet one of them was in an area already familiar with the nuclear industry. Nirex undertook to help those in the immediate vicinities of the sites who were unable to sell their homes [GOV/202, para.91]. In the subsequent 1987-8 site search for a DWR, Nirex & its present consultants eliminated all local authority districts with a population density of more than 5 persons per ha [6B.11], partly in the light of public perception of the acceptability of a DWR nearby, so it has told this inquiry. There was obviously little doubt at the time that the implementation of Nirex's plans would have a detrimental effect on local economies, and yet those plans were merely to explore some sites.

5B.36 Nirex has refused to identify most of the 12 sites examined by the MADA exercise because it would raise public alarm [3B.27]. It could not conceivably be irresponsible to raise such alarm, as Nirex claims, unless the alarm would in turn create an adverse impact. The MADA team itself identified an Attribute 26 described as Economic Blight [NRX/18/6, Table 1], and measured it by proximity to susceptible activities. It transpires that those activities included tourism, recreation, agriculture & food processing, all of which are significant within Copeland. On the other hand, the team failed to formulate an Attribute measured by degree of prejudice to future prospects of inward investment.

5B.37 Many local people have adverse perceptions of a DWR. The responses to Copeland's 1991 questionnaire showed over 60% significantly concerned or worried about the safety of people living close by [COR/403]. The 1993 opinion poll revealed that 63% of respondents were concerned about the safety of those living or working nearby [COR/404, p.19]. Although these relate to a DWR, so does Nirex's own research work, and this is because the connection between the RCF and the DWR is obvious. In any event, unlike Nirex, Copeland & Cumbria have also recently surveyed attitudes towards the RCF; and 46% of respondents

in Copeland's residents survey are concerned or very concerned about the RCF proposal, with about half of those people concerned about health or safety matters [COR/407, p.vii].

5B.38 Copeland considers that there is ample evidence to confirm the proposition that adverse perceptions are translated into social & economic decisions concerning land use. Copeland has first hand experience as an employer of potential recruits turning down jobs because of the presence of Sellafield. Its Development & Services Director has personally been told by a representative of Rowntree Mackintosh that one of the reasons for the closure of the Egremont factory, with the loss of 80 jobs, was customers' negative perceptions of confectionery produced near Sellafield. The owner of a Whitehaven sea-food company has told him that the business recently moved, with more than 100 jobs, out of the area partly because of its negative image. He is also aware of a major brewery which eventually decided not to build an hotel with 35-40 full-time job equivalents due to the presence of Sellafield.

5B.39 The survey reports actually relied on by Nirex reveal similar instances, in Copeland's view. The fact remains that the West Cumbria Development Agency originally told Nirex's own consultants that the proximity of Sellafield was the decisive factor in 2 companies choosing not to move to the area [COR/402, p.28, para.4.38]. The interim report for The West Cumbria Development Fund clearly showed that 4 out of 14 corporate respondents perceived the nuclear complex at Sellafield to be a disadvantage to operating in West Cumbria, and 3 more did so when prompted [COR/405, Table 6]. The telephone survey for the CBI indicates that, when prompted, 19% of 1,000 corporate respondents perceived the nuclear complex at Sellafield to be a disadvantage [NRX/10/10, p.7 & Table 9].

5B.40 This is consistent with overseas experience, in Copeland's judgement. Nirex's own updated literature review finds that surveys based on intended behaviour indicate that risk perceptions of nuclear waste repositories could have severe blighting effects on every investigated area of economic activity [COR/409, executive summary, para.5]. Also evidence based on actual behaviour suggests that there are blighting effects associated with nuclear facilities, with the consultants relying on positive economic effects to outweigh these [idem, para.6].

5B.41 Nirex has emphasised at first that the flow of inward investment to West Cumbria is weak. This is indeed correct, with a large number of companies closing down plants or re-locating elsewhere in the early 1990s, and no entirely new major international investment [COR/402, p.21, paras.4.8-10]. It has been such conditions which have led to the 1989 declaration of EU Objective 2 status and the 1993 grant of UK Intermediate Area status. But Nirex has eventually conceded that this is a point which strengthens Copeland's arguments. For the fragile investment position means that merely a modest adverse impact could have very significant effects.

5B.42 Again contrary to Nirex's initial insistence, there is a similar vulnerability to impact on tourism, in Copeland's view. In 1987, 15% of respondents to the English Tourist Board's survey stated that they would not want to holiday in Cumbria because of pollution, by which nearly all of them meant ionising radiation [NRX/10/9]. In 1993, the Cumbria Tourist Board told Nirex's consultants that the proposed DWR at Sellafield would be likely to have a negative impact on tourism [COR/402, p.32, para.4.65].

5B.43 The final version of the report for The West Cumbria Development Fund showed that the presence of BNFL at Sellafield makes it less likely for 20% of 1,024 respondents to visit West Cumbria for a day or holiday trip [COR/406, Table 12]. For some reason the 6% who are more likely to visit the Sellafield Visitor Centre are emphasised instead [idem, p.11], glossing over the net adverse reaction of 14%, and the curious feature of the Visitor Centre for a tourist attraction that entrance is free. Once more the overseas evidence confirms that a nuclear facility would have an adverse impact on the attractiveness of an area to visitors [COR/409, para.3.29].

5B.44 Copeland submits that this amply demonstrated deterrent effect upon inward investment & tourism of a Sellafield DWR would begin as soon as permission is granted for the RCF. The decision would be seen as concluding that the location has sufficient promise [4A.9] as a DWR site to justify an investigation of up to 13 years [2B.9] & expenditure of about £540M [3A.2]. This would be regarded as a very high level of commitment to a DWR here. There is accordingly a substantial socio-economic objection to the RCF proposals, because they would prejudice the use & enjoyment of some of the Borough's social & economic resources, contrary to emerging LP Policy DEV 4.

5B.45 Nirex has not offered any planning obligation to try to meet this objection, in accordance with LP Policy IMP 1 & hence criterion ENV 33.5. This failure to offer mitigation & compensation is contrary to the practice of BNFL [COR/401, Annex C] when granted permission for major projects, and of other countries, and to the recommendation of the RWMAC/ACSNI Study Group [GOV/409, para.6.14]. Copeland is consequently indicating obligations which could be offered, but by way of example only, albeit with broad orders of cost so that judgements can be made whether the suggested measures would be reasonably commensurate.

5B.46 The head office of Nirex is at Harwell, where 173 of its employees plus 23 secondees & consultants are based. There are only 19 employees plus about 100 contractors' staff at the Cumbrian offices in Greengarth Hall, Holmrook [5A.55]. The head office should be moved to Whitehaven where suitable offices are available, and at no net cost, but with the advantages of being closer to local suppliers and obtaining a better understanding of local issues.

5B.47 Nirex should invest about £10M over 5 years in the expansion of The Westlakes Science & Technology Park, to facilitate the local advancement of detailed research & analysis associated with the RCF. It should also commit itself to local training, recruitment and supplies & services, budgeting to spend about £500,000 on training. BNFL's contributions to the West Cumbria Development Fund to help diversify the local economy are due to end in 1997. Nirex could take over the main funding responsibility for the duration of the RCF, index-linked & amounting to a minimum contribution of £11M over 10 years. This might help to finance wider transport infrastructure improvements, such as sustaining the West Cumbrian railway line and providing a local airstrip.

5B.48 Thirty social housing units within 16 km of the site could be funded at a cost of about £2.5M over 5 years, to mitigate against loss of population due to adverse impact. A million pounds could be paid over 5 years for improvements to village halls & similar community facilities which are in a poor state of repair due to lack of public investment. Finally, as



discussed in Chapter 5C, the local road network is in need of improvement, at an estimated cost of £10.5M over 5 years.

5B.49 **Gosforth** points out that there are collectively many hundreds of person years of experience of working in the nuclear industry in its parish. For example, 2 of its witnesses are experienced engineers in the nuclear industry & former managers at BNFL. Such local expertise is actually the basis of the Technical Consultative Group [5B.6]. Whilst the formal liaison arrangements are welcome, they were instituted by Gosforth, and it is Gosforth which has taken the initiative to put them on a formal footing [GPC/2]. Nirex's lack of complete openness in the earlier years [WR/GPC/4], and its tardiness in entering into real dialogues with experienced scientists on matters of genuine concern [eg WR/GPC/2], have caused great anxiety.

5B.50 This is partly because another aspect of the parish's socio-economic profile is that less than half of its economically active residents work in the nuclear industry. The Nirex proposals have already had an adverse social impact, as the local community has split over what its response should be. The agreed view of the Parish Council, without wishing to become embroiled in the legal arguments [Ca.3A], is that it is in the general social & economic interest for all the important implications of the DWR to be dealt with now.

5B.51 BNFL did not purchase the Newton Manor Estate including the PRZ in order to expand the Sellafield complex, but merely in pursuance of its 40 year-old policy to buy up land coming onto the market within the Sellafield safeguarding zone [see notation on COR/306 Proposals Map]. The appropriate use of Longlands Farm is agriculture, and Nirex can only say that the agricultural holding would not be affected because the tenancy was terminated in order that it could go ahead with its proposals. Gosforth also doubts whether the re-introduction of agriculture after closure of the RCF would be viable, particularly because of the additional planting in the landscaping scheme.

5B.52 As has already been shown [5A], the RCF would be a conspicuous development in the countryside near to this National Park gateway settlement, which is also a local service centre & commuter village. The RCF would itself be a major mining development 400 m from a centre for scenic tourism, which would be bound to suffer as a result. The RCF's physical presence would also be a constant reminder of the proposed DWR. A much more objective & equitable way to proceed would be to operate a smaller underground laboratory over a longer timescale, whilst similar short-term employment benefits are obtained from the construction of the interim stores already approved for Sellafield [5B.33].

5B.53 Some local businesses have declined recently and jobs have been lost. Gosforth cannot prove that this has been due to the potential DWR, but equally Nirex cannot prove that it has not. Additional business from RCF & DWR construction workers for Gosforth's shops, eating places & accommodation could be a mixed blessing, for past experience with Sellafield construction contracts suggests that the workers temporarily crowd out & cut across the long-term tourist trade, which has difficulty in recovering afterwards. The specialist workers themselves would come from all parts, and not especially the local community.

5B.54 Local people are acutely aware of the stigma attached to being near Sellafield, especially when there has been a well publicised scare. Nirex concedes that there can be a blighting effect on property prices in the immediate locality after such incidents [COR/402, p.36, para.5.17]. Its other residential property value review [NRX/10/7] is unreliable because it used the records of just one building society [idem, para.3.5] and was unable, due to the postcodes, to concentrate on property immediately around Sellafield [idem, para.3.7-11 & Map 3.1]. Nirex also accepted in 1986 that its investigations at Fulbeck affected property prices; and seemingly it had a scheme to compensate home-owners in the vicinity of all 4 investigation sites [GPC/6A, pp.S4-10].

5B.55 Gosforth has in fact been under the impression that it is Government policy to acknowledge that Nirex's investigations cause blight - it believes that this is why Nirex has not been compelled to divulge the locations of the alternative sites [3B.27], and why a site deemed to have some local support has been preferred over others offering more promising geology [6B.30]. As the RWMAC/ACSNI Study Group [GOV/409] has pointed out, this acknowledgement of blight is certainly the policy of most other leading nuclear countries, which have accepted the need to compensate the host community.

5B.56 Gosforth points to some obvious ways in which the local community could be helped. The RCF would add to the risks of local emergencies, and some of the best emergency services in the vicinity are stationed at Sellafield Works, yet no direct access between the RCF and the Works is proposed. Nirex must also be required to contribute to improvements to the transport infrastructure - rail & air as well as road. It would not be enough to try to influence economic diversification by providing new industrial premises, because experience to date is that they are actually taken over by nuclear-related businesses. The most striking example of this is the Westlakes regional strategic site, where Gosforth has discovered that less than 3% of the employment provided is with employers who moved in from outside Cumbria [GPC/13, Fig.S4], and that most of the employment is nuclear-related in any event [see CFE/1/3]. This dependency on the nuclear industry, coupled with apprehension about blight, features in a number of the written representations.

5B.57 According to Gosforth, a principal public concern in the Parish is the anticipated drop in residential property values. The Parish Council is already struggling to maintain local services due to its complete dependence on precepting domestic taxpayers since the introduction of the uniform business rate. It is unsatisfactory to have to rely on occasional, voluntary contributions from major businesses like Nirex acting in its good neighbour role. A trust fund should be set up for the potential host community, as in France at Soulaines-Dhuys [GPC/6, pp.10-1]. The RWMAC/ACSNI Study Group commented [GOV/409, para.6.12], that this issue of compensation should be brought into the open, and Gosforth has consequently ensured that it has been aired in relation to the current proposals.

5B.58 The Shop Stewards support the RCF for social & economic reasons. They represent about 4,800 industrial workers at BNFL, and on their behalf have researched, & consulted on, the best way forward for the DWR project for the last 7 years. The paramount factor is safety, for their members & families and the rest of the people of West Cumbria. Some of the environmental groups opposing the DWR project must be following a hidden agenda, because they have been inconsistent in opposing both the surface storage of spent fuels and

the underground disposal of waste, and in opposing both the transport of waste to Sellafield for processing and the retention of waste at Sellafield after processing.

5B.59 In contrast, the Shop Stewards have responded to genuine concerns, such as the opposition of the Irish & Manx Governments to a deep under-sea repository. But radioactive wastes will continue to be created, and to need storage, treatment & disposal, and the Stewards' members will carry out the bulk of this work, which is centred on Sellafield. The deep underground repository on land is now the best practicable option, so long as retrievability of the emplaced waste is ensured. Longlands Farm is the presently favoured site, but everyone agrees that it still has to be proved that the geology is suitable. The RCF would be an essential part of that proving programme, and so must go ahead.

5B.60 The Stewards' support is not due mainly to the jobs which the RCF would provide, since their number would be small compared with the job losses at Sellafield & elsewhere, albeit well-paid long-term jobs with their greater economic multiplier effect are now at a premium. Satisfactory assurances have now been received from Nirex about a training programme for local people, and its Model Code for contract employers is also welcome. Whilst the Stewards do agree that the infrastructure in West Cumbria is chronically poor, it is not Nirex's responsibility to put this right, but the Government's. The construction of the DWR should supply some arguments & leverage for obtaining improvements, but that stage will not be reached unless the RCF is first allowed to go ahead.

5B.61 The Construction Workers also support the RCF, but for more direct economic reasons. Following the completion of the previous major building contracts at Sellafield, this Region now has the highest unemployment rate of construction workers in the UK, and one of the highest in the EU. Serious problems of poverty are appearing amongst this sector of the workforce which has done so much to help create the modern nuclear industry. The RCF project would bring very welcome re-employment to some, but there are 2,000 long-term construction jobs at stake in the provision of the DWR itself. The vast majority of Cumbrians know that the area's future rests with the nuclear industry, which has an excellent safety record, and they support the RCF. Minorities with greatly exaggerated fears about safety & property values should not be allowed to block this crucial opportunity to prove the suitability of the preferred site.

5B.62 There are also written representations in support of the RCF from local people for social & economic reasons. For example, M J Darvell [WR/D/99] claims that the case of the Parish Council is not properly representative of the village, because the Council does not behave in a truly consultative & open manner itself. Nirex would probably have provided more benefits for the village as a good neighbour, if it had not been criticised as acting out of base motives. The main tourist attraction in West Cumbria is the nuclear industry, and one of the main problems for both tourism & industry is poor communications. The RCF could well attract more tourists to the visitor centre [2B.3], plus businesses to service both the RCF & its workforce. Incoming workers & their families would also increase demand for house purchase, thereby sustaining the market & values.

5B.63 The Rt Hon Dr J Cunningham, MP for the constituency which includes the site, offers his qualified support for the RCF development. He has had the opportunity to study

the social & economic profile of the area in depth over many years, and is familiar with developments in the nuclear industry in his constituency and elsewhere in the UK & abroad. BNFL is a world leader, and Sellafield is to remain a large nuclear site of global significance. In his judgement, no practicable alternative has been put forward to spent fuel & waste re-processing & underground disposal. Continually expanding surface storage is not a credible long-term option, because of the safety & environmental management problems of coping with the massive sprawl of the Sellafield complex that would be entailed.

5B.64 The Sellafield area above all has to address the future of the nuclear industry squarely, and not try to shuffle off the problems. He considers that, on the scientific & technical side, Nirex is proceeding prudently, absorbing the lessons of best international practice & research. There is a reasonable case for exploring this site, subject to transparency & proper peer review, and on the understandings that the grant of permission for the RCF would not represent a commitment to the DWR nor rule out the options of monitoring & retrievability in any subsequent DWR.

5B.65 He considers that the largest economic problems faced by the Borough are long-term unemployment, over-dependence on BNFL, & large scale dereliction. There is no need for Nirex to exacerbate these problems, and indeed it has an opportunity to help alleviate them. For these reasons, he also supports the case put forward by Copeland for Nirex to enter into a planning agreement before receiving permission for the RCF. Following the precedents set by BNFL, the agreement should cover, amongst other things, the provision of training; guarantees of local recruitment & of supply contracts; and investment in the A595(T). These commitments should not await a decision to go ahead with the DWR, for they would merely be reasonable recompense to the Borough for already taking the strain of this national project. Moreover, in liaison with the local economic development agencies, Nirex should be dealing throughout the RCF development period with the local authorities' concerns about the property market, tourism & other economic impacts.

5B.66 Mr Dale Campbell-Savours, MP for the adjoining constituency, supported by Mr Tony Cunningham MEP [WR/C/180], believes that this RCF inquiry is the critical one for the future of the DWR project at Longlands Farm. This may be his only opportunity to influence the RCF & DWR inquiry decisions, for there may not be a Parliamentary debate on them. This DWR project is misconceived because it would irreparably harm the image of West Cumbria which local bodies & representatives have worked together for decades to defend. Although the negative image of Sellafield & Cumbria is unwarranted, it has been an uphill struggle to counteract it, and the DWR project would undermine this work, and make it very difficult to attract non-nuclear industry to West Cumbria.

5B.67 He is confident of this from his considerable personal experience. People who doubt the gravity of the concerns caused by Nirex's investigations should have seen the extraordinary lobbying in the House of Commons in 1986 by Government Ministers whose constituencies were affected then by the shallow repository site search, but who could not officially oppose the investigations. He thoroughly endorses the 1993 public perceptions report prepared for Cumbria [COR/401], especially the references to the dependency syndrome and fatalism. Personnel managers in West Cumbria are well aware of the difficulties of recruiting key personnel because of the negative image of Sellafield. The

general situation about closures is not as represented in Nirex's evidence. It is not the case that rumours circulate of closures occurring due to the negative image, and that they are then scotched when the managers responsible are contacted. What really happens is that managers publicly declare that the closure or re-location was due to some other reason, but tell people like him confidentially that it was indeed because of the image.

5B.68 Although the operations of BNFL are critically important to the future of the County, the future of Sellafield does not depend on the DWR being built in Cumbria. Another location would be found because nobody could afford to write off the billions of pounds invested in Sellafield. On the other hand, the future prospects of West Cumbria for social & economic development would be damaged by the reinforcement of the perception that the area can be regarded as a depository for everyone's radioactive waste. Government Ministers & other eminent figures have already floated suggestions that the DWR's functions could be expanded to take submarine reactor compartments or greater volumes of waste "substituted" under THORP's overseas re-processing contracts. This growing threat to the image & future diversity of Cumbria should be pre-empted by refusing permission for the RCF.

5B.69 The Irish Government points out that Nirex has paid no attention to the social & economic impact of the DWR project on the people of Ireland, notwithstanding the long history of concern expressed about the effects of operations at Sellafield on the eastern seaboard of that country. Similarly, the Isle of Man Government [WR/IOM/1] is firmly of the view that there is the potential for a detrimental effect on the Island's economy due to public perception of environmental harm, whether real or imaginary. This could damage tourism, fishing or inward investment. Nirex is trying to exploit the dependence of West Cumbria on the nuclear industry whilst overlooking both the potential harm to the Island and the benefits obtained from nuclear power by other parts of the UK with no involvement in the radioactive waste disposal problems. Patricia McKenna MEP considers that it is in any event fallacious to assume that a local population would support a DWR just because it supports other types of nuclear facility.

5B.70 FOE Cumbria similarly regard Nirex as confusing support with financial dependence. Nirex is misconstruing survey & poll information as showing little resistance to the presence of nuclear facilities, and glossing over some of the most crucial findings. For example, Cumbria's polling has found that about half of Cumbrian residents think that the nuclear industry is doing a bad job in disposing of its waste, and that Nirex specifically is not doing the best possible job [COR/411, executive summary at rear, 2nd bullet point]. Listening to Nirex's case, it is difficult to credit that there is now a 9% majority of the residents of Cumbria in favour of the County Council opposing Nirex's development [idem, last bullet point]. Moreover, Nirex has not dwelt on the findings of its own 1994 survey of attitudes towards the storage/disposal of radioactive waste [CFE/1/1]. Only 34% of residents aware of Nirex's proposals consider that the RCF should be built [idem, last bullet point, 1st page]. The survey puts this low level of support down to "misconceptions", but 32% still oppose the RCF when the misconceptions are dispelled [idem, top of 2nd page].

5B.71 The alleged misconceptions are that the RCF would be more than an underground research facility, but Nirex now concedes that parts of the RCF could become parts of the DWR development. Also the various survey reports contain plentiful evidence of blight which is inconsistent with Nirex's conclusions. Even 30% of the residents of Copeland who

work in the nuclear industry are concerned about the RCF project [COR/407, p.xv, Graph for Q.13a]. Of 12 local firms interviewed by Nirex's consultants, a majority actually expressed concerns in various ways [COR/402, eg paras.3.39 & 3.42-4]. All the development agencies interviewed were concerned about reinforcement of the area's negative image [idem, paras.4.44-53].

5B.72 There were some similar findings in the interim version of the research report produced for The West Cumbria Development Fund [COR/405] which are not apparent in the final version [COR/406]; and FOE Cumbria are still not satisfied with the consultants' explanation [COR/406A], especially bearing in mind that the consultants do other work in association with the nuclear industry [CFE/1/3, penultimate page, central item]. Much of the focus for such inter-relationships seems to be The Westlakes Park. EU funds intended to promote diversification are actually being devoted there to activities associated with the nuclear industry [CFE/1/4].

5B.73 Moreover, people familiar with West Cumbria are well aware of the industry's blighting effect. Tourism expenditure & tourist-related employment are lowest in Copeland of all Cumbrian districts [COR/408, Table 1]: as at 1992, Copeland had the most adverse past turnover trends [idem, p.64, Table 5.2]. Recruitment letters sent out by the West Cumbria Health Authority have been known to try to reassure people about radiation levels. Fish cannot be sold in the North East if they are disclosed to have been landed in West Cumbria. A local dairy moved to the South of Scotland when it discovered that its rivals were informing customers that its milk might be tainted by radiation. A school's exchange scheme with another in Germany was ended by German parents anxious about the health of their children when visiting West Cumbria. There can be little doubt that the nuclear industry already has a damaging effect on the economic well-being of the area, and that the RCF & DWR would increase this effect, a view shared by eg WRs/NTR/1, NCH/1, & S/235-6.

5B.74 CORE regard the Construction Workers' view on the nuclear industry's safety record as untenable. The industry & its regulators now accept with hindsight that former safety standards for both workers & public were too low. There are several current controversies about the long-term health effects of radiation on workers, their families & residents, which all contribute to the negative image: & see eg WRs/A/81, B/244, D/69 & 104, & O/32.

5B.75 Moreover the supporting workers & others are misunderstanding the real nature & extravagance of the DWR venture. Its location at Sellafield was effectively determined when the decision was made to go ahead with THORP. The current cost estimates [NRX/12/16, 1st column in each sub-table] are far too low, with a more realistic estimate by conventional accounting methods of more than £5 billions capitalization by the time the DWR is open for emplacement, comprising around £2 billions direct costs & the remainder interest & inflation [idem]. The latest design concept [5A.3] would be far too large for the present inventory [6A.4]; and the only way in which it could become an economic proposition would be to take in both ILW from elsewhere at open market prices and HLW.

5B.76 SCC submit that the RCF cannot possibly be justified on the grounds of benefits to the nuclear industry, its employees or recipients of Nirex's largesse. The potential hazards to future generations resulting from the project's attenuated timescale & premature commitment to an unsuitable location would be far more important than these benefits.

5B.77 **Mr J R Catlin** worked in the nuclear industry for 30 years, finally as Head of Engineering R & D at BNFL, and is now a local farmer. He wishes the industry future success but not at the expense of the well-being of local people. In his view, it is clearly untrue that West Cumbria has felt few ill effects from the nuclear industry, which has thrown an alien shroud over the area. For example, a well publicised incident led to the closure of a thriving school at Seascale, and seriously affected others in the area. Local farmers like himself are acutely aware of a negative image of West Cumbria. This would inevitably be exacerbated by the decision to locate here the largest DWR in the world, with particularly severe effects on farming & tourism. When combined in the long term with the Government's intended entombment of Sellafield (in contrast to the clearance of nuclear power station sites), the effects would be devastating.

5B.78 **Patricia England** is a voluntary community project co-ordinator, with experience of living within 2.5 km of 4 nuclear reactors at Heysham. She considers that Nirex's real view of the benefits of the current project is that it would avoid further costs which would be incurred by Nirex & its shareholders in spending more time & resources on investigating other locations with more scientific promise. Risk is primarily a matter of perception by involved parties. Nirex needs to address the psychological pressures which inevitably accompany the potential risk of living with a static hazard, by establishing a working relationship with the impacted communities which so manages the nuclear technology as to improve their quality of life.

5B.79 **Councillor D W T Gray**, the Borough Ward Councillor for Gosforth, follows this up by referring to the policies of Canada [GRY/1/5], France, Spain, Switzerland [GRY/1/3] & the USA to compensate local communities in advance for the stigma of receiving controversial development. The RCF as a site confirmation exercise is not a laboratory as generally understood internationally, despite being described as such when announced in 1991 [GRY/1/6, 2nd doc.]. Consequently the DWR project is already at the stage where the first level of compensation would be paid according to good international practice [GRY/1/7]. It is demeaning, & accentuates the stigma, to be told that it is not the UK practice to pay compensation. Also, public concern about the ambiguities of the highly technical aspects of the case for the development is heightened by the proponents not being local people, and thus being perceived as lacking a personal commitment to the area. Nirex (as opposed to BNFL) has not yet even set up the local subsidiary company promised in 1991 [GRY/1/6, 1st doc.].

5B.80 **Mrs Anne Lowery** & her family have occupied Newton Manor Lodge near the northern tip of the PRZ [2B.7] since 1986, and bought it from BNFL in 1989. BNFL drove a hard bargain and gave no inkling of plans to develop a DWR immediately behind their home. Nirex has paid no attention in any of its preparations to the effects of its project on her family and the 2 other independent families who live around the edges of the PRZ (Robinsons at Newton Manor Cottage & Steels at Low Lingbank - for details of the BNFL domestic properties within the PRZ see GRY/1/7, pp.42-3). No concern has been displayed over their legitimate anxieties over the RCF development about eg explosives storage, noise & traffic and potential blight. Nirex has actually paid more attention to the off-site effects on badgers & toads [Ca.5E] than human beings.

5B.81 **Ms J M Skinner** is a modern historian by profession who lives at Lancaster, and therefore close to Heysham & Springfields. Historians are more aware than most that the

history of the nuclear industry is very short, and includes a catalogue of errors, including mistakes still being made by BNFL & Nirex about the properties of plutonium. If the RCF were to go ahead, the people of West Cumbria & environs would be subjected to long-term psychological trauma because a development entailing significant potential risk would be imposed on them. The RCF would not provide much local work, but reinforce the dependency culture and undermine property values & tourism. In connection with the latter, a street survey in Blackpool on 16 September 1995 revealed, amongst other things, that 63.5% of the sample of 138 would visit Cumbria less frequently if the DWR were built at Sellafield.

5B.11 5B.82 **My conclusions** on the socio-economic impact can start with an uncontroversial  
5B.12 point. There would be some employment benefits from carrying out the RCF development,  
5B.32 including indirect & induced employment and other consequential additions to economic  
5B.60 activity. However, only an average of just under 100 direct jobs is predicted, and a  
5B.33 significant number of those would not be for local people, notwithstanding special  
5B.52-3 arrangements for recruitment & training. Such benefits would be relatively modest in the  
context of West Cumbria's overall employment trends. By way of comparison only, they  
would seemingly be less than those from the series of interim radioactive waste stores to be  
built at Sellafield. But I do believe that the fairly small numbers involved in the RCF could  
bring some more business to Gosforth village as the local service centre without competing  
detrimentally with the tourist trade.

5B.5 5B.83 This balance might well not hold for Gosforth if the construction & operation of the  
5B.61 DWR were to follow on from the RCF as Nirex hopes. The employment & related benefits  
3A.12 of the DWR for the wider area would nevertheless be on a significantly higher scale. Even  
5B.75 though Nirex has not sought to re-calculate the DWR benefits, as opposed to the DWR costs,  
for this inquiry, my view is that those benefits should be taken into account because they  
would be contingent, indirect effects of the RCF. However, I also consider that the RCF  
application stage is an appropriate juncture at which to review the dependency of the West  
Cumbrian economy on the nuclear industry.

5B.14 5B.84 Nirex is arguing on the one hand that the nuclear industry sustains that economy and  
5B.24 will remain the dominant employer, and on the other hand that the economy is not too  
NRX/10/4, dependent on the industry. But the Windscale (THORP) Inquiry Inspector's conclusion in  
p.76 the passage cited by Nirex was not, in my view, that BNFL's dominance would remain  
satisfactory. Rather it was that there was no evidence that less dominant yet equally stable  
employers would provide a similar number of permanent jobs if THORP was refused  
permission. He expressly stated that there might have been force in the over-dependency  
argument if there were such evidence.

5B.31 5B.85 The local economic situation is still similar in some respects to that in 1978 considered  
5B.41 at the Windscale Inquiry. The nuclear-related project under consideration would bring some  
employment benefits but they would only amount to some alleviation of the unemployment  
problem. There is no evidence of large-scale provision of new jobs by other stable  
employers. There is still a worryingly high dependency on the nuclear industry. On the  
other hand, it does seem to be clear now that other employers are continuing to close down  
or re-locate despite the development of THORP. There has also been the 1993 appraisal for



5B.28 Cumbria of public perception & the nuclear industry. I agree with its authors that this sheds  
COR/401, new light on the situation, largely because focus groups can give a perspective to people's  
pp.1-2 deep feelings different from that of opinion polls.

5B.65 5B.86 The appraisal identifies a sense of dependency which is founded substantially on a  
5B.68 fatalism about the nuclear industry's dominant economic role & the lack of alternatives. I  
5B.63 am also very impressed by the shared belief of the 2 experienced & committed local MPs that  
5B.66 West Cumbria is over-dependent on the nuclear industry. The fact that their overall  
2A.10 approaches towards the RCF project differ actually strengthens for me the importance which  
they attach to this point. I consider that it is now palpably obvious that the West Cumbrian  
economy is too dependent on the nuclear industry. It follows that any event which  
significantly consolidates the nuclear industry further would be an economic detriment in this  
sense. The establishment of the DWR at Sellafield would be such an event, particularly  
because the ultimately crucial factor in concentrating solely on the appeal site has been its  
proximity to the existing Sellafield Works.

5B.16 5B.87 In other words, the nuclear industry has chosen to establish the DWR at Sellafield,  
if it can, because it does wish to bring radioactive waste management & disposal activities  
together here, yet this would not be in the interests of the long-term economic health of West  
Cumbria, in my judgement. I do appreciate from the evidence put to the inquiry that many  
people in the area support the industry in its aim, but I am driven to the conclusion that if  
they persist in this they run a real risk of their long term prosperity being subordinated to the  
demands of a single industry. That would be the logical consequence of sustained over-  
dependence. This adverse effect has to be set off against the employment & related benefits  
of the DWR.

5B.17 5B.88 Whilst it might be thought that this line of reasoning has moved some way from  
assessing the effects of the RCF, the fact is that Nirex itself has led evidence about the impact  
of the nuclear industry and of individual nuclear facilities. This is an implicit contradiction  
of its legal submissions that the RCF must be kept separate from the DWR [3A.11-15], and  
reinforces my conclusions that they are connected as matters of fact & law [3A.18-24].

5B.17 5B.89 Another basic difficulty with Nirex's case on this topic is its considerable reliance on  
its definition of blight. Whilst I would not necessarily quarrel with the definition as such,  
the implication that the definition covers all the relevant circumstances of potential impact on  
people and their property is incorrect, in my view. For I am firmly of the opinion that a  
5B.34 genuine apprehension affecting the quality of life can be a material planning consideration,  
albeit that I am aware of current litigation in the Court of Appeal concerning the similar issue  
of fear of crime. To adopt the words in one of Nirex's reports, a person who perceives the  
risk associated with the DWR to be high may experience less enjoyment from occupation of  
their property [COR/409, p.3, para.1.10]. In the case of a resident, this would be an injury  
to residential amenity, and a land-use consequence of a perception of risk.

5B.90 So long as there is some substance to it, a resident's apprehension of risk does not  
have to be scientifically or statistically accurate before it can be material. It is of course  
necessary to distinguish such situations from sheer prejudice or simple opposition, but the  
basic question is not whether financial or other loss would be experienced but instead whether  
amenities & worthwhile existing uses would be affected, albeit financial loss could be strong

evidence of disamenity. Good neighbourliness & fairness are also amongst the yardsticks against which development proposals can be measured (PPG1, para.40).

5B.8-10 5B.91 The evidence to the inquiry on this pertinent point of public perception is  
CFE/1/1 unfortunately a striking example of voluminous but fragmented representations, in my  
CORJ/411 judgement. For example, Nirex Cumbria & Copeland commissioned separate opinion polls  
CORJ/407 which included perceptions of the RCF, whereas I believe that more meaningful information  
5B.16 could have been obtained by pooling resources in a single, independent & penetrating  
5B.71-2 survey. The various surveys into impact on tourism & other businesses also suffer from a  
number of difficulties, including both sample sizes and inferences drawn by the surveyors,  
often capped by selective quotations by parties to the inquiry.

5B.30 5B.92 However, the simple basic test in the case of residents, of a genuine public perception  
5B.35-6 leading to an injury to amenity, enables my conclusions to start from earlier principles. It  
5B.55 is clear from the criteria used by Nirex in its site selection exercise, and from its public  
5B.5 statements about that exercise, that Nirex then accepted that its quest for a site for a  
6B.46 radioactive waste repository would arouse considerable public apprehension at any location  
which it started to evaluate. Nirex has not withdrawn its vindications of those criteria, and  
yet it tends to deny that the phenomenon would occur significantly at this, its favoured  
location. In my view, it needs to bring forward a very cogent explanation for such an  
apparent inconsistency.

5B.16 5B.93 Looking at the burden of both the systematic & anecdotal evidence submitted on this  
5B.37 point, my judgement is that there is generally a lower incidence of apprehension in West  
5B.67 Cumbria than the overall site selection approach seemed to predicate. This may well be due  
5B.70 to what Nirex described as a measure of support and Cumbria & others describe as the  
dependency syndrome, but it ought nevertheless to be taken as the genuine level, in my  
view. Although appreciation of dependency illuminates social understanding, it carries weight  
in the economic arguments rather than the social ones. On the other hand, I am equally clear  
that the degree of apprehension is substantial & significant, and that it is considerable even  
amongst people associated with the nuclear industry. Since land-use planning is not  
concerned with simple volumes of opposition or support, the fact that the apprehensive people  
may be in a minority goes only to the relative weight to be attached to their fears, in my  
view, once it is clear that the minority is not insignificant. In this case, there is evidence that  
a moderate number of residents would have their amenity affected. In some ways, the  
5B.80 reaction of the occupants of Newton Manor Lodge to the perceived lack of neighbourliness  
typifies this effect.

CFE/1/1 5B.94 Primarily from scrutinising the responses to particular opinion poll questions about the  
CORJ/411 RCF, it seems to me that the apprehensions about the RCF are normally indirect  
CORJ/407 apprehensions about the DWR. Despite noting the distinctions between prompted &  
unprompted questions, and between questions coupling the RCF & DWR and others dealing  
with them separately, I infer that the underlying fears are mainly about health & safety in  
relation to radioactive waste. However, I have already concluded that such indirect effects  
should be taken into account at this stage [3A.21-3]. Also, whilst I agree with Nirex that an  
5B.40 appreciable degree of difference can be seen between the intended behaviour of residents  
faced with the prospect of the project and their less negative actual behaviour after the event,

the present situation is of course still at the heightened negativity stage of anticipating the main part of the project.

5B.8-10 5B.95 Turning to the impact on tourism & other businesses, I consider the bulk of the evidence to be either generalised or based on unreliably small samples. Moreover, I am unsure about the realism of distinguishing between poor communications, remoteness, and deterrence by the nuclear industry, as separate factors discouraging trips to, or investment in, 5B.19-20 West Cumbria. There is virtual unanimity that transport communications with the remainder NRX/10/10 of the UK are poor, and to my mind that must be a powerful contributor to the sense of remoteness. However, the wartime location of the nuclear complex and its subsequent NRX/10/4, civilian growth were surely due in large part to the relative remoteness of the location. para.2.24 Hence to my mind the factors of poor communications/remoteness and nuclear presence feed off & reinforce each other.

NRX/10/10 5B.96 My overall impression of the uneven survey evidence about what are mainly external perceptions of West Cumbria is that they are fairly similar in some ways to internal perceptions. Many outsiders seem hardly to think about West Cumbria at all, apparently 5B.23 because of its relative remoteness. When prompted or focused upon, a significant number 5B.39 refer to some negative image of the nuclear industry, but it can by no means be pinned down 5B.73 as an overwhelming liability to the area. On the other hand, the clear views of the Manx & 5B.69 Irish Governments from across the Irish Sea, of the negative perceptions associated with the industry and their likely accentuation by the DWR, are persuasive arguments of some adverse 5B.15 effect on tourism & other businesses, including fishing. Also I believe that reflecting on what 5B.41 businesses have done, as distinct from what they say they have been doing, suggests quite 5B.31 strongly to me that there is a special deterrent factor at work. The position of agriculture is 5B.77 more problematic, but it is also quite possible that West Cumbria is at a disadvantage in the current EU re-structuring of this industry.

4A.50-2 5B.97 In short on this topic, there would be modest employment & related benefits from the RCF, and much more significant ones from the DWR if it went ahead; but, particularly in case of the latter, these benefits have to be balanced against the detriment to the area's prosperity in being indefinitely subordinated to the demands of a single industry. Moreover, there would be a social detriment, in that the amenity of a significant number of local residents would be injured by genuine apprehensions about the project, mainly relating to health & safety. Similarly, there could be noteworthy effects on tourism, fisheries & inward investment in business, plus possibly agriculture. These various benefits & detriments should be carried forward to the final balancing exercise under SP Policy 54(i), but in the meantime there would seem to be some deleterious long term effects on the Borough's economic resources, contrary to emerging LP Policy DEV 4 [2C.28].

5B.26 5B.98 Since Nirex has not offered any condition or obligation to meet or mitigate significant socio-economic objections, it would be inappropriate for me to comment in detail on the suggestions of other parties. There is also the point that emerging LP Policy IMP 1 applies to costs or effects arising directly from the development concerned, whereas I have found that most of the effects would be indirect ones. Nevertheless it seems to me that potential obligations must at least be briefly considered as mitigation measures, although the transportation suggestions are postponed to the next Chapter.

5B.96 5B.99 Local confidence in the RCF venture's integration into the West Cumbrian economy  
could have been improved, in my judgement, by the setting up of the promised local  
5B.79 subsidiary, and perhaps seeking to incorporate it jointly with Copeland. The most realistic  
5B.15 way to help the economy to diversify must be, to my mind, to continue to encourage  
5B.47 currently nuclear-related businesses to adapt their expertise laterally into non-nuclear  
5B.72 applications, notwithstanding the views of some of the other parties. There could have been  
a commitment by now for such a joint venture to do this in a phased manner, geared to the  
progressive success of the RCF/DWR project. The informal practice of subsidising public  
5B.6 services & facilities in the Parish might also have been formalised into a trust fund with a  
5B.57 regular income; and with objects which include the support of services & facilities utilised  
by workers at the venture & their relatives & associates, and the relief of residents of  
properties certified to be blighted by the venture. Measures such as these could in my  
judgement have considerably mitigated the social & economic effects of the RCF.

## 5C. TRAFFIC IMPACT

5C.1 The preferred conceptual DWR design publicised in December 1991 [COR/206] was prepared as a result of the local community raising, amongst others, the issue of the routing of transport links to the DWR headworks area, both during construction and during the operational phase [idem, p.3]. Considerable support had been expressed for the view that DWR entry & exit should be via a point on or close to the existing Sellafield Works, rather than from the east. This last point was amplified in the more detailed progress report [SPD/1/1] as meaning a new link from the A595 [idem, p.4, top of r/h column]. The consequentially preferred design concentrated on construction & operational access to the PRZ from Sellafield. It included 2 ventilation/emergency access shafts above the vaults within a surface site of about 4 ha [idem, p.6], with little need following construction for above-ground access. As no manned operations would be involved, appropriate road access could be provided from the Sellafield direction. This concept was still being publicised by Nirex in 1994 [SPD/1/5, p.47].

5C.2 At the Nirex Liaison Group on 7 January 1992 it was confirmed that road & workforce access would be via the Sellafield Works [CCC/1/2, p.132, para.3]. However, by April-May 1992 an access from the A595 to the ventilation shaft area was being discussed [idem, p.103], together with an informal Cumbria scheme for the improvement of the road between Gosforth and Calder Bridge to a 7.3 m wide carriageway plus metre strips [idem, pp.104 & 108]. At a meeting on 12 June, pedestrian traffic along the road was discussed, at Copeland's instigation [idem, p.99]. On 23 November, the Department of Transport, in discussing the RCF & its Boreholes, stated its general preference not to have a new development's access directly onto a trunk road for safety reasons, but acknowledged that the A595 is not a typical trunk road, and that the use of Sides Lane would be reduced & the existing farm access closed [idem, p.80].

5C.3 In the event, the Department did not object, and the present access to the appeal site [2B.7] was permitted & constructed in 1993 as part of the RCF/RCM Boreholes development [COR/201, p.229]. Copeland, supported by Gosforth, recommended that permission should not be granted until a requirement was met to improve substantially the stretch of the A595(T) between Calder Bridge and Gosforth [idem, p.237, para.2.a) & p.238]. Nirex had confirmed that, looking ahead, it would be ready to give sympathetic consideration to a significant contribution to the costs of a cost-effective package of improvements to this stretch of road [idem, p.278]. This package & its timing would be for the Department of Transport to consider, in consultation with the local authorities & communities. But Nirex did not accept that its operations at Longlands Farm would add unacceptably to the traffic using this stretch [idem, p.277, para.2(iii)]: and the County Planning Officer advised the Planning Sub Committee that Copeland's suggestion went beyond Structure Plan policy and the advice in Circular 16/91; could be misconstrued as looking for an unrelated community benefit; and had an unrealistic timescale [idem, p.249].

5C.4 A former County Councillor, also supported by Gosforth, suggested alternative access arrangements [idem, p.285, item 13]. This concept [idem, p.293] was for a Sellafield Works by-pass along the eastern edge of the Works, linking the C4013 in the north to the U4465 in the south [2B.2], and with a spur eastwards to Longlands Farm, to link the Farm with the

Works and the railhead. Although the Planning Officer reported this suggestion also to the Sub Committee, he made no specific written comment on it, as opposed to Copeland's suggestion.

5C.5 However, Condition 5 of the RCF/RCM Boreholes permission requires that upon completion of that development [5A.4], the access shall be restored to provide an agricultural access to serve Longlands Farm only [idem, p.229]. The present application describes the access as an existing one which would be unaltered, to become the access point to the Surface Site [COR/102, pp.2 & 37]. The latest restoration scheme includes the retention of the first length of the access from the trunk road as the access to Longlands Farm [COR/113, Scheme H, Section 5.1, last para. & drawing no.008046A]. Therefore the amended RCF proposals include in effect the permanent retention of the present temporary access point.

5C.6 The ES contains an assessment of traffic effects as at the time of the planning application [COR/101, Ca.4]. The HGV flow estimates allow for the removal of 15,000 t of excavated BVG [2B.14] for off-site testing [idem, para.3.4.43 & Table 3.4.8]. The RCF/RCM/PRZ Boreholes traffic [2B.6] has also been taken into account [idem, paras.3.4.46-7]. The conclusions are that, although the increases in traffic would be material in terms of PPG 13, Annex B, para.4, there would be no significant effects on the A595(T) or other roads, on road safety, or on the use of the trunk road by pedestrians & cyclists [idem, paras.3.4.69-75].

5C.7 However, there have been a number of changes in the RCF proposals since preparation of the ES which have affected the traffic analysis. The amendments to the design, construction methods (adding some necessity for abnormal loads), programme and timetable, and consequential changes to the fluctuations in the size & nature of the workforce, have required fresh calculations [NRX/9/14, Tables 5.1-5 & 6.1]. The option to dig the shafts as far down as 935 m bOD [2B.12] has also been taken into account (the "Variant Case"). There is now also a programme to bore 4 Saline Interface Boreholes - BHs 15-18 - between the trunk road and the coast [NRX/14/12, Table 6.3], which would generate some traffic [NRX/9/14, Table 5.6]. The opportunity has been taken to utilise more recent traffic flow & accident data.

5C.8 **Nirex** has concluded that the use of rail in the development of the RCF would not be viable. It would be difficult to engineer a spur from the Cumbrian Coast Line near the Sellafield Works across the intervening topography to the PRZ. Also, with the excavated spoil remaining on site, there would be a variable mix of material flows, with a peak of short duration [NRX/9/14, Table 5.3]. Thus there would be no conflict with SP Policies 9 [2C.6] & 70 [2C.17] and LP Policy TSP 13 [2C.32]. Also there would be environmental, operational & logistical problems in constructing a new road access to Longlands Farm from Sellafield [idem, Table 7.1, Sheet 1].

5C.9 Moreover, such a road access is not needed, in Nirex's judgement, because the practical capacity of the A595(T) [2B.2] would be more than adequate to cater for the traffic likely to be generated by the development. The traffic would not necessitate the improvement of the length of the trunk road between Gosforth and the Nursery Road junction north-west of Calder Bridge [idem, Fig.4.1] sought by Copeland, namely to a 7.3 m wide carriageway

plus footway & cycleway. As Copeland concedes, the trunk road's recorded injury accident record [idem, Table 4.5 & Figs.4.14 & 15] does not warrant such an improvement. There is no objection to the RCF proposals by the Highways Agency as the trunk road highway authority or by Cumbria as local highway authority [idem, Table 7.1, Sheet 2], nor by the police.

5C.10 A realistic assessment of the practical link capacity of the A595(T) between Gosforth and Nursery Road based on the Department of Transport's Standard TD 20/85 [GOV/117] is approximately 12,000 vehicles per day (vpd). This assessment starts with the Standard's figure of a 13,000 Annual Average Daily Traffic (AADT) flow capacity for a new road link of this type, and then allows a reduction for poor alignment, variable width & limited junction design. Copeland seems to accept this assessment, and certainly has not put forward an alternative figure.

5C.11 Nirex has combined the predicted RCF traffic with the predicted traffic generated by the RCF/RCM/PRZ Boreholes, and also allowed for the effects of the BHs 15-18 traffic on the local network. The overall traffic generated by the Longlands Farm developments would be, on monthly maxima, of the order of 550 vpd 2-way for the first 4 years and 300 vpd thereafter, usually with relatively low HGV flows & proportions [NRX/9/14, Fig.5.2]. It has assumed a split of the generated traffic of 100% HGVs & 80% LGVs & cars to the north-west of the site entrance and 20% LGVs & cars to the south-east. Also it has taken the estimated generation in the busiest month of the year and added it to the highest monthly flow on the road (July). These are all worst-case assumptions, and have been multiplied by the National Road Traffic Forecast's (NRTF) low growth rate.

5C.12 The low rate is another conservative assumption in this case, for the flows on the road have actually been declining in recent years [idem, Table 4.1], probably related to the reduction in employment at the Sellafield Works [idem, Table 4.2]. Putting all the assumptions together as a worst case scenario, total flows on the road would not reach its assessed capacity during the life of the RCF [idem, Fig.6.1]. Even with NRTF high growth the assessed capacity would not be reached [NRX/9/13A]. The total project-generated flow would be of the same order as the recent reductions in flow at Calder Bridge & south of Gosforth; and would be within the growth range predicted by the NRTF over the period of the development. Representations of objection on traffic grounds [idem, Table 7.2] have taken little cognisance of this point or of the fact that the development would be temporary.

5C.13 Although Copeland claims that the capacity would be exceeded by the year 2009, the basis for this claim is a faulty 1994 AADT figure for the trunk road south of Calder Bridge traffic signals [idem, Fig.4.9]. The faulty figure of 8,900 is a conversion by Cumbria of an agreed 12 hour flow by a general county-wide factor rather than the more accurate site-specific factor derived from Nirex's observations [NRX/9/13, Section 5], which suggests a no-change-from-1993 figure of 8,300. Even then, a base figure of 8,900 would result in a flow of less than 12,000 on the NRTF low growth rate. Moreover, the stretch of road where the counts are taken has a higher practical capacity than the rural stretches further south-east [idem, para.6.3].

5C.14 Turning to junction capacity on the route north-westwards from the site, Nirex's OSCADY analysis of the Calder Bridge junction with the C4013 coming up north-eastwards

from the Sellafield Works [NRX/9/14, Figs.4.1 & 4.3] shows that the junction has the capacity, if necessary by automatic adjustment of the signals, to accommodate the flow generated by the appeal development in the peak years. Moving on to the next major junction at the Blackbeck Roundabout [idem, Fig.4.2], the peak hour there [idem, Fig.4.8] is 0700 to 0800 hours. After the RCF Phase 1 construction works, the RCF traffic is predicted to add only about 30 cars to the flow there in the peak hour. Nirex considers this addition to be insignificant, but if there is concern, Nirex could undertake to ensure that the RCF shift patterns do not coincide with those of BNFL.

5C.15 So far as the safety of the junction at the site entrance is concerned, the junction provides facilities to current design & safety standards [idem, Figs.4.4 & 4.5]. The major road has been re-aligned through the junction; there is good visibility for turning traffic; and a south-east-bound right-turn lane has been provided. A PICADY analysis shows that the junction has ample capacity, with the right-turn lane able to accommodate the highly improbable event of a queue of 3 HGVs. There is also capacity for waiting off the road at the approach to the security gate. If the access point were nevertheless blocked by an accident or incident, there would be emergency access via Sides Lane [2B.7].

5C.16 The incidence of pedestrian & cyclist traffic on the A595(T) is low [NRX/9/14, Table 4.4], with the emerging dedicated cycle routes being aligned more to the south-west around the Sellafield Works [idem, Fig.4.13]. The relatively small increase in traffic from the appeal development would have an insignificant effect on pedestrian & cycle use of the trunk road. Trunk roads are not designed for pedestrian usage. Nor is there evidence of suppressed demand, or to show that the appeal development would give rise to such an additional demand from the site to Calder Bridge as to justify refusal in the absence of highway improvements for pedestrians & cyclists. On the Surface Site itself, facilities for cyclists would be provided as warranted by demand.

5C.17 Hence the needs of pedestrians & cyclists would be taken into account in compliance with LP Policy TSP 7 [2C.31]. Moreover, the development would have overall a satisfactory standard of access to the A595(T), which in turn would be an appropriate standard of road, in conformity with LP TSP 5 & 6 and SP 36 [2C.13]. This sufficiency of the transport infrastructure of course means that no improvements can be required at Nirex's expense under SP 36 or LP IMP 1 [2C.29]. The traffic generation must obviously be acceptable under the key LP Policy ENV 33.4 [2C.27 & 4B.4].

5C.18 Hence, despite the eminence & number of those submitting that Nirex must offer a planning obligation for improvements to the A595(T) [eg 5B.63-80], there is no case for doing so. This is not surprising because there is no scheme for the improvement of this length of the trunk road in the development plan [2C.17 & 32]. Copeland in particular has effectively acknowledged the weakness of its arguments by confirming that it is not asking for the imposition of a condition that the development shall not begin until road improvements have been carried out.

5C.19 **Cumbria** acknowledges that the RCF project would be of insufficient size to make a rail link practicable. It confirms its opposition to a service road from Sellafield because of the adverse visual impact. There is sufficient highway capacity to cope with the proposed



development. It would be desirable to arrange the RCF working shifts so as not to exacerbate peak hour conditions at the Calder Bridge & Blackbeck junctions, but the overall level of traffic anticipated would be acceptable. Nevertheless, the periods of heaviest HGV use in connection with the development would affect the amenities of the area due to the poor alignments & variable widths of the trunk road. If permission is granted, Nirex should draw up a code of good practice for HGV drivers to minimise congestion & environmental impact. On the other hand, pedestrian & cycling use of the trunk road is low, and the effect of the additional traffic would not be so significant as to necessitate road widening or the provision of footways.

5C.20 **Copeland** points out that, although the traffic figures have been revised, Nirex concedes that the combined RCF & BHs' development-generated traffic would for the first 5 years represent an increase of about 7% over the A595(T) traffic in the vicinity of the appeal site, and so would be material in terms of PPG 13. Copeland's approach towards restricting development alongside the trunk road until essential improvements have been carried out accords with paras.6.3-6 of the PPG. The strategic role of trunk roads is to carry long distance traffic. The addition of significant local traffic movements prejudices this role. Also direct access onto primary routes is to be avoided as far as practicable; and it may be appropriate to require major road improvements if the type of road warrants it.

5C.21 This national policy background obviously makes the RCF project's traffic volumes significant for the purposes of LP TSP 6. When the project's traffic reaches a peak after the first year, nearly a quarter of it would be HGVs [NRX/9/14, Table 5.7]. This would be the largest development project served by the entire length of the trunk road from Egremont to Millom. Copeland does not accept a 13 year development period as temporary, a description which it would confine to durations of no more than 3 years or so. Yet the A595(T) is not an appropriate standard of road within the meaning of the LP Policy.

5C.22 The physical character of the length of the trunk road south-eastwards from the Nursery Road junction (north-west of which it has been improved) to Gosforth is not generally in dispute. It is sinuous & undulating, often with a carriageway considerably less than 7.3 m wide, and also often with no or only one footway and narrow verges. The stretch from Calder Bridge to Gosforth has characteristic alignments; carriageway widths almost always less than 7.3 m, and as narrow as 5.6 m just south of the hamlet of New Mill; and generally narrow verges or edge strips, with just one short stretch of footway at New Mill. Nirex accepts that the TD 20/85 Standard is for a main carriageway width of at least 7.3 m, plus 1 m strips on either side, making a total carriageway width of 9.3 m. Plainly this length of the trunk road is seriously sub-standard.

5C.23 The practical link capacity estimated by Nirex must have several limitations. The A595(T) is in reality an all-purpose road, so that flows are sometimes slowed by a range of vehicles, from agricultural ones to pedal cycles. Flows are also held up by passage through the village of Calder Bridge, where the frontages are built up & slow speeds are needed to avoid hazards; and by the Calder Bridge traffic lights & Blackbeck Roundabout themselves. Then Nirex is under-estimating the AADT also. There must be very little difference between the flows past the appeal site and those at the count point in Calder Bridge. Yet the 1994 base figure for Calder Bridge should be taken as 8,900, since Nirex concedes that the easing

of traffic conditions is only a temporary phenomenon. Then the counts south of Gosforth show that the peak month is shifting from July [5C.6] to August [NRX/9/14, Table 4.1]. This necessitates an uprating, at the 1994 difference between the months of about 16%, of the 8,900 to a peak flow of about 10,325 vpd.

5C.24 Projecting this peak flow at the NRTF low growth rate, the practical capacity estimated by Nirex would be exceeded by the year 2003, and at the high growth rate by the year 2000. Even if there were some flexibility in the capacity estimate, by the last year of the development the estimate would be exceeded by 1,000 to 3,000 vpd. This is a clear case of the road which constitutes the main transport infrastructure for the area not being up to an appropriate standard, and in need of improvement. The RCF's traffic would make a significant contribution to the excess, a view shared by Dr M Burns [WR/B/176]. In the absence of any improvement scheme or undertaking by Nirex to improve the road, there are substantial traffic reasons for refusal due to the conflict with LP TSP 6, IMP 1 & ENV 33.4.

5C.25 Gosforth considers that Nirex is failing to deal with issues raised in previous years which must now be resolved. These include the nature of the link between Sellafield Works and the PRZ. The preferred DWR design option includes an access road from Sellafield notwithstanding current visual objections, and yet Nirex has confirmed that it has not contemplated building it now, even as an emergency access. Further thought must be given to this question, because it is not being appreciated that there is no alternative to the A595(T) as a public road between Calder Bridge and Gosforth. The theoretical detour via public roads is about 210 km (130 miles) long through the Lake District. The realistic detour is along BNFL's private roads.

5C.26 Nirex can make extravagant provision at the RCF site for very large car parks [COR/102B/008009B] & other facilities, but is unwilling to commit itself to help sustain vital local air services; guarantee the retention of a railhead at Sellafield; and either link the site by road to Sellafield's infrastructure or contribute towards improving the seriously sub-standard trunk road. The Highways Agency is taking a similarly negative approach on the last point, despite agreeing that there are narrow bends & some hidden entrances, with no provision for pedestrians [GPC/6, pp.5-6]. The Agency does suggest that the Parish Council could negotiate for a strip of land for a footpath outside the highway boundary, but the appeal site frontage does not extend to Gosforth, and a single footway would be better on the north-eastern side of the carriageway, to serve the Red Admiral Hotel, Boonwood & Sally Hill.

5C.27 Gosforth is aware of regular pedestrian & cyclist use of this stretch of road, but usage is low due to the hazards & intimidation of going along an unlit, winding & narrow trunk route, as the Inspector will have appreciated on his inspection. A previous letter from the Department of Transport did specifically acknowledge the poor standard of the road [GPC/6A, p.S15] & the hazards to pedestrians [idem, p.S16], but it claimed that there was no evidence of demand. The actual experience at Holmrook, the next village to the south-east down the trunk road [5A.55], is that when an extra length of footway is provided beside the road, pedestrian flows increase several-fold.

5C.28 The Department also claimed in March 1993 that the accident rate over the majority of the length of the road between Calder Bridge and Gosforth was slightly less than the

national average of 0.39 personal injury accidents per million vehicle kilometres (PIA/mvkm) for this type of road [idem, p.S15]. But Nirex has acknowledged that the proper average for comparison is the 0.28 PIA/mvkm rate for all Class A roads in non-built up areas in 1993 [GOV/119, p.99, Table 4.15]. Although Nirex rightly says that national rates are declining, the average rate for the Calder Bridge - Gosforth length for 1991-3 of 0.34 was not only above the national average of 0.28, but also an increase on its own 1990-2 average of 0.31 [NRX/9/14, Fig.4.14]. Furthermore, Nirex admits that 2 of the 1992 accidents involved cyclists [idem, Fig.4.15, Sheet 4]. Those 2 were actually on a short section next to the village which the Department did concede had a higher rate, but Gosforth has heard nothing of the study which Cumbria was to undertake into that in 1993 [GPC/6A, p.S15].

5C.29 Mrs Anne Lowery corroborates Gosforth's evidence on injury accidents. Her neighbours have given her details of 5 serious accidents on the trunk road in the vicinity of Newton Manor Lodge between 1987 and 1991. Most of them appear to have been partly attributable to the poor visibility along the trunk road to the south-east from the mouth of Newton Manor Drive [WR/LOW/1, last page]. One involved injury to a cyclist.

5C.30 Seascale Parish Council [WR/SPC/1] generally supports Gosforth on the questions of rail use and the blockage of the trunk road between Calder Bridge and Gosforth. In the case of the latter, although it believes that the shortest detour is only about 130 km (80 miles), it emphasises that the emergency evacuation plans for the Sellafield Works assume that the A595(T) would remain open. It is also concerned about the ghost island at the existing access point, which does not seem to have the capacity for HGV turning movements claimed by Nirex, and appears prone to damage-only accidents.

5C.31 FOE Cumbria do not align themselves with any other party on this topic. Improvements to the trunk road as requested by Copeland & Gosforth would be likely to result both in more traffic on the road and in more major development projects. The physical improvements to the road itself would harm the character of the National Park as the road ran alongside it. The additional traffic would also disturb the quiet enjoyment of the Park and other environmentally significant areas such as the Duddon Estuary, where in turn the pressure would increase for an environmentally damaging road improvement, despite the requirement of SP Policy 63 [2C.17] for rigorous environmental assessment.

5C.32 I conclude firstly that traffic impact is a striking example of the importance of assessing the environmental effects of a project at the first opportunity. In this case, I welcome Nirex's inclusion of the effects of the Boreholes traffic in the assessment, but I sympathise with the frustration of Copeland & Gosforth in failing to achieve resolution of the principle of road access to the DWR project at the first (Boreholes) application stage. The position appears to be that the original concept of a DWR south of Sides Lane was rejected partly because it would have entailed a new road access to the A595(T). The revised concept as published consequently provides for access to the PRZ to be mainly from Sellafield, even in the case of surface access to the shaft compound after construction. Yet it also seems that as early as in 1992 proposals to revert to an A595 access were being informally discussed.

sc.11

sc.3

SA.2

sc.1

sc.2

5C.3 5C.33 The present access to the Boreholes development appears to be the logical consequence  
5A.4 of that discussion. Currently it has a temporary permission with about 4 years left before  
5C.5 expiry, but approving the amended RCF proposals would include granting permission for its  
5C.2 indefinite retention. The implication of the 1992 discussions is that this is intended to be the  
3A.1 access to the DWR ventilation shafts area also if the RCF is successful. Even though the  
5C.21 RCF shafts might themselves be transformed into the DWR ventilation shafts, there is also  
a possibility that they would be used as a secondary DWR construction access. In these  
circumstances, it is, in my view, not before time to settle the principle of the projects' road  
access to the A595(T); and it should no longer be treated as a purely temporary access.

5C.8 5C.34 This is all the more so because the situation on rail use is clear to me. I accept that,  
5A.2 in rail traffic terms, the RCF would be far too fragmented a project to be viable. On the  
SPD/1/1 other hand, the DWR's main excavation and emplacement operations would be prime  
candidates for utilising rail, and are being treated as such. That use should give a much  
needed boost to the Cumbrian Coast Line, and hence benefit the local economy, all in accord  
with SP Policies 9 & 70 and LP Policy TSP 13.

5C.1-2 5C.35 Concentrating, therefore, on the road access, PPG 13 should first be considered since  
a trunk road is involved. The guidance in the PPG is, of course, to be applied to individual  
planning applications and appeals as well as in development plan preparation [para.2.11].  
According to the guidance, as Copeland has pointed out, generally all trunk roads should be  
reserved as corridors for movement and associated development should be resisted.  
Specifically, the A595(T) is part of a key long distance route identified by Policy SP 63-2  
[2C.17]. Also the history of the DWR project does suggest that Nirex is seeking to associate  
the DWR development with the trunk road notwithstanding sustained local opposition.

5C.19 5C.36 Moreover, the A595(T) is of course a primary route, onto which direct access should  
5C.8 be avoided as far as practicable. The informal evolution of the DWR design concept, in  
withdrawing from a direct trunk road access and then proposing it again, does imply a  
judgement that access to a secondary road via Sellafield is not feasible. Cumbria has  
5C.1 mentioned visual objections, and Nirex now seems to have several kinds of objection.  
2B.3 Nevertheless, the published design concept, prepared after much consideration, includes an  
COR/101 access road from the PRZ to Sellafield. Also service corridors have been subjected to a  
5A.2 general environmental assessment for the purposes of the RCF application. The cut & fill  
to accommodate a road through the topography should be considerably less, in my judgement,  
than for the rejected surface rail link. In the absence of a detailed, public environmental &  
economic assessment of a road link between the PRZ and Sellafield, I decline to conclude that  
such a link would not be feasible.

5C.37 Consequently it seems to me that there is, on the face of it, a national policy objection  
to retaining the access from the PRZ onto the A595(T). Nevertheless, the question of  
whether there are other particular circumstances concerning this access which are sufficiently  
exceptional to warrant a departure from the policy remains to be considered. These can be  
examined in terms of the 3 issues - of the physical capacity of the main road; its suitability  
for pedestrians & cyclists; and its overall safety.

5C.12 5C.38 On the first point, I support Nirex's view that the carriageway would in practice have  
the physical capacity to carry the RCF project's vehicular traffic. It seems to me that

5C.24 Copeland's contrary view about the length from Calder Bridge to Gosforth does not fully  
5C.11 appreciate that Nirex's statistics are a worst-case scenario; that taking the highest month's  
5C.23 flows is a particularly pessimistic approach; and that the traffic patterns south of Gosforth  
are plainly different from those north of Gosforth. As to traffic patterns to the north-west  
5C.14 of Calder Bridge, I do not accept that slight additions to peak hour congestion at junctions  
could constitute a significant problem. Consequently, the vehicular capacity issue tends to  
5C.33 favour allowing an exception so far as the RCF project's traffic is concerned: but this might  
be followed by DWR secondary construction traffic, which would prolong the inappropriate  
usage.

5C.15 5C.39 On the second issue, the layout of the new Longlands Farm access provides good  
visibility around its junction for all traffic, including pedestrians & cyclists. Also, the  
projects' traffic is likely to travel more slowly than through traffic on the approaches to the  
access, creating fewer speed-related risks for slower users of the highway. I would also  
expect one of the main desire lines for pedestrian & cycle traffic to & from the site itself to  
5B.52 be in the direction of Gosforth as the local service centre, and Nirex has the option of Sides  
2B.7 Lane as a basis for that route in preference to the main road.

5C.25 5C.40 However, the trunk road is the only public road from Gosforth towards the north-  
5C.30 west. Although there is a roughly parallel footpath route through Middle Boonwood further  
east [see COR/101, Fig.3.12.1], I have found this on my site inspection to be muddy, &  
5C.27 difficult to follow even in broad daylight. Walking instead along the narrow stretches of the  
trunk road carriageway between banks certainly induces apprehension; and I readily accept  
2B.2 Gosforth's argument that a number of potential pedestrian trips between the village, New  
5C.28 Mills hamlet and Calder Bridge must be suppressed. The unsuitability of the conditions for  
5C.29 cyclists is even plainer, in my view, for they have figured too highly in accidents. Thus,  
5C.16 although I do not consider that the projects' traffic would add disproportionately to the risks  
for pedestrians & cyclists, the provision of safer conditions for them as encouraged by  
para.4.12 of the PPG must have a high priority if any spare trunk road capacity is to be  
utilised for local trips.

5C.30 5C.41 Turning to the general safety aspects, it is unfortunately commonplace to experience  
damage-only accidents even at a modern junction. On the other hand, any junction increases  
the risks of accidents & obstructions to some extent; and this stretch of road is a vital link  
5C.25 for the local community. I am also rather concerned to avoid complacency about the recent  
5C.9 accident record, which is somewhat above the average and against the trend for this type of  
5C.28 road. It seems to me that there have been clusters of accidents at either end of the appeal  
5C.29 site's frontage, mainly related to other local junctions. No detailed analysis of these apparent  
hazards has been supplied.

5C.42 I have concluded on these issues that the unavoidable local community use and the  
safety record of this stretch of all-purpose trunk road militate against the exceptional retention  
of the direct access to the road, notwithstanding its apparent physical capacity to  
accommodate more local & freight vehicular trips. It is in this sense that the proposals do  
not accord with SP Policy 36 [2C.13], in that the proposals do not include the infrastructure  
to connect the project to an appropriate secondary road; nor with LP TSP 6, in that the  
A595(T) is an inappropriate standard of road because of its existing functions as well as its

character. This unacceptable overall impact in relation to traffic generation would also be in conflict with LP ENV 33.4.

5C.16 5C.43 Consideration of the issue of suitability for pedestrians & cyclists also draws attention  
COR/102B to the virtually complete failure to observe the principles of PPG 13 in designing the layout  
5C.26 of the RCF. There is no planned provision for cyclists, nor any that I can see for  
pedestrians, whilst there has been no response to the criticism of the excessive provision of  
car parking. All this would be contrary to LP TSP 7 [4B.21], in my view, and hence LP  
DEV 3.6 too [2C.30].

5C.18 5C.44 No planning condition nor obligation has been offered to meet these objections, thus  
adding conflict with SP 54(ii) & (iii) & potentially with LP IMP 1. Nevertheless I do not  
agree with many of the other parties [Ca.5B] that the situation could be different if an  
5C.2 undertaking were given to improve the whole length of the carriageway of the A595(T) from  
5C.38 Gosforth to Calder Bridge or beyond. There is no approved scheme for such an  
5C.40 improvement; and I consider that there is, for the time being, an insufficient capacity  
5C.41 argument to justify one, as distinct from a segregated footway/cycleway & specific safety  
measures. There is also the point made by FOE Cumbria that there could well be a strong  
5C.31 environmental case against substantial road works on this length in particular or down this  
corridor in general. Thus I regard the prospects of linking the RCF/DWR projects to large-  
scale improvements of the trunk road corridor as rather remote.

## 5D. NOISE & VIBRATION EFFECTS

5D.1 The ES assesses the potential noise & vibration effects of the RCF development in some detail [COR/101, Ca.9], and concludes that they would not be significant. The existing levels in noise sensitive areas around the Surface Site are found to be typical of an essentially rural area, with HGVs on the trunk road, farm machinery & wind effects in vegetation the major sources [idem, para.3.9.2]. The RCF design incorporates standard noise control techniques, and any residual noise effects would be minimised [idem, para.3.9.3] by good operational practice & compliance with BS 5228 [NRX/3/2]. There would be periods when noise levels at the few closest properties would exceed existing levels [COR/101, para.3.9.4], but even the noisiest activities would produce levels well below the limits conventionally set for them [idem, para.3.9.1]. Vibration levels are unlikely to have any discernible effect [idem, para.3.9.5].

5D.2 The ES does not assess the noise & vibration effects of the RCF/RCM/PRZ Boreholes development, nor of operations in the ventilation shaft area of the preferred DWR design. However, the Boreholes permissions contain noise control conditions, including a prohibition on site construction & removal works at night, and imposing night-time drilling & testing noise level limits of 40 dB  $L_{Aeq}$  for the PRZ BHs [COR/201, p.226, Conditions 22 & 23] and 43 for the RCF/RCM ones [idem, p.232] (for meanings of dB and  $L_{Aeq}$ , see 5D.5).

5D.3 Nirex has carried out vibration & repeat noise level measurements in June 1995, after preparation & submission of the ES [see NRX/3/8, Table 6.2 for complete set of noise measurements & idem, Fig.6.1 for noise measurement locations]. The other parties accept Nirex's noise measurements, the averages & ranges of which are summarised in NRX/3/8, Table 6.1. Nirex's overlaid graph of vibration limits for residential areas [idem, Fig.5.1] is also accepted.

5D.4 **Nirex** points out that its average baseline noise levels are actually towards the lower end of the range currently experienced, because the surveys were concentrated into periods when the wind speeds were generally below the average for the area. The use of predicted maximum levels in the ES makes those assessments a worst-case analysis [COR/101, para.3.9.37]. Cumbria concedes that any adverse noise effect is capable of being dealt with by way of planning conditions: and Copeland is really concerned only with some predicted night-time noise levels.

5D.5 Although Copeland is contesting both the general night-time noise limit and the acceptability of predicted noise from concrete batching operations, its approach is not warranted by either absolute standards or the "exceedance" principle as utilised in BS 4142 [GOV/902, p.7, para.8.2] (ie that site-attributable noise exceeding existing background noise levels by more than 10 "A-weighted" decibels (dB(A)) is likely to give rise to complaints). On neither of these bases can Copeland show that the amenities of people living or working in the noise sensitive properties would be affected by noise levels at the night-time limit agreed between Nirex & Cumbria, namely a free field (ie away from a facade) value of 42 dB(A) equivalent continuous sound level over an hour ( $L_{Aeq,1 hr}$ ). This would already be a more stringent limit than for the RCF/RCM Bhs.

5D.6 In Nirex's judgement, the basic absolute standard is the World Health Organisation's (WHO's) expert group's recommendation of a bedroom noise limit of 35 dB  $L_{Aeq}$  [GOV/122, p.15, S.1.1.3.3 & p.19, S.1.1.4]. Copeland generally accepts that the WHO's group's recommendations are appropriate guidance. Copeland also urges that the guidance in MPG 11 on setting noise limit values be applied to the construction phase of the RCF; and yet para.34 of the MPG recommends the very night-time nominal limit agreed by Cumbria, which is effectively the external free field equivalent of the WHO's group's bedroom noise limit. There is no justification to be found in the WHO's group's recommendations or MPG 11 for Copeland's contention that the longer RCF development period necessitates a lower limit than for the Boreholes.

5D.7 Copeland is in some difficulty in relying on the exceedance principle, in Nirex's view, because that is only to be found in BS 4142, and yet Copeland otherwise regards the BS as inapplicable in the circumstances of this case because it deals with mixed urban areas and assesses the likelihood of complaints rather than disturbance. But the fundamental point is that the exceedance principle only applies above a certain threshold, as exemplified by the BS itself in stating that its method is not applicable in situations where the background noise level is very low ie below 30 dB(A) [idem]. The average night-time background levels for the 2 sets of properties most likely to be affected, Sides Bungalow & the dwellings at Boonwood Garden Centre [NRX/3/8, Table 6.1, Locations C & E] are respectively 27 & 29 dB(A) for more than 90% of the measurement period ( $L_{A90}$ ). Therefore the exceedance principle cannot be applied.

5D.8 Nirex also considers that a prohibition on night-time working cannot be justified, especially for the concrete batching plant required to line the shafts. Initial calculations of a typical sound power level for such plants of 106 dB(A) [NRX/3/8, Table 7.1] are out of date: the modern figure is 92 dB(A) [back calculated from results in NRX/3/3]. Reducing the predicted noise levels from concrete batching at the receiver locations [NRX/3/8, Table 7.2], by this difference of 14 dB(A) to a range of 7-17 dB(A) [NRX/3/4], shows that there could not conceivably be a problem from the concrete batching plant alone, even if 5 Db(A) were added back for the intermittent nature of the noise.

5D.9 Nor would it be necessary, in Nirex's judgement, to prohibit the night-time operation of the hoppers or the carriage of concrete from plant to shaft by truck. The sound power level of loading a concrete mixing lorry is 108 dB(A), and of loading a hopper is 102 dB(A) [again back calculated from NRX/3/3]. The higher figure would make the predicted levels at Locations C & E 33 dB(A), still 9 dB(A) below the equivalent of the WHO's group's standard. None of the predictions allow for special noise attenuation measures, in any event.

5D.10 In response to Mrs Lowery [NRX/3/7], noise levels were not measured at New Mill because they were measured instead at High Lingbank [NRX/3/8, Fig.6.1, Location D], which would be nearer the development but is further away from the trunk road's traffic noise. Since the effects predicted at High Lingbank were minor [idem, Tables 7.2 & 7.3], there was no need to measure levels at New Mill. The north-western outskirts of Gosforth were surveyed because they were thought to be less affected by traffic noise, but in the event the effects were found to be minor there too. Mrs Lowery is understandably concerned about the sensitivity of her son to sudden loud noises, but the loudest predicted noises from the



RCF development would be at least 30 dB(A) less than the noises already experienced by the occupants of Newton Manor Lodge from road traffic.

5D.11 Nirex has also obtained information on baseline vibration conditions in June 1995 at Newton Manor and outside the front of the Red Admiral Hotel. The measured levels at the latter from trial blasts and a passing truck can be compared with the BS 6472 curves [NRX/3/8, Fig.5.1]. The background level is typically a peak particle velocity of 0.0005 mm/sec, and the truck & highest test charge levels typically 0.001 mm/sec, an order of magnitude below Curve 1 of the British Standard [GOV/903, p.11, Fig.5]. The predicted vibration levels at the Hotel from blasting out parts of the Platform Site are below the 2.8 mm/sec acceptable night-time level, and in fact near-surface blasting would be confined to the daytime. The requisite controls by planning conditions have been agreed by Cumbria & Copeland.

5D.12 Cumbria has considered the noise & vibration effects in the context of SP Policy 21 [2C.11] & LP Policy 29 [2C.39]. It understands the operational reasons for activities such as shaft sinking, gallery construction, monitoring & experimentation being carried on 24 hours a day, 7 days a week. However the normal practice in construction & quarrying is to confine noisy surface activities such as site establishment and earth, spoil & soil movements to daytime hours in the working week: and Nirex concedes that it would not need longer working hours for these activities. The potential noise controls have been approached by Cumbria on this basis [CCC/1/25].

5D.13 Nirex has agreed that the general day-time noise limit should be 50 dB  $L_{Aeq,1hr}$  instead of the 55 limit recommended by para.34 of the MPG, because of the operation of the exceedance principle as set out in para.37 of the same. Whilst Cumbria is willing to settle for this limit, it should be appreciated that it entails one instance of exceedance. The average background level for Location C, Sides Bungalow, is 34 dB  $L_{A90}$  [NRX/3/8, Table 6.1]. Yet the predicted noise levels at it for most of 2007 & 2008 would be 46 dB  $L_{Aeq,1hr}$  [idem, Table & Fig.7.3]. The noisy activity in question would be restoration, which would include intermittent concrete-breaking, and so under BS 4142 methodology the level should be corrected by adding another 5 dB [GOV/902, p.6, para.7.2]. This corrected difference of 17 dB would lead to a marked deterioration in the noise environment of Sides Lane for very much longer than the typical period of 8 weeks given in para.61 of the MPG.

5D.14 As to night-time working, Cumbria appreciates that noise levels of 42 dB  $L_{Aeq,1hr}$  would be clearly audible in occasional periods of still air, and that para.39 of the MPG suggests local discussions on whether this is a reasonable night-time limit in quieter rural areas. But on balance the recommended limit is appropriate in this case. Cumbria also agrees with Nirex that there would be a minimal change in road traffic noise [NRX/3/8, Tables 7.4-5]: and that the predicted vibration effects would be acceptable in the light of BS 6742.

5D.15 Copeland points out that, although Nirex has referred to the Noise Exposure Categories in PPG 24, these are for new dwellings, and Nirex concedes that the appropriate guidance for the construction stages of the RCF is MPG 11. For its part, Copeland relies

firstly on para.39 of the MPG, and its expert witness is indeed a local Environmental Health Officer. Its aim is to avoid any disturbance of residents, by loss of sleep or otherwise.

5D.16 Nirex's 1995 repeat noise survey [NRX/3/8, Table 6.1] has revealed a wider range of background levels than in the ES [COR/101, Table 3.9.1]. Whilst the tops of the ranges for Location G, N-W Gosforth, have increased, the night-time average & bottom of the range have been reduced to 30 & 21 dB  $L_{A90}$  respectively. Nirex attributes these drops to occasional periods of still air, and Copeland contends that such intervals have been typically occurring in recent summers, after the end of the 1987-90 wind-speed data period in the ES [COR/101, Tables 3.8.2-3]. With such background levels, any night-time limit should be 35 dB  $L_{Aeq}$ .

5D.17 There are also problems with Nirex's predicted levels, in Copeland's view. The predictions have switched [see CBC/2/1] from maximum levels in the ES [idem, Table 3.9.3] to typical levels in the evidence to the inquiry [NRX/3/4 & /8, Table 7.2]. It is the maximum levels which must comply with limits [CBC/2/2], and not merely typical ones. The latter are sometimes based upon unproven assumptions, such as that the concrete batching plant would not operate at the same time as the hopper or a truck delivering concrete from the plant to the shafts. Nirex also concedes that it would be appropriate to use the BS 4142 methodology to add 5 dB for distinct notes, impulses or irregularities, but that it has not done this in its calculations.

5D.18 Hence this correction of 5 dB should be added in the case of concrete batching. Also another 2 dB should be added for the power sound level of loading a lorry exceeding the original power sound level for a batching plant. This could mean that, in the cases of Locations C & E, the maximum predicted levels  $L_{Aeq}$  would exceed the lowest background levels  $L_{A90}$  by 22 & 20 dBs respectively. Although Nirex claims that such low background levels mean that examining the excess is the wrong approach, the aggregate predicted concrete batching noise levels at the 2 locations are now 43 & 44 dB  $L_{Aeq,thr}$ . On warm, still nights, with wide open windows giving an attenuation of only 5 dB(A) [NRX/3/8, Table 4.3], these noise levels would exceed the WHO's group's bedroom limit of 35.

5D.19 Copeland has concentrated on the concrete batching activities because it is absolutely clear that Nirex would wish to undertake these throughout the night. However, the problem of principle is wider than that. Many of the predicted maximum noise levels from site establishment & fore-shaft excavation are above the night-time limit of 42 dB  $L_{Aeq}$  agreed between Nirex & Cumbria [CBC/2/1]. Moreover, even Nirex's typical site establishment predictions for Locations C & E, for example, are above the agreed limit at 43-48 & 44-51 dB  $L_{Aeq}$  respectively [NRX/3/8, Table 7.2], and well above the adjusted average backgrounds of 27 & 29 dB  $L_{A90}$  [idem, Table 6.1].

5D.20 However, Nirex's response to concerns expressed on this score is still to claim that such activities would be conducted during normal daytime working hours. It is not possible to reconcile this claim and Nirex's own predictions with its reluctance to accept a condition to confine such activities to daytime hours. To rely on a noise limit which the developer predicts would not always be met would create obvious enforcement problems. Although Nirex refers to the history of noise controls on its other boreholes [NRX/3/8, Table 5.3], some of the permissions, including those for the RCF/RCM/PRZ BHs, do not allow site construction at night; and some, including the PRZ BHs, have more stringent night-time

limits than proposed now. A key distinction is that the BH permissions are for much shorter developments, and even then there have been occasional problems in complying with the noise limits or in relation to unforeseen noise from eg mechanical breakdowns [CBC/2/3 & 5].

5D.21 Given Nirex's unwillingness to cease operations at night, or even to accept a prohibition on the RCF's noisiest activities at night, or even to accept a night-time noise limit on those activities below 40 dB  $L_{Aeq}$  free field, in Copeland's judgement there is no alternative but to refuse permission. For the public would be exposed to a noise nuisance, contrary to SP 21; and the predicted noise would not be reduced to acceptable levels by controls on operating hours or working methods, contrary to LP ENV 29. This aspect of the RCF's environmental impact would thereby also be unacceptable under LP ENV 33.4.

5D.22 Gosforth emphasises that the background noise levels are as low as Nirex's expert witness has ever experienced. More stringent noise controls than those agreed by Nirex & Cumbria would be required to protect the Parish's tranquillity. No night-time noise level should be higher than the background, and the daytime noise limit should be reduced to 45 dB  $L_{Aeq}$ , since there is an average background as low as 34 dB  $L_{A90}$  [NRX/3/8, Table 6.1, Location C]. This could be achieved by reducing the scale of the development as already suggested [5A.44], and by improved acoustic design.

5D.23 With regard to blasting, Gosforth points out that the key effect is not noise, as Nirex's PR office has suggested in statements to the local press, but vibration. The test charges were designed to be imperceptible to people off the site, but local experience of a seismographic survey indicates that even small charges can be felt some distance away. A less theoretical and more people-oriented form of control of the actual rock-blasting charges than that currently proposed is required.

5D.24 Mrs Anne Lowery considers that Nirex should have assessed the noise impact on the hamlet of New Mill. This comprises dwellings which are not owned by BNFL, unlike some of those surveyed. It is also nearer the proposed surface works than Gosforth village, and would suffer more from the increased traffic noise. Moreover, the increase in the traffic noise should have been assessed for the peak hours. Finally, she is most concerned about the effect of additional sudden, loud noises on the health of her adult son, who lives with her. He has cerebral palsy, and suffers from spasms in reaction to such noises.

5D.25 My conclusions on noise begin with my experience that it is customary to give the average of a range of background noise measurements as a typical background level, albeit with an elementary distinction between day and night and perhaps also the identification of evening & dawn periods. Of course, as in this case, the average can change with more information. On the other hand, taking the measurements when wind speeds are low is also standard practice, and so not a particular conservatism. Moreover, given the ways in which predicted levels from a complex development like this are gradually built up into  $L_{Aeq}$ s by following BS 5228 or similar methodologies, I have reservations about expressing the predictions in terms of typical levels, rather than merely in a range to cover any variables or uncertainties if requisite. Certainly, in my view, any reference to predicted  $L_{Aeq}$  noise levels

for purposes of setting or checking limit values should be to the upper ends of any ranges, so as to avoid limits being confused with norms.

5D.6 5D.26 I agree with the main parties that the above-ground & near-surface aspects of the RCF  
5D.12 development would share many common features with surface mineral workings, and so that  
5D.15 most of the advice in MPG 11 is appropriate. On the other hand, I also agree with Nirex that  
5D.8 for scientific, safety & operational reasons, underground working at the RCF would have to  
be continuous, together with at least some secondary surface activity. Therefore I consider  
it unrealistic to suggest a ban on all activities at night, whilst appreciating that disturbance  
arising from essential night-time activities could itself constitute an objection to the  
development proposals, particularly when experienced within the National Park.

5D.7 5D.27 The agreed aim is to set absolute daytime & night-time limit values. It is plain from  
5D.22 Nirex's own evidence that the setting of Longlands Farm is one of the country's quieter rural  
areas: and arguably it is an exceptionally quiet rural area, despite the trunk road. Therefore,  
under the advice implicit in para.38 of the MPG, the setting is a candidate for a daytime limit  
of 45 dB  $L_{Aeq}$ , as sought by Gosforth. Leaving the limit at 50 would not make conditions  
5D.13 always easy for any occupants of Sides Bungalow, as Cumbria has pointed out. However,  
5D.4 the Environmental Health Officer has acquiesced to this figure; and the range of average  
background levels at the 7 chosen noise sensitive locations [NRX/3/8, Table 6.1, A-G] rises  
from the 34 at Sides Bungalow to up as high as 43 dB  $L_{A90}$ . I also take into account that the  
Bungalow is owned by BNFL [GRY/1/7, p.42, reverse side], and so I accept the 50 figure.

5D.13 5D.28 This daytime limit of 50 is nevertheless 5 dB  $L_{Aeq}$  below the normal one recommended  
by para.34 of the MPG, due to the application in this quiet rural area of the "exceedance"  
principle, which is of course to be found in para.37 of the MPG as well as in BS 4142. That  
point leads on to the question of whether the night-time limit should nevertheless be set at its  
recommended normal value of 42 dB  $L_{Aeq,1hr}$ , or at something lower, in pursuance of para.39  
NRX/3/8 of the MPG. The background noise levels at night are significantly lower than during the  
day, albeit strikingly so only in the village. It seems to me that the clear policy of para.34  
of the MPG is to make a distinct difference at night, and I can see no reason why that should  
5D.2 not be reflected in this case by following the setting of the daytime limit down to something  
lower than normal, as has been done with some of the Borehole works on the site.

5D.6 5D.29 However I do agree with Nirex that the sticking point in lowering the value must be  
GOV/122, the WHO's group's recommended bedroom limit. That recommendation is actually for a  
p.15 level of less than 35 dB  $L_{Aeq}$ , which I take strictly to be a limit of 34. However the  
5D.18 measurement would take place outdoors, and even a wide open bedroom window in summer  
typically attenuates noise by 5 dB(A). Although inevitably somewhat arbitrary, it seems to  
me that the limit for still, warm nights should be 39 dB  $L_{Aeq,1hr}$ . In pressing for an even lower  
limit, Copeland & Gosforth are to my mind seeking to avoid disturbance to some human  
activity other than sleep, but they have not produced evidence that any common human  
activity or condition is more sensitive to noise disturbance than sleep.

5D.19 5D.30 There is also the unusual issue that Nirex is predicting some noise levels from site  
5D.20 establishment & fore-shaft excavation which would exceed the night-time limit it has agreed  
with Cumbria, let alone the lower limit which I believe to be appropriate. Nirex's position  
is that it does not intend to carry out these noisy activities at night, and would be prevented

5D.5 from doing so by the need to comply with the noise limit. However, it seems to me that such a position tends to confuse activities merely requiring constraint in order to secure good practice with activities which should be forestalled altogether. Consequently, my conclusion is that both kinds of condition are necessary. In a similar vein, Nirex appears to have overlooked the clear national policy set out in para.33 of the MPG to treat Saturday afternoons, Sundays & public holidays as periods of rest from surface mineral workings unless local variations can be agreed.

5D.21 5D.31 However, such matters do not amount in themselves to conflicts with the development plan, in my judgement, because Nirex has not refused outright to accept the requisite amendments to the proposed controls. The specific point about the concrete batching process is a slightly different one, because that would be an industrial process ancillary to the basic excavation of the mine. It does seem that Copeland's probing has revealed a weakness, in that it appears the use of a hopper or lorry as part of the process at night could conceivably cause noise difficulties. But I was even more persuaded by the detailed evidence on this point that now the matter has been drawn to Nirex's attention, it would be practicable to cope with it even within the lower limit which I prefer.

5D.24 5D.32 Whilst I have much sympathy for the general predicament of Mrs Lowery & her family in grappling with these proposals, I am satisfied that the noise survey has treated their home fairly. The key points are that their dwelling already experiences considerably more traffic noise than some of the other dwellings; that there would be little change to that traffic noise as a result of the Nirex proposals; and that High Lingbank is in a quieter setting but closer to the development site than their home, and was surveyed.

5D.24 5D.33 Similarly I understand the feelings of Gosforth in complaining about the extreme technicalities of predicting vibration effects, but I consider that those effects have been well evaluated in accordance with the standard which provides guidance on human response to building vibration, and incidentally should preclude even cosmetic damage to the buildings themselves.

NRX/3/8,  
Fig.5.1

## 5E. OTHER ENVIRONMENTAL EFFECTS

5E.1 The ES [COR/101] has chapters on flora & fauna [5], land [6], water [7], air [8], cultural heritage [11], and recreation [12]. The chapters are generally in the same order as lists & checklists drawn up for environmental assessment purposes, and this Chapter of my report follows the ES's sequence of topics, noting differences in terminology where appropriate. Items are specifically mentioned only if they have been of some concern to a party or to myself. I agree with the general conclusion of the ES that, in relation to the unmentioned items, any effects of the RCF development would be insignificant. But there is no assessment of effects from the DWR, on the marine environment [3C.23] or elsewhere.

5E.2 Nirex emphasises that its assessment & evidence on Nature Conservation ("flora & fauna" in the ES, "ecology" in Nirex's evidence) has been challenged only by Gosforth, which really has merely been seeking reassurance on minor points. There is no designated nature conservation or similar site [2C.19] in the PRZ or Services Corridors [NRX/4/1 & 11/6]. Gosforth is concerned about the possibility of trapping animals within the security fence, which it claims has happened at Sellafeld Works; but the secured part of the PRZ would be very much smaller than the extent of the Works, and would be periodically surveyed by ecologists as part of the badger monitoring. Nirex is aware of complaints of fly infestation at the Drigg Disposal Site, but this seems to result from rotting vegetation, which is ecologically valuable.

5E.3 The landscaping & restoration proposals, particularly the woodland & hedgerow planting [2B.18] coupled with the woodland management agreement [NRX/11/18], would in due course enhance the nature conservation value of the area, in Nirex's view. They would provide more extensive & varied habitats for a good number of flora & fauna, including badgers.

5E.4 The Lingbank badger clan is healthy, and Nirex recounts that the clan has expanded back into its Bluebell Wood sub-sett on the appeal site since the 2 badger surveys were carried out for the ES [NRX/4/2, p.9, Map 3], despite the RCF/RCM Boreholes development. This is in contrast to surrounding clans, 2-4 of which seem to have been exterminated by recent human persecution [idem, p.10]. With signs of use 3-6 times greater than any other field [idem, p.8], the proposed spoil disposal area [2B.14] is the main foraging ground of the Lingbank clan [idem, p.4, Map 1], in search of the earthworms [idem, p.11] which comprise about 90% of their diet. But there would be specific mitigation measures to ensure that adequate foraging areas would be maintained to sustain the clan, & thus the badger population over a wider area [idem, p.10]. Steps would also be taken to counter disturbance by site traffic, blasting & lighting.

5E.5 The requisite badger tunnels across internal roads would be provided as the fencing & roads were constructed [COR/113, Scheme E]. The disposal field would be managed so that there would always be a minimum aggregate of 8 ha of grass sward kept cut to no higher than 100 mm. This would include a continuous grassland route around the field. To conserve the earthworm population in the stripped soil, a system of stripping & replacement with the least amount of handling & storage would be utilised. The situation would be

monitored; and, if requisite, spoil disposal procedures would be modified and alternative foraging areas identified & their use encouraged [idem, Scheme F]. Cumbria & Copeland have agreed that such measures would be adequate: and English Nature's consultation response was that the impact on the badgers is unlikely to be significant [COR/107, p.104, para.2)].

5E.6 With regard to off-site effects, there is a heronry near Newton Manor and the birds take eels, trout & stickleback which are present in Newmill Beck. However, herons are exceptionally tolerant of noise & disturbance, and there would be special precautions to prevent significant changes in the quality of the Beck water. Foul water from the Platform Site would be removed via the separate drainage system [2B.9], whilst surface water would go through the settlement tank and be discharged through the new drain into the Beck strictly in accordance with the terms of the consent already granted by the NRA under the Water Resources Act 1991 [COR/114, 1st item].

5E.7 In Nirex's judgement, these precautions would also protect the natterjack toad habitat 2 km down the Beck [2C.19]. The possibilities of a flood, or of a pollution incident affecting the toads directly or indirectly through the invertebrate food chain, would be greatly reduced by these measures. Also the core of their habitat is a group of special breeding ponds especially provided off the Beck, which can be isolated by sluices. There would be automatic & continuous monitoring of the quantity & quality of water flows from the site, including water quality and flora & fauna in the Beck itself, coupled with arrangements to co-ordinate any discharges with the operation of the pond sluices [CCC/1/27]. Again, English Nature is satisfied that there would be no significant impact provided the measures are implemented [COR/107, pp.103-5]; and Cumbria & Copeland are content with the proposals. In the very unlikely event of an incident harming the toads, the juveniles might well suffer whilst sufficient adults survive to maintain the colony.

5E.8 Nirex considers that there would be no significant effect on Agriculture in the long term. There is no MAFF objection [COR/107, pp.97-8], and the reservations expressed in the Ministry's consultation response have been met [NRX/7/5, pp.5-6]. A compromise has also now been reached on the question of planting on soil mounds [5A.11]. Despite the overall development period of 13 years, the maximum loss of land from agricultural production would be just under 25 ha of predominantly Grade 3b land for no more than 12 years. Any disruption of land in the Services Corridors would be for a maximum of 6 months. Gosforth's anxieties are over-stated, in Nirex's view, because only 4.6 ha would be lost permanently to landscape planting: and the Longlands Farmstead could be converted back to farming use if required.

5E.9 Turning to Water Resources, and looking first at surface water run-off, Nirex points out that, although the culverts on the line of the rill [2B.4] do restrict the volumes of flow, this natural system is able to drain its small catchment effectively [NRX/1/3, bottom of 1st page]. The natural course of the rill would be piped under the Platform Site [idem, 2nd page], and this & the cut-off drains would carry the catchment's surface water to the settlement pond [2B.9]. There would be stormwater storage on the Platform Site itself, and the overall surface water design would be to a standard in excess of a 1 in 50 year storm return period - a very conservative provision for a temporary development, and in contrast to the EA's discharge consent criterion of a 1 in 2 year minimum. The other criteria which

have been set by the EA are a maximum discharge to the Beck of 600 l/s: suspended solids to be less than 50 mg/l; and no visible oils or grease [COR/101, p.27, para.2.42]. If by any chance, an extreme event led to an overflow, this would be over the southern lip of the Platform, achieving a great dilution of any sediments washed down.

5E.10 Subsequent to South Shaft fore-shaft excavation, underground water from the RCF would be discharged into the on-site sewerage system [2B.9], because it would be saline to varying degrees and sometimes include process water & suspended solids. The ingress of water into the excavations would be controlled by probe drilling, lining & grouting; and total inflow including process water is now estimated to average about 2.1 l/s long term, but pumping capacity would be 7.5 l/s subject to EA authorisation. The concerns of Gosforth about drawdown in the sandstone aquifer are unfounded, since there would be little or no effect on near-surface levels or flows of groundwater during shaft sinking or in the subsequent operation of the RCF. Effects are predicted to be undetectable more than 200 m away from the shafts. The development would draw its own water supply from the mains.

5E.11 Although concerns have been expressed about Air Quality, Nirex points out that there has been no evidence of problems with dust from the Borehole sites, and none are predicted from the RCF development. Indeed, Nirex's expert witness has not been challenged on his predictions, with Copeland merely discussing the wording of the appropriate condition, and Cumbria content to rely on that condition. This lack of challenge should be borne in mind when considering Cumbria's repetitive point about the cumulative effects on rural character of dust together with traffic, noise & vibration.

5E.12 Even without dust control measures on the site, the predicted maximum increase in dust deposition rates, based on a systematic analysis of materials & movement [NRX/6/2, Table 6.1] and the application of emission factors for each operation [idem, Table 6.2] to produce emission rates for 4 modelled activities [idem, Table 6.3], is less than 10% of the generally accepted 200 mg/m<sup>2</sup>/day nuisance threshold at the closest dwelling [idem, Figs.6.1-4]. This maximum increase would be the rate during the Platform Site earthworks [idem, Fig.6.2]. According to the US EPA Fugitive Dust Model, which effectively gives conservative predictions for the local topography since it assumes that the terrain is flat, the deposition rate at Newton Manor & Boonwood Garden Centre cottages would be about 16 mg/m<sup>2</sup>/day for 3 months. In contrast, the baseline survey [idem, Table 4.1] revealed background variations of as much as 100 mg/m<sup>2</sup>/day.

5E.13 Archaeology is the only aspect of the local Cultural Heritage which to Nirex's knowledge has been queried, apart from the possible setting of the Military Zone [5A.31], and even that query does not come from the statutory consultees or the local authorities. Within the context of a preliminary desk study & field inspection carried out for the DWR project [NRX/8/1 & 2], both the PRZ & the Services Corridors have been surveyed [NRX/8/3, 6 & 8] and an archaeological evaluation produced [NRX/8/10, Fig.8.1]. Site preparation for Boreholes RCF1-4 has also been monitored [NRX/8/5].

5E.14 The overall position is that only 1 out of the 18 sites of real or potential archaeological interest (not importance) identified within or close to the appeal site [NRX/8/10, Fig.3.1] would be adversely affected by the RCF development. That would be Site 15, which comprises vestigial remains about 5 m wide of rig & furrow on the ridge of the spoil disposal



field. The remains themselves are of very minor importance, but may be an indicator of more interesting remains beneath, which could nevertheless be investigated when the development went ahead, under the terms of a standard planning condition.

5E.15 Mr Forwood nevertheless challenges Nirex's evaluation in relation to Sites 12-14, the Gretigate Stone Circles. Gretigate is said to be the old name for Sides Lane, and the Circles are in a small cleft running north-westwards from the Lane up behind Sides Bungalow [see original 1961 presentation appended to WR/F/89]. Nirex has made a very careful investigation of the Circles [NRX/8/4 & 7], and concluded that Circles B & C (Sites 12 & 13) within the appeal site are more likely to be the results of stone clearance from adjacent fields [NRX/8/7, p.11, para.4.2.2] than the originally supposed Bronze Age monuments (Cumbria SMR 1292) [idem, p.4, paras.1.1.1-2.2]; and that the original discoverer's interpretation cannot be supported [idem, para.4.2.1].

5E.16 These conclusions have been accepted by the County Archaeologist for inclusion in the newsletter of the Regional group of the Council for British Archaeology [NRX/8/9]. Although Mr Forwood criticises in particular a failure to carry out a detailed investigation of Circle A [NRX/8/10, Fig.3.1, Site 14], this is outside the appeal site, and nothing that is known about it conflicts with the conclusions on Circles B & C [WR/NRX/2(8)]. There is no sign of Circle A visible on the surface: and, although Mr Forwood postulates that there may be underground evidence of stones in the field as at the Seascale Stone Circle ("Grey Croft"), this is not what the original presentation suggested. Furthermore the development in question is strictly landscape planting authorised under the RCF/RCM/PRZ Boreholes permissions [NRX/2/3, Fig.5.3, marked "1995"].

5E.17 As to Public Rights of Way and Recreation, Services Corridor A crosses the bridleways from Calder Town End to Fleming Hall & Ponsonby Tarn [COR/101, Fig.3.12.1, No.421010] and reaches the one from Calder Farm to Ladywood [idem, no.421016]. But the electricity route to the RCF would now probably not use this Corridor [2B.11], and even if it did, disruption to the rights of way would be for no more than 4 months. The provision of underground services along Corridor B would involve digging trenches across the Calder Town End to Fleming Hall bridleway [idem, No.409019 on this stretch] and the Calder Farm to Seascales byway [idem, also No.421016], but the disruption to them would be much shorter than the total 7 month construction period.

5E.18 Whilst the use of Longlands Farm by the Cumbria Riding Club for local events has been affected by the RCF/RCM/PRZ Boreholes development, and would be affected further by the RCF development, the lease of an alternative field beside the A595(T) has been offered to the Club [NRX/11/7]. A local syndicate shoots over Longlands Farm 2 or 3 times a year, and would lose the shooting at the Farm for the duration of the RCF development; but it would retain most of its shoot, across Newton Manor and Calder, Fleming & Seascale Halls' lands.

5E.19 A final point concerns the siting of the Explosives Store [COR/102B/008026/B], which would be located to the north-west of the Platform Site [idem, 008007/B]. This is the optimum stretch of the PRZ for storing the explosives away from dwellings & other sensitive premises. Whilst Mrs Lowery has expressed anxiety about it, it would be about 430 m away from her house, twice the minimum distance prescribed by the Stores for Explosives Order

1951 [GOV/802]. The dwellings at High Lingbank & Sally Hill would be closer than Newton Manor Lodge, although well over the minimum distance. A licence for the store itself would still have to be obtained from the local authority [COR/114, last item].

5E.20 Cumbria & Copeland note that the development of the Surface Site would lead to a loss of an area used by badgers for foraging, but also that English Nature & the Cumbria Wildlife Trust have not objected. Nor have the 2 Nature Conservation organisations objected in relation to the proposed Newmill Beck SSSI & its population of natterjack toads. Although English Nature has expressed caution about the consequences of possible pollution & flooding incidents, a Memorandum of Understanding has now been drawn up between English Nature, the NRA & Nirex to settle the matter [CCC/1/27]. There would thus be no conflict with SP 17 [2C.10] or LP ENV 1-5 & 23 [2C.35 & 38].

5E.21 Similarly, they accept Nirex's assessment of the impact on Agriculture, now that a compromise has been reached with MAFF on planting on mounds. Again, there need be no conflict with SP 22 & 24 [2C.11] or LP SVC 1 & 5 [2C.34] & ENV 15 [2C.37] on Water Resources, so long as Nirex is willing to agree to the requisite conditions. Their position is similar on Air Quality in relation to SP 21 [2C.11] & LP ENV 26 [2C.39]. Similarly, on Archaeology, in the absence of an objection by the County Archaeologist and given Nirex's willingness to accept an archaeological investigation condition, the proposals accord with SP 26 [2C.12], Mid Copeland Local Plan Policy 6R [2C.21], & LP ENV 51 & 52 [2C.41]. With regard to the Rights of Way in the Services Corridors, it is appreciated that Gosforth & the Ramblers Association have indicated some anxiety, but alternative routes on which they would be consulted would have to be provided, and then the bridleways & byway restored to their former condition. Hence there would be no conflict with LP ENV 14 [2C.37].

5E.22 Gosforth, in relation to Nature Conservation, is concerned for the well-being of the wild animals in its Parish. It has knowledge of animals becoming trapped by the security fences at both Sellafield & Drigg, with potential ecological problems from in-breeding, disease, & other aspects of animal behaviour, including fly infestation. It also gives a reminder on Agriculture that, prior to the grant of permissions for the RCF/RCM/PRZ Boreholes, Longlands was a working farm supporting 2 generations of a farming family. It would be preferable to utilise stripped soil temporarily on surrounding fields rather than risk deterioration in storage. Nearly 5 ha of land would be permanently lost to agriculture, adding to the factors which would militate against the resumption of a viable holding here.

5E.23 As to Water Resources, in Gosforth's judgement, Nirex has not shown satisfactorily how it would cope with the speedy run-off from the Platform Site in the event of an exceptional storm, and the consequent risks in the Beck downstream. It seemingly has not reached agreement with the EA on control of the ingress of underground water. There would be risks both of pollution of that water and of derogation (emphasised by FOE) to the many private water supplies in the locality, plus loss of pressure in the mains from over-use by Nirex. More stringent controls to protect Air Quality than are proposed would be required, because the dust generation would not be inhibited by vegetation as on farmland. Gosforth also wishes to be consulted on all detailed proposals which would affect Rights of Way (as

does the Ramblers Association) & Recreation, as even temporary local modifications to these can have consequential effects which outsiders would not appreciate.

5E.24 Mrs Anne Lowery believes the siting of the explosives store to be too close for comfort, notwithstanding the fact that the stand-off distance would comply with the law. The carriage of explosives to & fro would be a worry, as well as their storage. The blasting would be a constant reminder of their presence. The fear of sudden noises would inhibit her son [5D.24] from going for his walks, diminishing his quality of life even further.

5E.25 Mr Martin Forwood [WR/F/89] believes that Nirex is basically missing the point about the Gretigate Stone Circles. They are officially recorded as a Monument, and were visited by an eminent archaeologist as they were originally being surveyed in 1960. Not every archaeologist who has visited them doubts their authenticity, and, if authentic, Circle A would form one of the largest stone circles in Britain. Since they appear to be a group, the best practice would have been to investigate the largest one thoroughly before writing the group off as not authentic. As it is, there is a distinct possibility that the development would be extended in due course over Circle A without the authenticity of the group having been established one way or the other.

5E.5  
5E.4  
5E.26 My conclusions on Nature Conservation are on the basis that the presence of a protected species is a material consideration if the development would be likely to cause harm to the species or its habitat [PPG 9, para.47]. It is quite clear to me that the spoil disposal operations would harm the habitat of the Lingbank badger clan, for the operations would take place over most of the clan's principal feeding ground. It is particularly important to sustain this clan, since it seems to be the only one in the locality to have survived human persecution. I note that the badger survey recommendations included encouragement of extended foraging into 2 potential alternative areas before operations start; and a search for alternative soil storage locations [NRX/4/2, pp.16-7].

5E.27 In my view, these recommendations did not go far enough. The best solution would have been to identify another spoil disposal site altogether: and a better mitigation measure would be a commitment to the establishment of proven foraging areas before spoil disposal commences. There must be a serious risk, in my judgement, of the sheer amount of activity on the foraging ground severely disturbing the clan, notwithstanding that badgers are largely nocturnal. Even more importantly, the piecemeal stripping of their feeding area could gradually remove the bulk of their food supply, if Nirex's experimental measures to conserve the earthworms fail to work.

5E.28 Notwithstanding the views of the authorities & consultees, I consider that this part of the RCF development would constitute a serious interference with the core habitat of a protected species, and that the untried mitigation measures fall well short of ensuring that the harm would be kept down to a tolerable level. Although I doubt whether the feeding ground of a single clan can be an important nature conservation interest in terms of SP 17, it is obviously a site supporting a protected species within the meaning of LP ENV 5. There would also be an adverse impact by a waste disposal operation, contrary to SP 60 & LP ENV 23, reinforcing the landscape objection [5A.69]. This environmental harm should be carried forward into the final appraisals under the key policies SP 54 & LP ENV 33.

- 5E.20 5E.29 It has been appreciated that there would be some risk to the Annex IV protected toads & their potential SSSI habitat downstream. This habitat must be regarded as of national significance, in my view, and so brings into play SP 17 & LP ENV 2, as well as LP SVC 1 & 5. The consensus is that there would be sufficient protection of the toads & their breeding ponds from pollution & sudden surges, by the liaison & monitoring arrangements agreed by English Nature & the NRA to help implement Nirex's compliance with the terms of its water discharge consent. Although I would normally consider that it is appropriate & necessary to make the requisite precautions the subject of planning conditions, rather than rely on the enforcement powers of the EA, I accept that these particular arrangements would be adequate. Moreover, I do consider that the other points made about nature conservation are very minor.
- 5E.22 5E.30 On the other hand, I agree with Gosforth's point on Agriculture that the RCF project has resulted in the indefinite loss of an agricultural unit. This reinforces the conclusion about the inappropriateness of the development in this setting [4A.56]. As to Water Resources, I am satisfied with the drainage arrangements, as it is only with abnormal incidents that my preceding paragraph is concerned. Also I agree that a derogation of other water abstractions would be highly unlikely: and I do not accept that the water utility would offer a mains supply if it felt this would prejudice existing customers. However, there is another technical point to resolve on the control of the ingress of underground water. But I entirely accept
- 5E.9-10 5E.12 Nirex's case on Air Quality.
- 5E.13 5E.31 Similarly, Nirex has carried out some impressive work on Archaeology. I note that this started out as part of the DWR project, and that on this topic the effects of the Boreholes have also been taken into account. Yet Mr Forwood has a good underlying point about the Gretigate Stone Circles. They are officially recorded as a monument; and, according to PPG 16, the preservation of important remains & their setting should be considered regardless of Scheduling. Nonetheless the very careful evaluation by Nirex has persuaded me that it is very probable that Circles B & C are not archaeological remains at all, and were wrongly judged to be such due to initial over-enthusiasm. The putative Circle A, although adjacent, has a rather different setting and could be of a somewhat different nature. Although the indications are strongly that this too is not an artefact, it would be wrong to investigate it invasively unless threatened by development, in case it does constitute archaeological remains. In my view, Nirex has carried out the requisite degree of evaluation of it at this stage.
- 5E.15 5E.16
- 5E.17 5E.18 5E.19 5E.32 I consider that the actual disruption of Rights of Way would be very minor. On Recreation, I am pleased that another venue has been offered to the Riding Club, because this is yet another example of the development's disturbance of rural activities, as is indeed the loss of some shooting, albeit in a smaller way. As to the Explosives Store, whilst I once more understand Mrs Lowery's feelings, this is a topic definitely for control under other legislation, albeit a reminder of the failure of the ES to deal with risks of accidents [3B.48].

## 6A. BASIC REPOSITORY LOCATIONAL CRITERIA

6A.1 The legal, political and regulatory frameworks which set the requirements for the suitable location of a DWR for ILW and LLW are outlined in Chapter 2A above. The fundamental requirement in finding a suitable location for a DWR is to provide a PCSR and PCSA which will satisfy the regulators that the risks would be acceptable.

6A.2 In order to meet the regulatory requirements for deep disposal, Nirex has evolved the concept of a multi-barrier containment system for a DWR. This system is explained in Chapter 6C but, in brief, it would comprise a natural barrier provided by excavation of vaults at depth in a stable geological setting; an engineered physical barrier constituted by packaging the waste in steel or concrete containers; and an engineered chemical barrier comprising cement-based vault backfill. It is mainly the radioactivity from the emplaced waste to be released through the chemical barrier, predicted by Nirex to be 0.01% of the total, and transported away from the DWR through the natural geological barrier, mostly by groundwater flow, which could cause long-term risks to health [COR/501, para. 6.3.1].

6A.3 Thus, the main determining factors in meeting the  $10^{-6}$  risk target, or those required to achieve the necessary degree of safety with optimisation using best practicable means, are geological, hydrogeological, chemical and radiological. The engineered barriers are broadly generic in character. It is common ground that the work involved in research and development of a DWR is at the leading edge of science. This Chapter deals with the geological, hydrogeological and radiological criteria leaving aside other factors for later Chapters. Guidelines for these matters derive from International, EU and national sources.

6A.4 The waste inventory is described in COR/522, Vol.3, Tables 6.1 and 6.2. It is extracted at NRX/15/43, Table 5.1. Of particular note are the inclusion of long lived radionuclides such as  $^{36}\text{Cl}$  (16.6 TBq),  $^{129}\text{I}$  (0.919 TBq) and  $^{238}\text{U}$  (35.8 TBq), having half lives in millions of years of 0.301, 15.7 and 4,468 respectively. The estimated radioactive decay of the disposal inventory with time is displayed at NRX/15/43, Fig. 5.1. A summary of projected radioactive waste arisings in the UK (1991) is at NRX/15/40 but should be treated with some caution due to subsequent modifications including, for example, more efficient forms of packaging, so reducing waste volume. The updated planning requirements to 2060 for the DWR are in a range of 200,000 m<sup>3</sup> to 275,000 m<sup>3</sup>, including 15,000 m<sup>3</sup> of LLW.

6A.5 The thermal evolution of the DWR is described at COR/528, and summarised at idem, p.7-8 Box B. The main sources of heat in the DWR are the exothermic cement hydration reaction and energy deposited in the system from the decay of radioactive isotopes. The DWR will experience a significant rise in temperature after closure to about 80 °C with a heat output of some 400 kW. Although the main radionuclide heat input will have ceased within the first 300 years, decay heating will continue (with overall heat output of more than 10 kW for more than 10,000 years) due to the longer lived actinides, which undergo energetic  $\alpha$  decay. Heating could affect the performance of the cement vault backfill, metal corrosion, chemical degradation of organic wastes and microbial populations.

6A.6 In responding to consultation on the draft regulatory guidance [HMP/1/1] Nirex suggests that ILW "should include wastes with a radioactive content which exceeds either of

the upper limits for LLW but of a lower radioactivity and heat output than high level wastes. ILW's encompass a large range of different forms including the metal cladding of nuclear reactor fuel, reactor components, chemical processing residues and filters". LLW should be "wastes with a radioactive content which does not exceed  $4 \times 10^9$  Bq/t of  $\alpha$  radioactivity or  $1.2 \times 10^{10}$  Bq/t of  $\beta/\gamma$  radioactivity other than very low level wastes" [NRX/12/17, p.4].

**6A.7 International Guidelines** and regulations of relevance are reviewed in Cm 2919 Chapter 2 [GOV/208]. Para. 10 states that the principles of radioactive waste management set out by the IAEA [GOV/504] have been fully reflected in the White Paper's policies.

**6A.8** Early IAEA attention was focused on HLW and other long-lived wastes [GOV/501]. In 1983, guidelines advised that the hydrogeological characteristics of the geological environment should tend to restrict groundwater flow within the DWR and, on a wider scale, that the hydrogeological characteristics of the host rock and the groundwater regime of the surrounding geological environment should favour waste isolation [GOV/501, GOV/502]. The geological medium should have a lithology and depth appropriate for the categories and quantities of waste to be disposed of, it should be geodynamically stable including avoiding potentially destabilising structural features [GOV/502]. The suitability of the host rock will depend upon individual circumstances related to the specific site rather than the general properties of the host rock type [COR/501, p.9]. Rock characterisation should therefore facilitate the effective prediction of DWR performance [GOV/501, para. 6a].

**6A.9** The IAEA document, 'Safety Series No.99 - Safety Principles and Technical Criteria for the Underground Disposal of High Level Radioactive Wastes' 1989 [GOV/503] is principally concerned with HLW and is in the process of review of disposal of all radioactive waste as part of the RADWASS programme.

**6A.10** The latest IAEA guidance on identification and selection of sites for deep geological disposal of radioactive wastes is to be found in GOV/507 of 1994. Its status is presently advisory [para. 2A.2 above], but it is not confined to HLW applying also to  $\alpha$  bearing wastes in solid and packaged forms [GOV/507, para.109]. The advice suggests principles based on best practice upon which the most appropriate detailed standards, criteria and specifications can be established for the physical characteristics and waste type and performance requirements of the country concerned [GOV/507, para. 108]. Only general guidelines can be identified owing to the predominance of factors and processes which may be highly site specific and interactive [idem, para. 401]. The system of natural and engineered barriers has to be considered as a whole. Flexibility in the disposal system is important and the possibility to compensate for uncertainties in the performance of one component by placing more reliance on another should be retained [idem, para. 402].

**6A.11** The key locational principles are set out as site selection guidelines at GOV/507 paragraphs 404 et seq. to achieve "adequate isolation of radionuclides from the accessible environment for desired periods of time" [idem, para. 301]. The guidelines are not meant to be complete, neither should they be applied in isolation but used in an integrated fashion for an overall optimisation of site selection [idem, para. 403]. In summary, the DWR locational criteria are:

- a. a geological setting to inhibit the movement of radionuclides from the (DWR) to the environment during the time periods of concern [idem, para. 404];
- b. sufficient distance from geological discontinuities that could provide a rapid pathway for radionuclide transport: uniform rock formations in comparatively simple geological settings and formations with few major structural features or potential transport pathways are preferred [idem, para. 405];
- c. favourable mechanical properties of the host rock to ensure long term stability and so safe construction, operation and closure of the DWR and resistance to gas transport [idem, para. 406];
- d. absence of unacceptable susceptibility to future geodynamic phenomena and consequent radionuclide release [idem, paras. 408-409];
- e. restricted groundwater flow but sufficient dilution capacity [idem, paras. 412-413];
- f. physicochemical and geochemical characteristics of the geological and hydrogeological environments that tend to limit the release of radionuclides from the DWR [idem, para. 416];
- g. minimisation of the risk of human intrusion [idem, para. 420];
- h. acceptable radiation exposures to the public from transportation of the waste [idem, para. 429].

6A.12 IAEA radiation safety standards [GOV/505] are also in the course of revision in the light of the recommendations of ICRP 60 [GOV/506]. The general principles, based on IAEA's latest safety standard [GOV/510], are set out in Cm 2919 [GOV/208, para. 46] where they are stated to be embodied in the reformulation of national policy. The IAEA RADWASS Safety Fundamentals document (1995) proposes that radioactive waste should be managed in such a way that predicted impacts on the health of future generations will not be greater than relative levels of impact that are acceptable today [GOV/504]. This principle was endorsed by the OECD's Nuclear Energy Agency (NEA) Radioactive Waste Management Committee in 1995 [FOE/1/4, pp. 7-9] and nationally in Cm 2919 [GOV/208, para. 81]. The NEA added that, in their view, geological disposal should ensure that residual radioactive substances reaching the biosphere should be at concentrations that are insignificant compared, for example, with the natural background levels of radioactivity [FOE/1/4, p. 16].

6A.13 **EU Guidelines.** The ICRP recommend the principles of justification, optimisation and the establishment of individual dose and risk limits [GOV/208, para. 55] The ICRP's recommended changes in the methodology used to calculate doses are subject to negotiation as part of the Euratom Basic Safety Standards Directive.

6A.14 Although the present legal dose limit is that members of the public should not be exposed to a dose of more than 5 mSv/y from all man-made sources of radioactivity other than from medical exposure, in 1990, ICRP 60 recommended instead a dose limit of 1 mSv/y

except in special circumstances. This is likely to be reflected in the revised Euratom Basic Safety Standards Directive and then implemented in UK law [GOV/208, para. 63].

6A.15 Euradwaste Series No.6 [NRX/14/2] reflects IAEA advice on DWR location [NRX/12/15]. Particular importance is placed upon the natural barriers formed by the host rock and surrounding geological formations for  $\alpha$  bearing wastes containing isotopes with an extremely long radioactive half-life. The criteria are [NRX/14/2, Section III.1]:

a. Stability. The site shall present a high degree of stability; tectonic movement should not be expected to occur (or to induce significant phenomena) before e.g. 10,000 years, evaluated at regional levels and forecasted from present trends and historical evidence. More generally, the site should be deemed to be stable as long as necessary according to the safety assessment. Seismicity should be low, levels depending upon the waste option and the site, but below level 7 of the Richter scale (or intensity IX-X in the modified Mercalli scale). It should be, say, some tens of km from geothermal anomalies or volcanic evidences.

b. Hydrogeology. Low groundwater flow and/or appropriate dilution capabilities are essential requirements together with appropriate characteristics of the underground waters. The hydrogeology of the formation and the hydrology of the site shall be such as to ensure negligible radiological consequences, if any, on the site and at regional level both in the case of the normal and of altered evolution scenarios. Preference should be given to formations having high homogeneity and continuity and more generally showing simple patterns.

c. The chemical and geochemical properties of the host rock should favour the retention of the radioelement when released from the DWR.

d. The mechanical behaviour of the rock should allow safe operation of the DWR and ensure that an appropriate sealing of the various DWR areas and shafts can be achieved.

e. Thermal guidelines mainly concern HLW, however DWR temperature, the physical properties of the rock, and the geological setting should ensure that the confinement properties of the formation are not impaired and undue heating of the overlying sediments and waters does not take place.

e. The appropriate dimensions of the host rock will depend upon the option, the waste to be disposed of, the DWR capacity and the geological settings. The formation should have sufficient depth and be large enough to provide an efficient isolation of the DWR from the biosphere. The depth of the DWR should be great enough to take into account such phenomena as erosion of the ground surface layers notably for sedimentary formations. The site and its geological setting should be selected so that perturbations due to the excavation of the DWR should not impair its performance.

f. Presence of Natural Resources. The formation should be located far enough from either ore deposits or minerals scarce enough to be considered as a possible object of



future exploitation. More generally, preference should be given to a formation and a site for which the risk of human intrusion is deemed to be small.

The guidance advises satisfying a combination of its criteria prior to an overall safety assessment on the whole system, to finally show if the radiological protection standards are met.

6A.16 EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances [GOV/132] has been implemented by the NRA's Policies and Practices for the Protection of Groundwater [GOV/131] and Pollution Prevention Guidelines [GOV/133].

6A.17 National Guidelines include advice from the Institute of Geological Sciences (now BGS) in 1976 that hydrogeological conditions for deep disposal of HLW should be simple and determinable [COR/615]. Broad geological disposal options appropriate to different classes of radioactive wastes were considered in the 1982 White Paper on Radioactive Waste Management [GOV/203] as in the National Strategy [GOV/301]. The 1986 DOE comparative assessment of disposal and storage options for LLW and ILW [GOV/303] concluded that the BPEO for most ILW was disposal deep underground or offshore.

6A.18 In 1993, as a result of ICRP 60, the NRPB recommended acceptance of the reduced dose limit to an individual of 1 mSv/y. This has been accepted by the Government [GOV/208, para. 65]. To account for multiple exposure sources a target of 0.5 mSv/y from any one nuclear site has been established and authorisations assume maintenance of the discharge limit for the radionuclides specified. A dose constraint of 0.3 mSv/y has also been set to assist in the optimisation of new facilities [idem, para. 68]. This broadly translates into a dose of 0.03 mSv/y for an individual over his or her lifetime for an annual risk of death of  $10^{-6}$  [idem, para. 73]. However, the Government has decided to err on the side of caution and set a threshold of 0.02 mSv/y [idem, para. 73]. Thus, since 1989, the dose for an individual has been modified from 0.1 mSv/y, (incorporating an element for uncertainty - GOV/302, para. 3.8) to 0.02 mSv/y in order to maintain the  $10^{-6}$  level of risk of death. In the case of post-closure safety for a DWR, the Government has made the  $10^{-6}$ /y risk target one of developing either a fatal cancer or a serious hereditary defect [cf GOV/302, para. 3.7 & GOV/208, para. 78].

6A.19 The draft replacement regulatory Guidance, although not laying down geological criteria nationally for deep disposal, suggests that the geological barrier of any DWR must operate to ensure that,

"Radioactive wastes shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today" [HMP/1/1, para. 5.5]

6A.20 In the period after control is withdrawn from the DWR,

"the assessed radiological risk to a representative member of the critical group should be consistent with a risk target of  $10^{-6}$ /y." [idem, para. 6.7]

Nirex considers the requirement to be ambiguous as it could be construed as including past discharges from the Sellafield site or elsewhere in the risk calculations [NRX/12/17, para. 6.4]. The guidance goes on to say that where the Inspectorates are satisfied that good engineering and good science have been adopted by the operator and the estimated risk is below the target, no further reductions in risk will be sought. However, if the estimated risk is above the target, the Inspectorates will need to be satisfied not only that an appropriate level of safety is assured, but also that any further improvements in safety could be achieved only at disproportionate cost. No indication is given of what is meant by an appropriate level of safety.

6A.21 The degree of isolation required of the waste depends on the concentrations and radioactive half lives of the radionuclides present in the wastes, among other factors. The timescale is for the developer to justify [GOV/208, para. 81 & HMP/1/1, paras. 5.6 & 6.13]. At the inquiry the period of 10<sup>8</sup> years was used for risk predictions [NRX/15/43, Fig. 5.1]. During this period population and climate changes and other naturally occurring processes such as glaciation would take place [COR/522, Vol. 3 Section 6.3]. However, as Cm 2919 points out at paras. 80-81, there are likely to be limitations on the degree of quantified prediction which can be made and qualitative factors will need to be relied upon in very long timescales [see also HMP/1/1, para. 8.23 & NRPB comments at GOV/409, paras. 3.31-32]. The draft regulatory guidance refers to reliance upon "multiple and complementary lines of reasoning" to support assessment [HMP/1/1, para. 9.5]. Cumbria is concerned about the means of accounting for low probability high-consequence events in the use of risk targets for the post institutional phases of the DWR [CCC/1/26, para. 3.1 bullet pt. 6 & 3.12].

6A.22 In relation to environmental radioactivity,

"It shall be shown to be unlikely that radionuclides released from the disposal facility would lead at any time to significant increases in the levels of radioactivity in the accessible environment."

This assessment takes account of the comparative radiotoxicity of different radionuclides and of the ambient variations of levels of radioactivity in local environmental media [HMP/1/1, para. 6.19]. Nirex suggests that the levels of radioactivity should be those overall in recognition of the fact that the levels of those radionuclides not naturally present in the surrounding environment could be significantly increased due to their presence in the DWR waste inventory [NRX/12/17, para. 6.9].

6A.23 Radiation exposure of the UK population was reviewed by the NRPB in 1993 [GOV/416]. It concluded, based upon 1991 data, that the annual effective dose equivalent to the general public from all sources of ionising radiation is 2,600  $\mu$ Sv (2.6 mSv) on average and the collective effective dose equivalent is some 150,000 man Sv [idem, Table 35 & Fig.13]. About a half of the collective dose is due to radon (100  $\mu$ Sv/y to 100,000  $\mu$ Sv/y, with scattered higher values - average 1,300  $\mu$ Sv/y) and the predominance (2210  $\mu$ Sv/y - 127,000 man Sv) originates from all natural sources including cosmic rays (200  $\mu$ Sv to 300  $\mu$ Sv - average 260  $\mu$ Sv/y), gamma rays (100  $\mu$ Sv to 1000  $\mu$ Sv - average 350  $\mu$ Sv/y), food and drink (100  $\mu$ Sv to 1000  $\mu$ Sv - average 300  $\mu$ Sv/y). Artificial sources include medical exposure (average 370  $\mu$ Sv/y), consumer products (up to 100  $\mu$ Sv), fallout (5  $\mu$ Sv), occupational exposure (average 1.5 mSv/y) and discharges to the environment (average 0.4

$\mu\text{Sv}$ ). The report expresses concern about exposure to radon in some locations [idem, para.9(b)] but concludes favourably that fallout doses are quite low, the Chernobyl increment having virtually disappeared, and that doses from nuclear discharges and radioactive consumer products are trivial.

6A.24 Cumbria has just under the average exposure of 2210  $\mu\text{Sv}$  for annual doses from natural radiation in England [idem, Fig.7]. However, the report also shows that discharges from Sellafield into the marine environment are widespread in their effects [idem, Table 13]. These effects arise from both fish consumption and external radiation. The locations of the nuclear installations monitored is at idem, Fig.11. Exposure of infants from the consumption of milk in 1991 shows Sellafield to have the greatest maximum annual dose of 28  $\mu\text{Sv}$  with Dounreay at 16  $\mu\text{Sv}$ .

6A.25 In 1995, the NRPB suggested that there is no lower threshold for health risk from radiation exposure although it recognised that there is a practical limit to the lowest doses at which excess risks have been detected in epidemiological studies [GNP/1/3]. It found that its studies in the case of exposure to low linear energy transfer are consistent with a linear trend in cancer risks at low doses without any threshold.

6A.26 In March 1995, the RWMAC/ACSNI Study Group Report 1995 [GOV/409] was published. Its conclusions were not all accepted in Cm 2919 [GOV/208, para. 8.6]. In summary its principal findings related to locational factors included:

- a. The health and safety of today's and future generations is the prime consideration in the selection process.
- b. The approach to safety, the terminology used and the standards set should be those of the Tolerability of Risk (TOR) applied to nuclear plant but more consideration needs to be given to the intolerable or unacceptable risk level for a DWR in the light of the public's regard for a risk of  $10^{-6}/\text{y}$  as the maximum acceptable figure.
- c. For the finally selected site(s) the associated risk criteria must be demonstrably satisfied over a period of 10,000 years after making appropriate allowance for uncertainties in current understanding and future performance. Beyond this time arguments must be presented to demonstrate that safety will not be reduced.
- d. The various stages of the open site selection process must ensure that sites for further consideration satisfy the "acceptable risk" level of the TOR criteria. The contribution expected from the engineered barriers to the safety case should be stated at the outset.
- e. The development and use of derived equivalent criteria which are based directly on known geological and hydrogeological site characteristics. These would involve groundwater return indices (GRI) together with disqualifying factors.

6A.27 Although the Study Group favoured a more quantitative approach to site performance than hitherto, the usefulness of the GRIs is challenged by BGS [NRX/14/5]. Notably they

draw attention to the considerable uncertainty as to the geological formations present at depths typical of those considered for deep disposal of radioactive wastes; the lack of available reliable hydrogeological data for deep formations in the UK and the large uncertainties associated with inferring values for parameters where data are lacking [idem, para. 3.3i]. The RWMAC/ACSNI Study Group's comments on the acceptability and tolerability of risk levels were the subject of submission of minority views [GOV/208, para. 76, GOV/409, pp.79 et seq.].

6A.28 It is common ground between the main parties that the geological barrier should achieve four goals. Firstly, it must ensure that there are low flows of groundwater through the DWR so that the physical and chemical barriers can operate to retain short-lived and most long-lived radioactivity. Secondly, it must ensure substantial dilution, or other retardation, of those radionuclides that are released from the vaults in order to limit concentrations reaching the surface to meet regulatory requirements. Thirdly, it must ensure that gas does not reach the surface in concentrations that would pose a flammability hazard or lead to concentrations of radionuclides in gas which would pose an unacceptable risk. Fourthly, pathways for return of radionuclides should not be created by natural disruptive events, inadvertent human intrusion or by RCF construction. PERA [COR/501] in effect sets out the 1st, 2nd & 4th of these characteristics at Chapter 3. It is also accepted that nuclear radiation, even in small doses, can have harmful effects [e.g. GNP/1/3].

6A.29 Nirex points out that, following the withdrawal from Billingham in 1985, it sought advice from BGS on potentially suitable generic geological environments. BGS identified the following characteristics [COR/614]:

- a. predictable groundwater flow paths, preferably long and resulting in progressive mixing with older, deeper waters or leading to discharge at sea;
- b. very slow local and regional groundwater movements in an area with low hydraulic gradients;
- c. ease of construction to allow for repository design;
- d. meeting the many accepted caveats regarding seismicity, depth, etc.

6A.30 This contrasts with the approach in the 1976 report from the Institute of Geological Sciences [COR/615] which put great emphasis on the properties of the host rock itself rather than defining what are considered to be suitable large scale hydrogeological environments. Nirex draws attention to the need to differentiate between the significantly different storage requirements for HLW, with its heat generation, and ILW.

6A.31 In 1987, "The Way Forward" [COR/203] explained Nirex's approach to deep disposal, identifying 5 potentially suitable generic hydrogeological environments [COR/614]. These were:

- a. hard rocks in low relief terrain;

- b. small islands;
- c. seaward dipping and offshore sediments;
- d. inland basins of mixed sedimentary rocks; and
- e. low permeability basement rocks under sedimentary cover (BUSC).

Environments a. to c. were initially identified as the preferred group with their hydrogeological structures seen as simple and more predictable. But after a re-evaluation the BUSC environment was examined along with the other 3 [COR/501, p.43, para.6.4.1].

6A.32 Nirex claims that selection of a DWR site cannot rely upon generic characteristics but must be based upon a safety assessment of the complete system. The Sellafield PRZ exhibits the essential characteristics of the BUSC environment mentioned in PERA [COR/501, para. 6.3.3(d)] because groundwater flow is dominantly occurring in the sedimentary cover and there is little anticipated connection to the underlying older hard basement rocks which are of low intrinsic permeability. The Bredehoeft and Maini paper (CCC/4/1) cited by Cumbria does not provide the authoritative definition of this generic geological term, since there are other interpretations such as that in PERA; but in any event the essential characteristics of the Sellafield PRZ conform to the definition in the paper.

6A.33 It believes the paper gives examples of a coastal site broadly analogous to Sellafield and of an inland BUSC site as described by PERA [CCC/4/1, Figs.3 & 5]. Nirex does not regard these sites as showing the cover rocks as shales with a downward hydraulic gradient isolating groundwater beneath, because in both examples permeable sandstone aquifers are a component of the cover sequence [CCC/4/1, p.295, para.4], and basement rocks crop out on land in both [idem, Fig.3 and CCC/4/11, Fig.2b (Sellafield Variant)].

6A.34 In relation to geological complexity, the nature of the rock structure will determine the location of the DWR in any rock mass [NRX/14/2, p.5]. DWR depth is limited by increasingly high temperatures and rock stresses [NRX/14/2, p.6]. Nirex submits forcefully that complexity of a site is not a disqualifier although it may add to the difficulties of characterisation. It is the capability to predict hydrogeological behaviour, and so support a reliable probabilistic safety assessment, which is essential at any potential DWR location, in its view. The IAEA guidelines [GOV/507, para.401-402] are merely general advice on geological environments, and Nirex has no fixed view on an appropriate environment in this case.

6A.35 But it does regard the 2 key functions of the geological barrier in relation to the transport of radionuclides in groundwater as being to ensure, firstly, low flows through the DWR so that the physical and chemical barriers can operate to retain short-lived and most long-lived radioactivity (amounting to some 99% of the total radioactivity of the emplaced waste) and, secondly, that there is sufficient dilution of those radionuclides released from the vaults in order to limit concentrations to regulatory limits. Nirex notes the importance of groundwater dilution to the Swiss NAGRA project as outlined in NRX/13/3, p.81-83. The RCF is designed to establish whether the geological setting at Sellafield can perform these key

functions and Nirèx contends that the site has the characteristics favourable for doing so in the very long term.

6A.36 The "Regional Evaluation" stage of Nirèx's site selection was carried out using qualitative features and indicators to identify generic geological environments [COR/501, para. 6.3.2], but it was considered unlikely that any one location would prove superior to all others in terms of all the physical properties offered by the host environment. Again, it was generic post-closure radiological safety assessments which were applied when narrowing the list from 500 to 39 candidate sites [COR/501, para. 6.5.8]. As it is the total geological and hydrogeological character of the site which is relevant to risk performance and the safety case, rather than site performance on individual attributes, Nirèx asserts that the promise of Sellafield, or any other short listed site, needs to be established through site investigation and modelling to build sufficient understanding of conditions in that setting, a view it sees supported by the regulator [HMP/1/1, paras. 7.6-7.7].

6A.37 Furthermore, Government policy and regulatory guidance makes it necessary only to meet the regulatory requirements for pre-closure and post-closure safety performance, which Nirèx expects to meet at Sellafield, and not exceed them. No further reductions need be sought in Nirèx's view if the estimated risks at a location are below the target and BPM is employed, a situation unchanged from the requirements of the Green Book [GOV/302, para. 3.8 & 3.9]. It is also unaffected by the reduction in the annual dose [para.6A.18 above]. Calculated collective dose is not a primary consideration but good engineering practice and good science will need to be demonstrated.

6A.38 Whilst consideration of other sites with theoretically lower risks is not precluded by such an approach, in Nirèx's contention, nevertheless it is for the regulator to decide whether a safety case based on a higher risk than  $10^{-6}/y$  would be acceptable. It is not Government policy, nor regulatory guidance, that an authorisation application consistent with the risk target should be refused because another site has, or might have, the potential for a lower risk. The risk target of  $10^{-6}/y$  of an individual developing either a fatal cancer or a serious hereditary defect is accepted as being well below the level of risk of between  $10^{-4}/y$  and  $>10^{-3}/y$  implied by the natural background radiation in the United Kingdom [HMP/1/1, para. 6.20]. The risk to dose factor is 0.06 per Sv, made up of 0.05 for risk of death and 0.01 for risk of developing a serious hereditary defect [NRX/15/3, para.10(i)].

6A.39 Nirèx adds that for the PCSA, the DWR risk would have to be predicted to a degree of accuracy acceptable to the regulators: other regulatory requirements will have to be met: the pathways highlighted in the NRPB's Radioactivity Review [GOV/416] would involve short lived radionuclides which would have decayed: present day nuclear facilities would not be operating when the potential DWR risks would apply: measures can be taken to reduce the radiological impact of natural radiation, and the peak additional doses from a DWR would be relatively very small. Furthermore, public doses of radioactivity would be minimised by reduction of waste transportation.

6A.40 Although Nirèx is not responding to the Irish Government on any matter of policy, it points out that there is no UK Government policy that DWRs should not be sited on the coast of the Irish Sea. At the technical level, the very extent of the Irish Sea over the timescale of  $10^8$  years is of course problematic. But, using preliminary safety assessments

at Sellafield as an example, the forecast peak radiation risk to an individual from an eventual marine discharge from a repository in the PRZ [COR/522, Vol.3, Table 6.18, Fig.6.6 & Section 9.1(g)] would be incurred by an inhabitant of the mainland which is currently England, and that at well below  $10^{-6}$ . The peak risk that might be incurred by an inhabitant of the present continental shelf around Ireland for  $^{129}\text{I}$  would be insignificant [NRX/15/34, para.12].

6A.41 Dr Elliott concedes that disposal is a radiologically advantageous option over surface storage [WR/E/1A] and Nirex believes that there is no evidence to support the proposition that the 1 mSv/y level could be reached from artificial sources. Even adding the 1 Msv/y level postulated to the average annual dose quoted by NRPB for Cumbria results in a lower average annual dose than Cornwall, Derbyshire, Devon, Northamptonshire and Somerset and is comparable to many other counties [NRX/15/24]. In addition, Nirex does not accept that any increased cancer incidence in Cumbria is associated with the presence of the Sellafield nuclear facilities or atmospheric fallout [NRX/15/42, p.7].

6A.42 **Cumbria**, while agreeing with Nirex on the requirements of a geological barrier [COR/501, paras. 3.2.6 & 3.2.7], and that suitability of any particular site must be based upon a safety assessment of the predicted performance of the complete repository system at the site, submits that environments in which low permeability basement underlies sedimentary cover (BUSC) provide the best overall performance of land based options with respect to post-closure radiological safety [CCC/4/1 and CCC/4/11]. It regards it as relevant to consider whether a site has the characteristics which are likely to lead to a successful safety case and feels that departures from BUSC characteristics would lead to substantial problems in proving a safety case. It also suggests that the post-closure design requirements imply a Tolerability of Risk zone between  $10^{-6}/\text{y}$  and  $10^{-5}/\text{y}$  along the lines recommended by the RWMAC/ACSNI Study Group & the NRPB [GOV/208, paras.76-7].

6A.43 In Cumbria's view, the BUSC concept is characterised by groundwater movement taking place predominantly in sedimentary rocks overlying older low permeability basement rocks. Because of the difference between the permeabilities in the basement and cover rocks being measured in orders of magnitude, and of the lack of a significant hydraulic gradient within the basement rocks, there should be little interchange of groundwater between the 2 formations. If there were to be any interchange, the presence of alternating impermeable and permeable rocks within the cover sequence would act as a barrier to upward migration [CCC/4/11, Fig.2a].

6A.44 Cumbria maintains that the Sellafield variant [idem, Fig.2b] has an inherent flaw in comparison with the BUSC concept because groundwater recharge to the basement rocks, which outcrop some 2.5 km (rather than some 64 km as in CCC/4/1) away from the PRZ, will provide a driving force for groundwater to flow through the repository volume. This is not regarded by Cumbria as a variation of BUSC but as fundamentally different. Sellafield also has a major fault of hydraulic significance (the FHFZ) about 500m downstream of the PRZ, unlike examples in CCC/4/1; and the sandstones in the sedimentary sequence in CCC/4/1 do not rely upon dilution within them to satisfy the safety case. As regards comparison with other sites, Cumbria points to the lack of data such as quantitative

information on type III fractures in Nirex's post closure performance assessment [COR/522] to enable any meaningful comparison to be made.

6A.45 Cumbria also believes that the novelty of DWR science means that outcomes are inherently uncertain, but that an ideal BUSC environment should produce a margin in the safety case to allow for uncertainties such as the effects of climate change. Deviation from an ideal BUSC environment could result in, for example, there being some hydraulic continuity between the basement and cover rocks, plus permeable layers in the latter being exploited as aquifers. Then there could be short groundwater return times and exposure of radionuclides to the biosphere, and human ingestion, at significant concentrations. Furthermore, complexity of geology, and particularly faulting, makes the controls on groundwater flow much more difficult to define, predict and model.

6A.46 **Gosforth** strongly advocates a cautious approach, including the selection of simple and safe potential DWR sites, in view of the many uncertainties it perceives. It also draws attention to a potential hazard from the cumulation of plutonium oxide particles from contaminated waste, a concern shared by **Mrs M S K Higham**. While Mrs Higham sees a health risk through eventual release of the particles into the biosphere, Gosforth is concerned that recurrent criticality incidents could take place in the DWR creating heat, steam, gas and radiation [WR/GPC/1, particularly pp.10 & 11], a matter which Nirex takes seriously and is working upon [NRX/15/41]. **Mr S Balogh** draws the analogy of such a fission reaction with the Oklo phenomenon [GOV/630, pp.303-7]. Gosforth sees the solution in the design of a dry DWR [idem, p.12-13].

6A.47 **Friends of the Earth** particularly identify the need for avoidance of dewatering, and so derogation of shallow and surface water resources, and other perturbation effects in any DWR. Nirex accepts that the geochemical characteristics of a PRZ could be fundamentally important to the control of radionuclide transport through oxidisation, complexation, sorption and mineralisation [eg FOE/8/1 & FOE/8/14], and yet these, like the impact of excavation damage on fluid flow, and fluid fracture flow generally, are complex areas of science with many unknowns.

6A.48 They agree with Cumbria, Greenpeace, **Patricia McKenna MEP**, **Mr J Fitzsimons MEP** and others that the host rock needs to facilitate detailed characterisation and hydrogeological modelling on a regional scale. The many uncertainties point to the need for application of the precautionary principle in site selection in their opinion and merit subsection of research results to peer review. They also highlight the need for validated modelling of baseline conditions at any location.

6A.49 **Greenpeace** submits that geological investigations are characterised by uncertainty and it shares the view of Friends of the Earth on the need for application of the precautionary principle. Radiological safety is paramount in site selection as set out in the optimisation guidance in Directive 80/836/EEC (as amended by 84/467) in its view and all exposures to radioactivity should be ALARA and the risk broadly acceptable [GOV/701, para.175]. Nirex accepts that BPM should be applied regardless of risk and concedes that a further reduction in the safe radiation dose level in future cannot be ruled out. Greenpeace points out that Nirex welcomes the "explicit recognition" that uncertainties in human dosimetry do not have



to be taken into account in making radiological assessments in the regulator's draft guidance [NRX/12/17, para.8.7] and that it is not prepared to accept that the risk of  $10^{-5}/y$  is an upper bound on optimisation. Greenpeace sees this as a contradiction of the regulator's guidance that the dose constraints (i.e. 0.3 mSv/y) place an upper bound on optimisation [HMP/1/1, para.6.6], which it equates to a risk of  $10^{-5}/y$  [idem, para.6.8]. This demonstrates that Nirex is showing a candid disregard for fundamental principles relating to radiation protection, in its view.

6A.50 A low groundwater flux and chemical containment by groundwater is crucial to providing sufficient levels of safety for chlorine and uranium respectively in Greenpeace's contention should the engineered chemical barrier fail. It also sees a requirement for simple groundwater flow and evidence for geologically long term stability of water or a downward rather than upward flow. Sufficient generic research and validated hydrogeological models are also needed to support any detailed safety assessment with the requisite degree of confidence.

6A.51 Greenpeace and others consider that a tectonically active location could increase groundwater flows through a DWR as could glaciation [GOV/507, p.12]. Furthermore, they share the view of Friends of the Earth that perturbation of the hydrogeological regime during RCF/DWR construction must be avoided.

6A.52 The Irish Government adds that it regards hydrogeological and geological complexity as making the radiological impact of a DWR on the marine environment impossible to predict over an extended timescale such as that required by the waste inventory. It sees reliability in prediction as fundamental to the principle of sustainable development. Uncertainty requires application of the precautionary principle which, in this instance, means the assessment of alternative inland sites.

6A.53 Together with Patricia McKenna and Mr Fitzsimons, it considers that there is already an excessive concentration of nuclear activity in the general Sellafield area and that the addition of a DWR will add to it unacceptably in terms of health and safety so exposing the Irish people to further risk. It believes that optimisation of protection requires inter alia, keeping ALARA, economic and social factors being taken into account, the number of people exposed to ionising radiation - EC Commission v. Belgium Case C-376/90: 1992 2 CMLR 513 at para.23. These concerns are shared by the Isle of Man Government [WR/IOM/1].

6A.54 GAG has misgivings about the shift of emphasis from a safe natural host rock to a multi-barrier containment system because it sees this leading to a compromise on the degree of safety achieved and an undermining of proper site selection. It regards safety as being of pre-eminent concern in site selection.

6A.55 South Cumbria Citizens, together with other local groups and individuals, are also concerned about the uncertainties arising from human error generally, but particularly in predictions and assumptions supporting the safety case. They cite national and international nuclear accidents and resulting pollution in support of the proposition that insufficient caution is displayed generally by the nuclear industry and regulators [WR/SCC/1]. They draw particular attention to the probability of an uneven distribution of radionuclide pollution [SCC/6/5] and the inherent susceptibility of exposed populations to "second event" radiation

damage from some radionuclides [SCC/6/4]. The NRPB's investigation into this phenomenon is open to question in their view.

6A.56 Interested Persons in their written representations reflect an overwhelming concern that radiological safety should be paramount in site selection of a DWR. There is a similar measure of feeling that geological and hydrogeological stability and predictability should characterise any PRZ. Some of these representations are from persons with specialist knowledge. The concern is supported by instances of miscalculation and error in nuclear industries at home, as mentioned by the Irish Government and South Cumbria Citizens above, and abroad in Russia for example when disposing of waste [WR/A/2] or operating nuclear plant [WR/M/146].

6A.57 Dr Patricia Elliott is concerned at the burden on a local population in terms of radiation exposure when that population already has a high average exposure to various sources of radiation, and the highest in UK from artificial sources [WR/E/1A & 1B]. She cites the cumulative impact of doses from natural and artificial sources and additional doses received by certain groups (eg high fish consumers) which could already approach the 1 Msv/y level. History has shown that populations have received significant exposures of radiation as safe dose levels have been revised downwards [WR/E/1B].

6A.58 Ms J Allis-Smith draws attention to the need to review the health profile of communities resident in any potential DWR location in order to ensure that levels of cancer, especially amongst children, are not unduly high [WR/A/81]. The potential effects of radioactivity on children, and its high incidence in Cumbria, is also cited by Mrs S D'Arcy [WR/D/104] and Mrs P A Kilshaw [WR/K/2]. Their point is reinforced by Mr R Stirzaker [WR/S/247] who also draws attention to the significant radiotoxicity of some substances, and especially  $^{14}\text{C}$  and  $^{40}\text{K}$ .

6A.59 Dr W R Burton, formerly technical co-ordinator for a UKAEA radioactive waste design study, perceives serious shortcomings in deep disposal where high salinity and a high head of groundwater is encountered causing early return of radionuclides to the biosphere [WR/B/57 & WR/B/57 Enclosure, p.5]. He believes that these shortcomings would be exacerbated by perturbation, gas generation of the wastes and erosion of rock cover [WR/B/57 Enclosure, pp.5-7, WR/B/57A, pp.1-3 & WR/B/57B].

6A.60 My conclusions about basic DWR locational criteria are merely a preliminary step in appraising the overall scientific & technical benefits of the RCF. For the general international & national criteria are just lists of indications, with a choice of DWR location really expected to conform to only a number of the indications in any list. Nevertheless, the indications are significant, since many of the more detailed submissions on the benefits of the RCF, to be considered later, stem from them. Moreover, the Assessor's advice is that 2 principles of overriding value can be derived from his review of the geological, geomorphological & hydrogeological criteria. One principle is that the location should be in a region of low hydraulic gradients, so that there should be slow-moving & long groundwater pathways: and the other is that the geology & hydrogeology of the site and its district should be sufficiently uncomplicated as to be readily characterisable & predictable.

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6A.47-8

6A.61 Although Nirex rightly draws attention to the difference between the respective storage requirements for HLW and ILW, the 2 principles hold good for DWRs for long-lived, alpha-bearing ILW. Indeed, the importance of the 2 principles is to my mind emphasised by the nature of the various uncertainties highlighted by other parties and elaborated upon in Chapter 6C, such as over the particular science of physico-chemical reactions within the repository; the circular difficulties of affecting the natural groundwater & rock mechanics; and establishing the baseline geochemical conditions. The multiple natural barriers afforded by the setting of the DWR need to be understood before a mixed natural & artificial multiple barrier can be properly devised to complement them and produce a reliable PCSA.

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6A.21

6A.62 Moreover, whilst there has been a shift of focus in the guidance from the properties of the host rock to the wider hydrogeological setting, there are still some common factors relating to geodynamic stability. The host rock & general locality should not be liable to be affected by climatic changes, neotectonics, seismicity, volcanism & diapirism to such an extent that these could unacceptably impair the isolation capability of the overall disposal system. Rather more specific advice on some aspects of stability has been introduced by Euradwaste Series No.6, including distancing the site from geothermal anomalies or volcanic evidences. However, this guide's short timescale for tectonic movement appears to require further consideration in relation to the 10<sup>8</sup> design period used for risk predictions.

6A.63 The requisite features of potentially suitable environments identified for Nirex by the BGS in 1986 were part of the shift in focus, and complied with the general principles. The extent to which Nirex's ultimate choices of site contained these features remains to be evaluated in later Chapters of this report. There is an inevitable element of circularity between the role of an overall safety assessment on the whole system in finally showing whether the regulatory protection standards are satisfied, and the essential prerequisite that the host rock & its hydrogeological setting are uncomplicated enough for their character to be satisfactorily described. Although the concept of a Groundwater Return Index has been devised to help reduce this circularity at the first stage of site selection, I accept the view of the BGS, as broadly endorsed by the Assessor, that the concept is impracticable for the UK.

3C.23

6A.64 In any event, it seems to me that the Irish Government's basic objection, founded on international law, is now raising a fundamental difficulty about some of the environments identified for Nirex. For PERA specifically mentioned the huge dilution offered by migration of the residual amounts of long-lived radionuclides to a marine receptor in the biosphere, and the prospect of effective marine dilution of any leakage of radionuclides [COR/501, paras.3.2.8 & 3.3.3]. Such factors obviously would have influenced the choice of potential environments, particularly small islands and seaward dipping & offshore sediments. I have already concluded that international treaty law subscribed to by the UK suggests that, where an eventual marine discharge is foreseen, the location must be at least specifically justified, and the potential effects on the marine environment must be considered in addition to the dilution value on the human pathway.

6A.65 For its part, much of Cumbria's scientific case rests on the concept of the BUSC environment. As I understand the issues, there are a number of points to be made when considering the differences between Cumbria & Nirex over this concept. The first is that, for our purposes, it does not matter who devised the concept so long as it is a practicable one. Then, the description of "basement rocks under sedimentary cover" is intended to refer

to an essential, basic element of the concept, but cannot give the complete picture: it is not suggested that in every instance of basement rocks under sedimentary cover there would be a promising situation for a DWR. For example, the presence of a number of faults of large displacement & which enhanced conductivity between the basement rock and the cover would appear difficult to reconcile with the concept. Thirdly, in the Assessor's view, the 2 principles set out in 6A.60 above effectively mean that in applying the concept in specific instances we should be looking for some minimum scale of hydrogeological system. Finally, Nirex seemingly does not share the judgement of Cumbria, endorsed by the Assessor, that an essential element of the concept is a mix of relatively low & high permeability layers in the sedimentary cover, serving to further inhibit potential vertical flow.

6A.66 In consequence, Nirex is relying in its present work on some dilution by the groundwater in the sedimentary cover, whereas the BUSC concept is for the flows in the sedimentary cover to be, if anything, an active barrier. Whilst reliance on appropriate dilution capabilities is contemplated by modern guidelines, it would not in my view be appropriate to transform a theoretical barrier into a receptor, thereby turning this particular concept on its head. Although Nirex has cited the importance of groundwater dilution to the NAGRA project in support of its own approach, the Assessor advises me that the geological setting there is so different that no useful comparison can be made with Sellafield.

6A.67 On the other hand, this does confirm the crucial role claimed by Nirex for establishing through site investigation & modelling the total geological & hydrogeological character of a preferred site. Also the yardstick of the site characterisation need be no lower than the  $10^{-6}$  risk target, since the optimisation of the site selection & justification of the final choice, which the planning authority wishes to review, logically come before that. But the very point in this case, of course, is that Nirex is seeking permission to proceed further with its preferred site's characterisation whilst delaying that review. The difficulty yet again is Nirex's failure to appreciate that it is for the planning authority and not the regulators to review the choice of location, and that the authority is entitled to its own view about the acceptability of the risk, so long as it does not seek to substitute its own detailed risk assessment for that of the regulators.

6A.68 Cumbria and Greenpeace have so far, however, made one important error in interpreting Cm 2919. Although both the NRPB and the RWMAC/ACSNI Study Group advocated the application of the Tolerability of Risk approach to DWR safety, with an upper bound risk of  $10^{-5}$  to complement the lower bound of  $10^{-6}$ , this is specifically rejected by the 4th sentence of para.78 of the White Paper in respect of post-closure safety. The Government has confirmed in this its preliminary conclusion that it is inappropriate to rely on a specified risk limit or risk constraint as the criterion for determining the acceptability, ie as an upper bound, of a disposal facility. The references in the draft regulatory guidance to an upper bound expressly relate to pre-closure safety.

6A.69 Be that as it may, Cumbria has not so far indicated that it is minded to significantly evaluate site selection against any criterion relating to existing radiation levels, whether directly or indirectly by reference to human health. The anxieties of those who criticise the nuclear industry's attitude to dosimetry & its prediction record, and who emphasise the remaining uncertainties about the low-level & secondary effects of artificial radiation, are somewhat understandable, but in their turn they tend to display some lack of awareness, in

my view. For, in addition to the Assessor's point about the positive function of the Sievert as a qualitative measure of the potential harm from radiation, the general radiological protection principles of justification, optimisation & limitation are essentially precautionary, all being aimed at minimising exposure to radiation from artificial sources and not simply at avoiding unacceptable levels. Paradoxically, it is also necessary to keep a sense of perspective by considering the health of potentially millions of future generations, and not concentrating too much on the present.

6A.70 It is certainly invalid to claim by dint of aggregating the estimated doses of different critical groups that the Cumbrian population has the highest average UK exposure to radiation from artificial sources. Nor is it obvious that there would be a net detriment in terms of current exposures to radiation from artificial sources if the DWR were located in Cumbria. Then to take radiation from natural sources into account, as Nirex wishes to emphasise for the very long term and some of its opponents for the short term, would seem to me to run counter to the general principles of radiological protection. Recent experience suggests that the particular risk to guard against is the accumulation by any means of isotopes discharged from the DWR; and it appears that the draft regulatory guidance seeks to do this. Therefore I agree with the Assessor that insufficient reasons have been put forward for the planning system, in focusing on the location of the DWR, to contemplate setting criteria based on levels of existing radiation from artificial or natural sources.

3C.2

6A.22

3B.28

## **6B. SITE SELECTION PROCESS**

6B.1 Nirex accepts that there is an onus upon it to demonstrate that it followed a rational procedure for identification of Sellafield as the location at which to concentrate further investigations for the DWR development in July 1991 [NRX/12/1, p.11]. Nirex carried out its site selection procedures under the aegis of the (now superseded) Green Book which required the developer to show that a rational procedure for site identification had been followed and had not ignored a clearly better option for limiting radiological risks [GOV/302, paras. 5.3 & 5.4].

6B.2 Nirex's DWR site selection procedure started with consultation with the BGS in 1985 and was intended to follow IAEA guidelines to proceed in stages from generic to specific site assessments carried out in progressively increasing detail, the number of candidates being reduced as the requirements to be satisfied were refined and enhanced [COR/501, para. 6.1.1].

6B.3 The 1983 guidelines [GOV/501, Table 6.1] set out 4 main stages:

- a. Planning and general studies - to develop overall plans and criteria and review basic data.
- b. Regional evaluation - a search on a national scale to define favourable areas of the country - supported by laboratory and reconnaissance field work as appropriate.
- c. Site identification - the identification of specific candidate sites for comparative evaluation and the selection of outstanding prospects for physical exploration to confirm their suitability.
- d. Site confirmation - the final choice based on the results of in situ investigation and laboratory and other studies.

6B.4 The guidelines suggest that at each stage of the site investigations, societal, ecological and national legislative issues are considered and the regulatory body should be involved in accordance with national requirements [GOV/501, Table 6.1 footnote].

6B.5 The 1994 IAEA guidelines for HL/ $\alpha$  wastes [GOV/507] advise 4 similar stages to those above except that site identification becomes site characterisation involving the study and investigation of one or several potential sites to demonstrate that they are acceptable, and in particular from the safety point of view [idem, para. 324]. A reasonable comparative evaluation may be made between sites at the characterisation stage on the basis of their ability to meet all safety requirements and of their acceptability for construction of the disposal facility [idem, para. 327]. The result of this stage is the identification of one or more preferred sites for further study, shown by preliminary safety assessment to be potentially suitable for a repository [idem, para. 326].

6B.6 At the conclusion of the characterisation stage the preferred sites are identified. The final site selection is expected to involve judgements based on socio-economic, environmental and political considerations [idem, para. 328]. Site confirmation consists of detailed investigations at the preferred site(s) to:

- a. support or confirm site selection of a preferred site(s); and
- b. provide additional site specific information required for detailed design, safety analysis, environmental impact assessment and for licensing [idem, para. 329].

6B.7 The siting process should proceed according to a plan developed in consultation with the regulatory authority, and should include the establishment of guidelines or criteria for site characteristics and procedures for applying them as well as optimisation for long term safety concerns [GOV/507, para. 310]. The potential worth of "volunteer" sites and existing nuclear sites or land adjoining existing nuclear facilities are suggested for special consideration in site selection, the latter particularly in relation to waste transportation [idem, para. 302]. The guidance suggests early identification of factors or criteria which might result in the rejection of a site during the planning stage and that they be investigated during the area survey (regional evaluation) stage, even if such factors are not among the most easily applied [idem, para. 314]. The area survey generally involves regional mapping and site screening during which consideration should be given to important groundwater resources, national parks, historic monuments, national laws and regulations [idem, paras. 317 to 323].

6B.8 Although site selection in the UK is no longer a matter for the regulators, they would be willing to comment on site selection to the planning inquiry into the DWR application. Whatever site was selected, they would expect the same performance requirements to be met. Examples of economic and social factors taken into account by the regulators on the issue of site suitability can be found in the decisions on THORP [GOV/632] and the Sizewell B Power Station [GOV/633].

6B.9 The RWMAC/ACSNI Study Group recommended [GOV/409] that:

- a. The details of the site selection process should be publicly transparent.
- b. The various stages of the open site selection process must ensure that sites for further consideration satisfy the "acceptable risk" level of the TOR criteria. The contribution expected from the engineered barriers should be stated at the outset (as noted in 6A.26d above).
- c. The TOR criteria cannot be directly applied in the early selection process stages (hence the recommendation of the development of groundwater return indices - see para.6A.26e & 6A.27 above).
- d. The selection of preferred areas, and sites within those areas, for detailed investigation leading to the eventual selection of a preferred site should involve the relevant local authorities and there should be public consultation.

- e. The necessary regulatory (licensing and authorisation) procedures should be effectively and efficiently undertaken in parallel with the planning process.

6B.10 Nirex have carried out the following procedure so far:

- a. The identification of 500 sites in Great Britain based on desk studies and then the incremental sieving down to 12 sites for detailed consideration in a multi-attribute decision analysis (MADA) process.
- b. In 1988, the MADA process considered 12 sites, splitting one of the offshore options into 2 to make 13 sites, and recommended a short list of sites for further investigation to the Nirex Board.
- c. In 1989 the Nirex Board decided to investigate further 3 of the sites recommended by the MADA group, one of which was not pursued in the event (see 6B.32).
- d. In 1991 the Nirex Board decided to restrict further investigations to Sellafield.

Steps a. to c. above are described in COR/501, Chapter 6 and fall short of physical exploration including field drilling and environmental studies [idem, para. 6.1.2]. The process is summarised at idem/Fig. 6.4.

6B.11 During the first stage of site selection several reassessments and re-evaluations were made to ensure an adequate level of assurance that the groundwater regimes could be characterised and modelled [idem, para. 6.4.1]. Locations in areas of national environmental importance eg National Parks, AONB's, Heritage Coastlines and Districts and Boroughs with a population density exceeding 5 persons per ha, or near major population centres, were excluded from further consideration [idem, paras. 6.4.2 & 3] because sufficient sites were believed to exist elsewhere. This reduced the area of search [idem, Figs. 6.2 & 6.3]. The population density criterion was applied because of perceived public acceptability and disturbance effects of a DWR [idem, para. 6.4.3]. Off-shore areas were screened for practical and geological constraints and potential oil or gas exploration [idem, para. 6.4.4]. Some 30% of the land area of Great Britain was classified within the 4 hydrogeologically promising environments [idem, Fig.6.2]

6B.12 Following the definition of the areas of search, specific sites were sought within these areas for evaluation. Consideration was also given to some sites outside the areas of search which appeared to offer particularly favourable features coupled with a satisfactory geology [idem, para. 6.5.1]. Nearly 500 potential DWR sites were then identified, including a site underlying Sellafield works (referred to in the MADA process as Site 9 - Sellafield A).

6B.13 Further scrutiny reduced the sites to some 200 coastal and inland showing real potential including favourable generic geological characteristics. This scrutiny excluded sites designated as SSSI's and those, although with a population density less than 5 persons per ha, near major population centres. The sites were reduced to about 160 by exclusion of those with potential ownership constraints because Nirex does not possess compulsory purchase powers [idem para 6.5.4], and then to some 120 imposing a flexibly applied land area



guideline of 400 ha inland and 200 ha coastal [idem, para. 6.5.5]. Further detailed scrutiny by BGS to select sites with the best potential hydrogeological performance reduced the number to 39 [idem, para. 6.5.6].

6B.14 At this stage a site near to the east of Sellafield works, in addition to "Sellafield A", was included (referred to in the MADA process as Site 10 - "Sellafield B") [NRX/12/11 & NRX/12/11A, correcting COR/104, Enclosure, para. 3.5.3]. The 1980 IGS (now BGS) study had marked the Volcanic rocks below Windscale and Drigg as having good potential [COR/616/Fig.2, p.5] but, because of their 900-1,000 m depth, the cost of investigation was described as likely to be prohibitive. The potential for ILW disposal within the overlying sandstones was considered to be limited although some prospect of success was suggested involving leachate discharging into the Irish Sea [idem, pp.7-9]. The nature of the volcanics below Sellafield was considered speculative at that time [idem, pp.7-9]. 1988 desk studies of the Sellafield area pointed Nirex to the "Sellafield B" location where the BVG was considered to be at an accessible depth. Neither the location for Sellafield A nor that for Sellafield B overlap the PRZ.

6B.15 A list of 17 land-based and 2 off-shore sites resulted from examination of site availability and specialist assessment on a comparative basis of radiological safety, geology, socio-economic and environmental issues, DWR design concepts and transport [COR/501, para. 6.5.7]. During this assessment transport and its costs became an important issue and attribute values were not always dependent on quantitative measures [idem, para. 6.5.11, 6.5.13]. Further refinement led to 12 sites going forward for detailed decision analysis in the MADA process which were judged to be at least acceptable on the attributes of concern. The candidates comprised coastal, inland and island sites underlain by hard rock; coastal and inland sites underlain by basement rock under sedimentary cover (BUSC); coastal sites underlain by seaward dipping sedimentary rock; and 2 generic offshore sites, one being underlain by sedimentary formations off the east coast of England, and the other by igneous rock off the west coast of Scotland [idem, para. 6.5.14]. The latter offshore site was later divided into a shallow and a deep option by the MADA team to make the 13 sites mentioned above [6B.11(b)].

6B.16 The MADA sites are set out in Tables 2 and 3 to NRX/18/6 and the attributes used in the analysis are at idem, Table 1. The numbered order of attributes is the same on all 3 tables. The attributes are clustered around major and minor nodes [idem, Fig.1 and COR/101A, Enclosure, Appendix 1, Fig.1]. The latter reference gives percentage weighting figures for the base case. The geological characteristic of each site is at NRX/12/18, Table 5.3 and NRX/12/14, Table 1. The MADA exercise team reduced the 12 (then 13) potential DWR sites down to a short list of sites worthy of investigation. Their objective was not to determine which was the best site and neither were they structured to do so.

6B.17 The MADA team of 14, including the facilitator and analyst from the London School of Economics, comprised a mix of 4 Nirex employees and 8 consultants from BGS (2), JMP (1 transport specialist), UKAEA (2) and Piedad (3 planning/environmental specialists). They performed their function of choosing a short list for Nirex as the DWR developer, by generating conditionally prescriptive values. They deliberated over 5 meetings with the help of computer assisted requisite decision modelling and saw their work as pioneering in this field. The additive, or compensatory, models were considered sufficient in form and content

simply to obtain a short list of sites for further investigation and are distinguishable from more complex models which may be used for site selection such as those which are normative, satisficing or descriptive.

6B.18 The team of experts drew up the list of attributes which could discriminate between sites [NRX/18/6/Fig.1] and provided scales and weightings for them to reflect their relative importance [NRX/18/6/Tables 2 to 5 and COR/101A/Enclosure, Appendix 1, Fig.1]. Preference scores represented "best guess" evaluations of the options on the attributes and were tested for independence through weighting assessment after a process of normalisation. Uncertainty in many of the "best guesses" was recognised by participants and taken into account by establishing 90% confidence intervals around the "best guesses".

6B.19 The nature of requisiteness in the modelling is illustrated by the treatment of the pre and post-closure safety attributes. For 3 of the pre-closure safety attributes a great deal more work would have been needed for the experts to provide confidence intervals, and in the light of the overall low weighting on the safety attributes, the extra work would not have affected the overall scores of the options. For the 4 post-closure safety attributes uncertainty was considered to be expressed entirely by intervals of confidence solely on Attribute 18 (safety to individuals).

6B.20 Sensitivity analyses were also carried out using varying weightings of the major nodes [NRX/18/6/Table 6 and Figs. 3 to 7] to check consistency. These analyses did not include the possibility of further changes to the dose risk limit but some revisions were made to weightings in the iterative process looking at overall results and applying pessimistic weightings. The group eventually agreed to accept weights of 100 on costs, 20 on robustness, 10 on safety and 10 on environment as a base case with other weighting sets used in the sensitivity analysis [idem, Table 6]. The cumulative weighting in percentage terms was costs 71.4, robustness 14.3, safety 7.1 and environment 7.1 [idem, Table 4 & Fig.1]. The difference in costs was thus judged to be 10 times more important than the difference in safety for the sites considered which relates to valuing a life at £300,000. The cumulative weights for the base case [idem, Table 4], showing the discriminating power of the attributes, reflect the group's judgement based upon information available in Autumn 1988. The exercise showed several sites consistently less or more preferred to others, even when pessimistic scores were substituted for "best guesses", and sites were reassessed according to relative advantages and disadvantages, leading to the recommendations listed below.

6B.21 The MADA team identified stakeholders interested in the short list of sites as being Nirex Board, National Environmental Groups, Local Residents, Local Authorities, HM Treasury, Regulatory Bodies, Politicians, Scientific and Technical Community, European Neighbours. The team provided weightings for the views of these groups though each participant was limited by the facilitator to 5 factors in total no matter how many roles were played. There was no check that each stakeholder was represented fully, or at all, in the choices made.

6B.22 Although the preliminary results of the consultative exercise, "The Way Forward" [COR/203], provided some input into the exercise, there was no formal linking of the 2 exercises because the consultative exercise, published in COR/204, was incomplete at the time of the MADA team's meetings. Sellafield was the only location specified as being under

active consideration for a DWR during "The Way Forward" consultations, although noted as being geologically "complex" [COR/203, para. 5.2.7] and "uncertain" [idem, para. 6.3], a point recognised in the MADA exercise. At that time hard rocks in low relief terrain, small islands and seaward dipping offshore sediments were suggested by BGS as hydrogeological environments preferred over inland basins of mixed sedimentary rocks and low permeability basement rocks under sedimentary cover (BUSC), the former group of 3 being simple and predictable and probably yielding a sufficient number of sites for further investigation [idem, para. 5.2.5]. The concept foreseen for Sellafield in "The Way Forward" was a fully engineered offshore facility below the sea bed with access by underground tunnel from a point on the Sellafield site [idem, para. 6.3].

6B.23 In terms of site selection, the "Responses to the Way Forward" [COR/204] found concern about blight, especially in areas dependent upon tourism, agriculture and fishing; unanimous support for the paramountcy of safety, including during transport of waste; and concern at any radioactive pollution of the sea. Local support was not seen by many as an important factor in site selection [idem, paras 7.6 et seq.]. Some matters were the subject of mixed views eg. the importance of excluding areas of high amenity and the level of population density. The report showed a degree of support for deep disposal [idem, Map 4]. It reported Copeland (quoting not from their official response but from their leader's press release of a BNFL initiative) as welcoming the possibility of developing a new approach towards the storage and disposal of LLW and ILW [idem, para. 1.3.16], and Cumbria's qualified support for investigation of an off-Sellafield facility [idem, para. 1.3.6]. Local support was represented in the MADA exercise to the extent of Attribute 24 - local experience - nearness to a nuclear establishment [NRX/18/6, Table 1] which, at 1.3% weighting in the base case model [idem, Table 4], had little impact on the MADA result.

6B.24 In 1988, RWMAC responded to "The Way Forward" by declaring support for a pragmatic approach to site selection but on the basis of a fixed set of assessment criteria [GOV/412, para. 12]. It also recognised some difficulty in publicly identifying more than one site for investigation prior to development [idem, para. 13].

6B.25 MADA sites were paired for comparison near the end of the procedure to keep in play sites of different geological environments and, after reaching conclusions on the sites, the group re-introduced geology, but not geographical spread, as a discriminating factor to arrive at the recommendation that at least 3, and perhaps up to 5, sites were worthy of further investigation. These were:

- a. If 3 sites: Sellafield B (Site 10), BUSC Sites 6 or 7, and Coastal Hard Rock (CHR) Dounreay (Site 1) or Low Relief Hard Rock (LRHR) Site 2.
- b. If 4 sites: Sellafield B, BUSC Sites 6 or 7, (CHR) Dounreay or LRHR Site 2 and island Site 3.
- c. If 5 sites: Sellafield B, BUSC Sites 6 or 7, (CHR) Dounreay, LRHR Site 2 and island Site 3.

6B.26 Site 6 was found to be marginally better than Site 7 but, because they were both geologically similar, Site 7 was not recommended for further investigation concurrently with

Site 6. Dounreay and Site 2 were both recommended for further investigation because they were assessed as being geologically different and relatively good. Site 3 was assessed as being as good overall as Dounreay and Site 2, and particularly good on robustness though less good on environmental issues.

6B.27 BUSC Site 8 had been dropped in preference to Sites 6 and 7 because it did not score so well on 9 attributes [NRX/18/6, Table 6] although it scored better than 7 on geologically predictive (Attribute 12), transport capital (Attribute 1) and economic resource sterilisation (Attribute 27) in the base case [NRX/18/6, Table 3]. Sites 5 and 13 were dropped after the fourth meeting because they scored consistently poorly. Site 4 was dropped because it showed little difference in overall scores and sensitivity analysis from Site 3 [NRX/18/6/Figs.3-7].

6B.28 The results of the MASCOT modelling of radiological safety in the MADA post-closure safety analysis [COR/501, Table 5.2] required adjustment to account for program inputs based on judgements rather than calculations [idem, 5.6.6, 5.6.10 & NRX/12/14, para. 8]. Sellafield B was adjusted (from 0.0003 mSv/y to 0.02 mSv/y) by the time of the MADA exercise but others were adjusted between the MADA and issue of PERA by factors of up to 100 to allow for site specific uncertainties [NRX/12/14, Table 1]. No other change was made subsequently as a result of the increase in dose estimates for individual sites or for the dose to risk conversion factor [NRX/15/32, para. 9, NRX/12/14, paras. 4-8 & Table 1]. The outcome in terms of preference scores for post-closure safety reflected in PERA made little overall change to relative site performance as found by the MADA team [NRX/12/18, Table 5.2].

6B.29 As regards pre-closure radiological safety for waste transport, estimates of collective doses to the public of up to 1.2 man Sv/y (60 man Sv during the 50 year operating period for the DWR) were considered small in relation to 2000 man Sv/y from cosmic rays and terrestrial radiation [COR/501, para. 5.3.7]. In MADA, Sellafield B demonstrated the lowest risk to the public from waste transport and DWR (Attribute 16) some 37 man Sv less than Sites 5, 6, 7, 8, 11, 12 and 13 and some 152 man Sv less than Dounreay and Caithness (Site 2). The latter 2 sites were lowest for workers (Attribute 14) [NRX/18/6, Table 2].

6B.30 In 1989, after the MADA exercise and the consultation process ["The Way Forward" -COR/203], and assuming the site selection process had been based upon a thorough methodology, Nirex regarded it as clear that the sites under consideration were divided between those where there was a measure of support for nuclear activities in the local community and those where there was not [COR/501, para. 6.7.11]. Sellafield B, Dounreay and Site 2 (Caithness) were selected. Caithness was then proposed for designation as an SSSI and, also recognising the technical, practical, time and resource constraints on investigating several sites simultaneously, Nirex decided to limit further investigations to just 2 areas with a perceived measure of local public support, namely Dounreay and Sellafield [COR/501, para. 6.7.11]. This set aside Sites 3, 6 and 7 recommended by the MADA team, of which Sites 6 and 7 were acknowledged to have a potential for lower radiological risks than the 2 locations selected. The Government accepted the Nirex Report of its decision to concentrate on Dounreay and Sellafield [GOV/211] after consulting with RWMAC who had published their views [GOV/402/Appendix C]. The conceptual DWR design [COR/501/Fig.4.2] was refined and preparations made for a DWR planning application [COR/208, NRX/12/1, pp.5-

7] with a continuing expectancy that surface investigations would be sufficient for the supporting safety assessment [NRX/12/2, p11-17].

6B.31 The surface implications of Sellafield B were considered in MADA by reference to the Pelham School Estate [NRX/12/11A] which is some 2.4km north west of the RCF location. Nirex moved the location to Longlands Farm in 1989 to avoid the Carboniferous Limestone present under Sellafield B. The Newton Manor Estate, including Longlands Farm, had been offered for sale to BNFL in 1987, but was not purchased until March 1989.

6B.32 The further investigations at Dounreay and Sellafield led to Nirex's decision in 1991 to concentrate on Sellafield as its preferred choice with Dounreay remaining as the next option [NRX/12/1 p.11, NRX/12/2, p.10]. The key factor in the choice was that 60% of the waste destined for the DWR would arise from Sellafield. That position remains the case with some small change in percentages, although no optimisation of waste transportation has been calculated since the MADA exercise. Sellafield has its own rail infrastructure.

6B.33 The decision to concentrate on a single site was determined by costs and demands on highly specialised scientific manpower. It was also recognised that much further work was required before a long term safety case could be made. The Dounreay investigation results were summarised in COR/506 and published in December 1994. It was decided to proceed with the RCF as a contingent development stage in September 1992.

6B.34 The geological and hydrogeological requirements within the PRZ include a minimum of 100 m to 200 m of BVG cover over the DWR and a maximum depth below ground level of 1000 m. The PRZ is contained by the presence of permeable Carboniferous Limestone to the north west, the Fleming Hall Fault Zone (FHFZ) to the southwest, the Seascale Fault Zone (SFZ) to the southeast and the National Park boundary (A595T), where BVG cover is reducing, to the north east [COR/518, Vol.1, Drgs.010054, 010061 & 010062 & NRX/2/3/fig.4.1]. The 2 fault zones are presumed to be associated with enhanced hydraulic conductivity.

6B.35 The 1:1,000,000 scale national vulnerability map included in the former NRA's 1992 Policy & Practice for the Protection of Groundwater [GOV/131] indicates a Major Aquifer with soil of High Leaching Potential running down the Cumbrian coast from St Bees Head to the Ravenglass Estuary, and extending inland over the PRZ. The 1992 document also contains the NRA's policy statement on physical disturbance of aquifers and groundwater flow [idem, pp.26-7]. The NRA's consultation reply on the RCF planning application [COR/107, letter of 11 November 1994] made no specific reference to this policy statement nor to the ES [COR/101], Chapter 7 of which addresses effects on water resources, including groundwater. The NRA reply dealt instead with a miscellany of technical matters, including an outstanding application for consent to discharge and the possibility of requiring an abstraction licence. In further communications [culminating in COR/113C Addendum], the NRA sought planning restrictions on the RCF development, to avoid groundwater contamination and to control groundwater discharge from the RCF. These matters are considered in Chapters 5E and 7A of this report.

6B.36 Until the RCF planning application stage, the MADA process had been publicly summarised in COR/501. On receipt of the planning application Cumbria sought, and

received, further information on the site selection process [COR/101A & COR 104, Appendix D]. At this inquiry more information on the site selection process was provided by Nirex witnesses. The site selection process has not been the subject of peer review, although Nirex has called upon external expertise for comments and advice at some points in the programme [eg COR/516]. It is accepted by the parties that more information has been made available to this inquiry on site selection than to any other body, including RWMAC and the Royal Society.

6B.37 **Nirex** does not accept that it needs to justify the merits of its choice of sites or of the sequential sieving of those sites to the point of decision to concentrate further investigations on Sellafield and Dounreay and then on Sellafield alone. The rationality of the site selection procedure is clearly distinguishable from the merit of the decisions made during the procedure. In its view the latter is appropriate for a review of alternative sites at the stage of a planning application for a DWR and not for the RCF application. Nevertheless, the overall process of site investigation, carried out with the aid of several different groups of consultants, was generally satisfactory and thus can now be endorsed by the Secretary of State.

6B.38 It points out that the IAEA guidelines make provision for individual site characteristics to be taken into account in the practical application of site selection [GOV/501, pp.2 & 19], as well as socio-economic factors [idem, p.23] and this has been done. The procedures kept a wide range of siting options under review, whilst at the specific level this PRZ is spacious enough for both the RCF and the DWR. The RCF has been sited potentially to enable its utilisation by the DWR for drainage and in connection with ventilation, spoil removal and emergency access while ensuring that the DWR rock volume suffers no adverse perturbation effects. It does not accept that this PRZ would be so geologically complex that so much intrusive investigation would be needed as to compromise the safety case. Cumbria concedes that the IAEA guidelines were followed: and generally there has been little criticism of the thoroughness of the systematic reduction of 500 sites to 12.

6B.39 As to the MADA exercise, Cumbria accepts that MADA provided a reasoned basis to proceed to identification of a short list and that Sellafield emerged fairly from this process as a candidate site. Greenpeace acknowledges the validity of MADA as a technique.

6B.40 All the MADA sites were seen by Nirex as having the potential to achieve the regulator's risk target of  $10^{-6}$ /y [COR/101A/Enclosure, para. 4.1.1], even after the change to the calculated post-closure annual doses to an individual [NRX/12/14 & NRX/12/18, Tables 5.1-5.3], because of the very conservative model of engineered barriers, of hydraulic conductivity, and of containment of some heavy metals. Little importance was therefore placed upon the margins by which the target could be exceeded by any site [GOV/409, paras.3.37 & 3.38] or on the weighting for post-closure safety.

6B.41 Although safety is a material consideration in planning terms, in the MADA exercise, costs, for example, were a greater discriminator between sites and so merited greater weighting. It points out that, provided BPM is employed to limit discharges, then the risk target does not need to be exceeded under present guidance or under the Green Book [GOV/208, para. 78, HMP/1/1, para. 6.17, GOV/302, para. 5.3] because post-closure safety

is already assured. This is not tantamount to ignoring any "clearly better option for limiting radiological risks" [GOV/302, para. 5.4]. The sites thought by the MADA group to have potential for lower risks were considered by the Board and discounted for good reason. Furthermore, the CASCADE study revealed very low collective doses for post-closure safety (attribute 19) [COR/501, Table 5.2] and the longer term estimates (attribute 20), weighted on a value curve [NRX/18/6, Fig.2], are similarly small. Nirex regards safety other than post-closure radiological performance as also being important, as in the case of public doses associated with waste transport, which would be minimised by location near Sellafield where the bulk of the waste is generated, a point reinforced by Dr Cunningham. The performance of the hard rock off-shore option, although having a low post-closure radiological risk, was marred by conventional safety considerations [COR/501, para. 6.6.10].

6B.42 In the MADA sensitivity analyses, the variations in base case nodal weightings of costs, robustness, safety and the environment, and displays of the scores for one node against the scores for any other node [NRX/18/6, Figs.3 to 7], were thorough and sufficient and have not been queried by any party. Shifts of about 14% points (about a fifth) on the total weight on costs [NRX/18/6, Fig.4], and some 8% points (more than double) on the total weight on safety [NRX/18/6, Fig.6], would be needed before Sellafield B loses the highest weighted preference score. Until the safety weighting is increased from 7% to some 67%, or the cost weighting drops to some 30%, Sellafield B remains in the top 4 of the MADA sites. If the safety weighting is increased to 67%, the implied value of a life increases from £300,000, twice the figure recommended by the NRPB [NRX/18/2], to some £7.4m [NRX/18/5].

6B.43 Progressively increasing the weighting on Attributes 12 and 13 (geological certainty and investigability) would eventually take overall preference scores for Sites 2, 3, 4, 6, 7 and 8 above Sellafield B, but Sites 4 and 8 were not robust to sensitivity analysis and so were dropped by the team. Sites 2, 3, 6 and 7 were all included in the recommended short lists and so it is unclear how an increase in weighting on Attributes 12 and 13 would have aided the MADA team's judgement.

6B.44 A weighting of over 45% on the environment node would be needed to displace Sellafield B and Cumbria does not suggest that too little importance had been given to it. Indeed, Nirex points out that 5 of Cumbria's 7 weighting sets give this node a weighting of 5%, 2% less than in the MADA Base Case [CCC/6/10, Tables 3,4]. This is not surprising in view of the environmental screening stages in the preceding sieving process.

6B.45 Although the treatment given to divergent perspectives is disputed by some objectors, further inputs would have simply produced another range of views on weightings which the MADA team would also have needed to resolve. Sellafield B scored consistently well on a wide range of weighting sets designed to simulate different perspectives as it was. Nirex submits that the merits of the MADA team's judgement are not the issue, but whether that judgement was reasonable having regard to such divergent considerations as cost to developer, customers and consumers and meeting the regulatory target. In its view the team's judgement was reasonable and rational, and it was considered by RWMAC to be "defensible" [GOV/402, Appendix C]. Re-runs of MADA results up to 1994 have not altered Nirex's view of the outcome of the exercise.

6B.46 RWMAC also accepted the logic in identifying Dounreay and Sellafield for further investigation and establishing their suitability before evaluating other sites in detail, an approach accepted by Government [GOV/211]. The rationality of the Nirex Board's approach in first concentrating investigations at these 2 sites due to scarcity of resources has not been challenged. Nirex contends that the importance of support in the local community recognises reality [COR/104, COR/407, COR/411] and does not prevent any planning application being decided on material considerations according to law. Public controversy severely hampered the site investigations for a shallow repository between 1983 and 1987; and there was no measure of local authority support for a DWR in the areas of Sites 3, 6 or 7. In contrast, local people already familiar with potentially hazardous industry understand it better, and feel more comfortable living alongside it.

6B.47 Nirex refutes the assertion that the potentially suitable extensive areas of East Anglia and east-central England identified in COR/501/Figs. 6.2 & 6.3 are likely to be less complex than the BVG. The geophysical surveys show the basement rocks to be more varied and complex than previously thought [NRX/14/4]: there are too few boreholes to allow confident prediction of the basement geology: the rocks are just as folded, cleaved fractured and faulted as rocks of a similar age in the Lake District and Belgium: some Tremadoc rocks contain small quantities of methane: and data on the hydrogeological characteristics of deep basement rocks in the UK are sparse, especially for hydraulic conductivity [NRX/14/5, paras.3.3i, 4(iii), 4(iv) & 4(v)(d)]. BUSC Site 6 could therefore be as faulted in its basement rocks as the BVG even though it may seem superficially simpler geologically. Furthermore, the minimisation of ILW transportation, resulting in the lowest collective dose to the public during the DWR operating period at Sellafield, almost exactly offsets the post closure advantage over 10<sup>5</sup> years of the generic BUSC option evident from COR/501/Table 5.2.

6B.48 The decision in 1991 to concentrate on Sellafield as the preferred choice did not mean that Nirex had decided to submit a planning application for a DWR at this location [NRX/12/2, p.10 para. 3] and that remains the case today. The 1991 decision as such has not been criticised, and was also entirely rational. Preliminary assessments have been made on DWR post-closure performance to demonstrate that the site holds good promise [COR/522], and on matters such as earthquake risk [COR/516, para. 3.1.1(a)], glaciation [COR/527] and chemical effects [COR/525]. This investigative, research and assessment work is progressing at Sellafield but, if a DWR application were to be made in the future at Sellafield, further investigative work is not intended at other potential DWR sites except perhaps Dounreay. Other sites considered in the selection process remain options if needed. A DWR inquiry for Sellafield would probably have the benefit of reworking of existing data as far as alternative sites are concerned so the work carried out in the 1980s would not be entirely relied upon.

6B.49 The scale of the shift from Sellafield B to Longlands Farm is too small in Nirex's view to uncouple the site selection process leading to the MADA short list and the Board's decisions to concentrate on Dounreay and Sellafield and then Sellafield alone. The depth of the BVG at Sellafield B is no less than the present PRZ and the cost of constructing waste transport arrangements would be similar for both locations.

6B.50 As to the purported lack of public information and involvement with the site selection process, Nirex points out that confidentiality was in the interests of not needlessly



concerning the public about potential DWR sites and has not hampered Cumbria and Greenpeace from making their arguments based upon COR/501 as amplified at the inquiry. "The Way Forward" [COR/203] and its Responses [COR/204] effected consultation on the broad approach and the rationality of the site selection procedure is unaffected by the absence of additional public involvement. Furthermore, Nirex asserts that public involvement in site selection is a matter for Government policy and Government has not suggested that there should be such involvement, even in Cm 2919. In accordance with its policy Nirex has published a wide range of information of high quality on the DWR programme and scientific activities in order to promote public confidence for which it has earned praise [GOV/407, para. 4.6, COR/605, sections 1.9 & 6.8]. It intends to continue to be pro-active in improving the quality of its interaction with interested parties [NRX/12/6].

6B.51 **Cumbria** finds it striking that the Nirex Board did not follow the recommendations of its own MADA team, and take the common sense course of investigating at least one BUSC site with a more robust and promising generic geology than Sellafield B as demonstrated in the Bredehoeft and Maini Paper 1981 [CCC/4/1]. This would have given more confidence in validity of techniques and promise of potential host environments. Extensive areas of East Anglia and east-central England identified in COR/501/Figs. 6.2 & 6.3 are likely to be far less complex than the BVG, particularly the Tremadoc and possibly intrusive igneous rocks in east-central England. Nirex concedes that data from deep basement rocks in UK are sparse and borehole data does not allow confident prediction of their geology or hydraulic conductivity [NRX/14/5, paras.3.3i, 4(iii), 4(iv) & 4(v)(d)]. Cumbria believes that disposal of ILW does require simple and determinable geology. In order to cope with the paucity of data an investigation programme at alternative sites should involve at least 2 to 4 boreholes of the sort used for the first few years of the Sellafield investigation.

6B.52 A BUSC site, with relative lack of complexity and vertical continuity and low hydraulic heads, would enable a more readily achievable safety case which is where the balance of public interest lies, in Cumbria's view. It contends that Sellafield locations do not exhibit crucial BUSC characteristics, and points out that there are more potential BUSC sites than the MADA Sites 6 and 7, as others were identified in the pre-MADA stages. Many sites with better potential than Sellafield have been discarded, and passing over the best site options for limiting radiological risks at the short list stage is tantamount to ignoring it in Green Book terms. It considers that the MADA exercise distorted the proper comparative rankings, particularly of Sellafield B, BUSC Site 6 and Dounreay; and Nirex made insufficient allowance for the problems involved in a long and difficult process of investigation.

6B.53 Cumbria considers the lack of weight given to the risk of failure and to safety in the MADA exercise to be a fundamental flaw. Geological certainty (combining predictive - Attribute 12; and investigability - Attribute 13: [NRX/18/6/Fig.1 & Tables 1-3]) attracts a base case total weighting of only 3.97% [COR/101A Enclosure, Annex 1, Fig.1]. The base case weighting for post-closure safety is only 6.82% [COR/101A/Enclosure/Annex 1/Fig.1]. These weights are plainly inadequate when the public regard safety as paramount.

6B.54 This can be seen by changing the emphasis of the weighting in the base case [CCC/6/10, Table 4], and particularly increasing the weight on the predictability of the host

geology as shown at CCC/6/10, Table 2 to a wholly credible weighting set. An increase in Attribute 12 (geological certainty) - [NRX/18/6, Table 1] from 3.27% to 20%, and a reduction in Attribute 4 (operations costs) - [NRX/18/6, Table 1] from 32.47% to 15.74%, result in BUSC Site 6 scoring first (81.5) with Sites 2, 3, 7 and 8 all scoring better than Sellafield (76) and Dounreay scoring poorly at 74.3. Furthermore in CCC/6/10, Table 1 (referring to detailed weightings in CCC/6/9, Table 4), Site 6 performs best overall in a sample of 5 of the sites recommended by the MADA team. BUSC Site 7 is second, and a worthy alternative to Site 6, in each case. Sellafield B comes fourth of the 5 and Dounreay always last. This outcome is consistent with Nirex's concession that only 3 of the sites would meet the regulatory target at the lower 90% confidence limit, not including Sellafield B nor Dounreay.

6B.55 The point is reinforced by examining the cost of a life, which Cumbria considers to have been too low. Although the figure used of £300,000 was an increase on the £150,000 suggested by NRPB for very low individual doses in 1986 [NRX/18/2], in transport a sum of £600,000 was adopted at that time and valuations have increased markedly since with £2M being commonly quoted in literature [CCC/6/7]. Nirex concedes that the value of a life would alter with context and even with personal expert judgement.

6B.56 If the value of a life is taken as £2M [CCC/6/10, Table 5], the cost and safety relative node weights are changed from 10:1 (MADA Base Case) to 1.5:1. Leaving robustness (14.29%) and environment (7.14%) unchanged, cost (71.43%) becomes 47.14% and safety (7.14%) becomes (31.43%) [idem, Table 7]. Site 6 (87%) then becomes preferred to Sellafield B (83.7%). Discounting costs further narrows any lead Sellafield B had in the MADA exercise over BUSC Site 6 [idem, Tables 6-8]. The MADA exercise showed that Site 6 should have been included in any pair of sites chosen for further investigation. In addition, the BUSC sites would meet the risk target for the new dose limits introduced after the MADA exercise and publication of PERA [COR/501] whereas Sellafield B and Dounreay would not.

6B.57 Cumbria is surprised that Site 12 had to be rejected because it was found to be virtually uninvestigable since such elementary criteria should have been applied at the earliest stages of site selection, and not left for the last 12 sites. On the other hand, population density should have been a site discriminator rather than acting as an eliminator with a threshold of 5 persons per ha. In turn, land ownership was introduced as a factor far too early when technical considerations should have been overriding.

6B.58 Proceeding with Sellafield and Dounreay can no longer be justified on evidence now available in Cumbria's judgement, having regard to the complexity, cost, novelty and long term nature of the DWR project. The inherent difficulty in replicating investigation, and the knowledge imbalance between sites acknowledged by Nirex, places a premium on making the correct choice first time. However, both of the sites preferred by the Nirex Board had been predicted to fail to meet the regulatory requirement at the lower 90% confidence limit. Dounreay was exactly on the risk target, offering no leeway at all on best estimates. Although the Board's decision to concentrate on sites in areas having some familiarity with the nuclear industry is politically and commercially understandable given the (then) recent trauma of the shallow sites search, it was short sighted and flawed as a means of site selection in land use planning terms. It constituted elimination of sites because of local opposition

which is not a ground for refusing planning permission [PPG1, para. 42]. The 1989 endorsement by Government was expressly made subject to the normal planning procedures: and RWMAC actually had reservations about Sellafield & Dounreay meeting the regulatory target, & the realism of hydrogeological assumptions [GOV/402, para.2.25].

6B.59 Cumbria points out that the composition of local authorities is transient and, like local communities, they may change their views. It submits that to reject Site 6 for an apparent lack of support from a local authority when considering such an important long term project of this sort was not rational, especially as each of the MADA team's recommended group of sites included a BUSC site, and during the MADA process little weight (1.3% [NRX/18/6, Table 4]) was given to "community support", simulated by "local experience - nearness to a nuclear establishment" - Attribute 24 [NRX/18/6, Table 1].

6B.60 Cumbria also finds some inconsistency between using waste transport as the discriminator between Sellafield and Dounreay on one hand and the emphasis on the safety of waste transport in the Sellafield (BNFL) Discharge Authorisation 1993 [GOV/632] and the Sizewell B Nuclear Power Station determination 1994 [GOV/633] on the other.

6B.61 The Nirex Board was over optimistic about the time necessary to demonstrate that a site could support a satisfactory safety case. Investigation is, by its nature, drawn out, lengthy and difficult to draw back from; and has safety implications for the locality. Moreover, because of the flaws in site selection, a site with some fundamentally unsatisfactory features has been selected in preference to a manifestly more suitable option. Site 6 would be likely to meet the design target, stricter since MADA, without the need for optimisation.

6B.62 Cumbria contends that Sellafield was effectively chosen as the DWR site in 1991 and then entered a confirmatory stage as the sole focus of investigation. This inquiry has presented the first opportunity for sufficient evidence to be made available for proper public scrutiny of the selection of the appeal site. This is a particularly important point in the light of the RWMAC/ACSNI Group advice on the need for transparency and availability of information [GOV/409, particularly at p.48].

6B.63 Copeland shares Cumbria's concern that Nirex decided to focus investigations on Sellafield and Dounreay on the basis of a measure of local support for nuclear activities [COR/501, para. 6.7.11]. Nirex concedes that this factor is not material in planning terms albeit important to Nirex. Copeland points out that responses to "The Way Forward" suggested that local support for radioactive waste management should not be decisive [COR/204, paras. 7.6,7.7 & 7.9] and disagrees with Nirex's interpretation of its view as supportive [COR/501, para. 6.7.8]. Although concerned that the future of civil nuclear activities in the Borough could be put at risk by investigations elsewhere, Copeland regards safety as being paramount in the search for the "best" site, wherever it is [NRX/12/2, p.1].

6B.64 It also points out that, although it is Government policy that there is to be one DWR, that does not apply to the RCF. Since there now needs to be an RCF wherever there is to be a DWR, it suggests that investigating a number of candidate sites in parallel would give Nirex's site selection process some credence. As it is, Copeland regards the selection process

as being flawed, with insufficient attention being given to alternative sites and the RCF development being unjustified.

6B.65 Gosforth also feels that there has been a lack of public consultation on site selection, and complains that the site shifts which took place from the Sellafield undersea proposal to Sellafield A, Sellafield B and then Longlands Farm were not made clear at the time. It, like some other Councils [eg WR/SLC/1], has misgivings about the site selection exercise because of the lack of some detail and the lack of emphasis on safety - a concern shared by Mr Dale Campbell-Savours MP, who seeks the very best geological characteristics for the DWR. Longlands Farm is an unsuitable site in Gosforth's submission, and the Parish Council lacks confidence in future decision-making on the project.

6B.66 The Rt Hon Dr J Cunningham MP envisages site selection at the time of a DWR application, together with consideration of economic and social aspects as well as geological evidence collected from the most rigorous scientific examination of the area, plus a thorough debate on all aspects of the safety case. The Windscale and Calder Shop Stewards Committee draws attention to the high proportion of nuclear waste and handling expertise already at Sellafield and sees increased safety in disposal locally underground.

6B.67 The Irish Government shares the views and concern of the Isle of Man Government [WR/IOM/1] and other objecting parties that the site selection process has not been open, as required by Council Directives 85/337 & 90/313/EEC and Appendix II of the 1991 Espoo Convention [see also Chapter 3A above] and that insufficient weight has been given to safety and the environment. It points out that Sellafield B did not attract the highest scores for predictability of geology and the level of post-closure safety in the MADA exercise. Furthermore, the MADA exercise failed to take account of the special quality and status of the marine environment.

6B.68 Greenpeace maintains that the choice of Sellafield for further investigation now has to accord with the precautionary principle and the sustainable development strategy and cannot be justified primarily by arguments of cost. It shares Cumbria's view that Sellafield has been chosen for the DWR over better sites subject only to confirmatory investigation; and so DWR safety effects are material and should be considered at this stage. Detriment through radiation exposure is inevitable for a DWR and is a material planning consideration - Stringer v Minister of Housing and Local Government [1970] 1 W.L.R 1201 at 1294. No real assessment of the benefits of disposal can be balanced without taking account of other sites holding potential for greater levels of radiological protection.

6B.69 Delaying a review of alternative sites until a DWR planning application or authorisation is not in the public interest in terms of time, money and public anxiety in Greenpeace's submission. It points out that the memories of witnesses to the site selection exercise are already failing, and the MADA "audit trail" is incomplete.

6B.70 There are strong indications that Nirex has, in selecting Sellafield, ignored a clearly better option for limiting radiological risk and failed to undertake a rational procedure for site identification, as required by the Green Book. In the MADA exercise, the imposition of a

threshold for post-closure safety to society  $0-10^5$  yrs (Attribute 19) - [NRX/18/6, Table 1] on all the sites except offshore Site 13 [see idem, Table 3] precluded the long term public safety benefits from making any difference to the final ranking order of sites. This imposition was inconsistent with the lack of a threshold for pre-closure radiological safety to workers (Attribute 14) or the robustness node.

6B.71 Greenpeace also regards the application of the value curve to longer term post-closure safety [NRX/18/6, Fig.2] as indefensible, for it failed to make risks ALARA. Because the MADA team considered, and then assumed, that all 13 sites would meet the  $10^{-6}$  risk target, and so only a threshold of risk needed to be achieved without optimisation, they applied the value curve to relate long term individual post-closure safety to preference. This meant that differences between sites which had higher risks were given greater value than differences between those sites with lower risks, and thus MADA failed to give due weighting to sites which performed considerably better than Sellafield B on safety. The low overall weighting on safety, together with a value curve on individual safety, tended to disguise sites with safety advantages even though they may have had similar costs. This approach is inconsistent with keeping radiation risks ALARA and should be contrasted with that taken by the US Department of Energy in its analysis of 3 candidate radioactive waste repositories [GNP/1/2, p.175-176]. Moreover, the value of a life should not have been an input into the MADA exercise. That amounted to making a cost/benefit calculation on a single yardstick, whereas MADA-type exercises should be utilised to suggest valuations of a life rather than assume them.

6B.72 Greenpeace criticises several other aspects of the exercise including the restriction of sensitivity testing to the nodal group of attributes, namely costs, robustness, safety and environment [idem, Fig.1]. Sellafield B's position in the preference scores was more volatile than Nirex suggests. For example, Sites 6 and 7 performed better on long term safety, predictability and investigability; and Sellafield B failed to meet the safety target under pessimistic assumptions [NRX/18/3]. Site ranking sensitivity should have been tested against changes in individual attributes to explore divergencies rather than convergencies. Greenpeace contends that Sites 6, 7 and 12 would better accord with the principles of sustainable development. The variation of approach during the process in relation to geological discriminators undermined the credibility of the site selection process. Utilising the pessimistic assumptions would be more consistent with the precautionary principle.

6B.73 Similarly, divergent perspectives in the MADA exercise did not reflect a proper balance of views but were obtained in an ad hoc and idiosyncratic fashion. Focus groups would probably have attached greater weight to safety than the specialists. Local experience of the nuclear industry, despite being of overriding importance in later site selection, is unclear in its meaning and relevance to various parts of the site selection process. Moreover, the assertion that only Caithness and Copeland gave some measure of support in responses to "The Way Forward" seems questionable, since the County Council for Suffolk, a BUSC area, gave qualified support [COR/204, Map 4 and para. 1.3.5].

6B.74 Nirex's change of site from Pelham House School to Longlands Farm was another anomaly. In principle, the short list of sites should have been reviewed and fresh comparisons made when Sellafield B proved unacceptable. The cumulative base weight of Attribute 3 - repository capital costs - had been 3rd highest of all at 16.23 [NRX/18/6, Table

4], and Sellafield B had been estimated at £444M at 1988 prices [idem, Table 2]. The estimated cost of the PRZ at 1995 prices is £1,820M [MRX/12/18, Table 4.1]. Even discounting back to 1988 by the Retail Price Index, the estimate would be £1,650M, which would rank the PRZ as the second most expensive after the discounted Site 13. This factor alone warranted re-evaluation of the short list.

6B.75 Greenpeace also regards the MADA exercise as not in accord with Government policy because exposure pathways and health effects yet to be recognised, considered as uncertainties in the Green Book [para. 3.8], were not included in the exercise; and neither was any comprehensive evaluation of uncertainties. It believes that the effects of glaciation and risk of geological fault movement are both very relevant to the promise of the appeal site, in terms of their potential for significant hydrogeological effects, yet they have not been taken properly into account in the site selection process contrary to international guidance [GOV/507, p.12]. It is not confident that Nirex has taken, or will take, sufficient account of uncertainties in its safety assessment citing Nirex's response to the consultation on the new draft guidance [HMP/1/1] as a case in point [NRX/12/17, para. 8.7-8.8]. It sees this again as being in conflict with the proper application of the precautionary principle.

6B.76 **FOLD** and **NSCNFLA**, would expect sufficient information to be available at this stage on alternative sites to enable an assessment to be made of likely hydrogeological characteristics and uncertainties in geology, and to include results of BGS site visits and borehole data. An environmental and radiological evaluation of a DWR for each site would also be appropriate including reasons for rejection or choice of any site.

6B.77 NSCNFLA finds the published information in PERA, more recently supplemented by COR/104, pp.91-119 and at the inquiry, inadequate, obscure and misleading in character as exemplified by the revelation during the inquiry that the PRZ was not the same location as MADA Sellafield B. The rationality of the whole site selection exercise is more apparent than real in its view because of the anomalies found and the lack of information available, particularly on the MADA process.

6B.78 NSCNFLA refers to the variety of interpretations placed upon local support reported in COR/501, paras. 6.7.8, 6.7.11, "The Way Forward" Study [COR/204, para. 1.3.16 & Table 4.2], COR/104, p.106 paras. 4.1.10-11 and in oral evidence which it regards as confusing and misleading. It cites the position of Copeland as a case in point for the Borough Council did not support deep disposal in its locality in its press release [NRX/12/1, p.4] which in any event was considering an undersea DWR accessed from neither Sellafield B nor the PRZ locations.

6B.79 **Friends of the Earth** consider that an unsuitable site has ultimately been chosen, because there may well be insufficient space for both the RCF and the DWR within the PRZ due to the likely perturbation effects of the RCF and the need for the DWR to be free from the effects of the RCF damage zone and in stable baseline conditions. Nirex concedes that it cannot engineer a solution to every complex geological problem.

6B.80 **GAG** takes issue that local support for nuclear activities was scientifically assessed in the site selection exercise and that it is material. It shares the view of **CORE**, **Cumbrian FOE Groups**, **South Cumbria Citizens** and others who lack confidence in this PRZ and that

safety has been, or will be, given sufficient priority over economic considerations. They, and **Mr S Balogh** amongst others, are also critical of the MADA exercise citing a failure to declare agreed criteria for attributes beforehand and conduct the selection exercise openly or rationally as examples. GAG does not comprehend how any meaningful comparison of alternative sites could be carried out in the future without comparable detail for those other sites; nor does **The Highland Regional Council** [WR/HRC/2]. GAG sees postponement of this consideration to a DWR inquiry as pre-empting the outcome so rendering the exercise meaningless, a concern also of **The National Trust** [WR/NTR/2, para. 11(1) & (4)]. GAG also points to the geological problems with Sellafield B as being the product of inadequate data during site selection which erroneously judged all sites as having the potential to satisfy the demanding post-closure target.

6B.81 **Mr J Fitzsimons MEP** and **Patricia McKenna MEP** feel that local residents around candidate DWR sites have a right to know the identity of the sites despite any alarm which may be caused and they are critical of the lack of transparency in the selection process. The overwhelming proportion of those writing share these views and are sceptical that Sellafield has been selected for sound reasons of long term public interest [eg WR/KUD/1, WR/R/48] or complying with international guidelines. They regard the Sellafield site as having been effectively selected for the DWR, unless some intractable problem is discovered, yet the PRZ appears seriously flawed through shortcomings in geology and hydrogeology [WR/ACC/1], a point supported by **Mr E McGrady MP** [WR/M/196].

6B.82 **Mrs M Higham** draws attention to the views of the IGS (now BGS) in 1975 that more than one site should be investigated at one time to obviate delays of many years caused by a single failure [GOV/201 para. 405]. Delays also prolong the local hazard from plutonium contaminated waste in temporary storage [HIG/1/7, p.134, para. 21 & p.137, para. 358]. She also fails to see how a DWR inquiry could assess the relative merits of different sites when so much more essential data will be available for Sellafield, including that from the RCF, than any alternative. She supports the proposition that site selection should be examined now; and emphasises that "The Six Parish Councils Committee" responded to "The Way Forward" that none wished to have the sole national DWR [HIG/1/4, P.6, point 6]. This was a reiteration of earlier submissions to the House of Commons Environment Committee [HIG/1/7, p.134 paras. 13 & 14, p.137 para. 395].

6B.83 Mrs Higham suggests that the Longlands Farm site would involve greater commitment than Sellafield B to tunnelling, adding significantly to the estimated costs and reinforcing the argument for a re-evaluation of the short list.

6B.84 **Ms J Sutcliffe** points out the advances in knowledge which are taking place and advocates a cautious approach to site selection.

3B.42 6B.85 **I have already concluded that**, as matters of law & policy, outlines of the main  
3B.45 alternative sites for the DWR studied by Nirex should be considered as part of this appeal;  
4A.52 and there should not be set tests or formulae for applying the development plan's basic policy. There is no reason in law, or of planning policy, of which I am aware for distinguishing between the rationality of the overall site selection procedure and the merits of individual decisions made during that procedure. Whilst any sensible exercise of

judgement or discretion should naturally be respected, an illogicality or absurdity in a single but key decision is capable of undermining an entire procedure, in my view. Hence an assessment of the comparisons made between candidate sites necessarily entails a review of both the overall rationality and individual decisions. The Green Book, for example, used to call for both a demonstration of a rational procedure and a comparison of options. Also the planning authority in this case has required more material on the decision to focus on Sellafield by reference to other locations which may provide a better prospect of limiting radiological risk.

6B.86 This review of alternative sites cannot lawfully be postponed until the DWR application itself is made. Such a delay would also be unrealistic in practice, since it is clear from Nirex's evidence to this inquiry that full written records have not been kept of the MADA exercise and personal memories are understandably fading, whereas a very large body of data is being built up on the PRZ & its setting. Moreover, I consider it to be in the public interest to review the selection of this site before yet more time & money are devoted to the investigation of it. For example, if it were to transpire later that Nirex had been persisting with an unsuitable site, the temporary storage of plutonium wastes & others would have been prolonged unnecessarily.

6B.87 Whilst basically it was for Nirex to set about the exercise in its own way, Nirex must have expected that the exercise would be subject to a public inquiry at some stage. The Advisory Committee's approval of the results of the exercise was qualified by a perceptive caution about the suitability of the 2 identified sites, whilst the brief Ministerial statement on radioactive waste management policy was cast in terms which did not pre-empt any land-use planning judgement. There is also the point that, although it is easier to judge with hindsight, the benefit of hindsight does have to be applied in a case of this significance. The first matter that has to be addressed on this basis is that the national area of search (the guidelines' "regional evaluation") was mapped with a precision commended by the Assessor but with some predisposition towards maritime settings, due to the diluting property of the sea. It now seems that such a bias is contrary to international law; and it appears that even at the time little heed was paid to public concern about radioactive pollution of the sea.

6B.88 In my judgement, there are also criticisms to be made of the gradual reduction to 12 sites from the original 500 or so which were delineated out of the modified areas of search. In this respect, I endorse the Assessor's analysis of the process from the geological & hydrogeological viewpoints, and now add my own comments from the overall planning perspective. In the first instance, it would in my experience have been more conventional to proceed to search for a location for a development of this significance by assessing complete grid squares instead of immediately delineating potential sites. I consider that this hasty delimitation might well have contributed to other premature decisions discussed below.

6B.89 On the other hand, it was in accordance with international guidelines and national planning policy to exclude locations of national environmental importance from the initial area of search. Such locations should be examined only if a search of the rest of the country has failed to identify a suitable site. Also PERA [COR/501, para.6.4.3] fairly summarised the arguments on the importance of population density to the exercise, as to do with public perception & minimisation of disturbance on the one hand and regulatory assurance & long term population changes on the other: and it concluded that areas of low population density



are to be preferred. However, the consequent decision was not merely to apply this preference but rather to eliminate from the area of search all local authority districts exceeding the average population density threshold advised by the NII for the siting of nuclear power stations. To my mind this decision not only arbitrarily transformed a preference into an eliminator of the same order as a designation of national conservation importance, but also then applied the eliminator on a crudely extensive basis. The combined effect of the 2 exaggerations was bound to be significantly excessive, in my judgement.

6B.90 Because Nirex has no compulsory purchase powers, land ownership was a direct eliminator at one stage in the reduction process; and in terms of land assembly & availability it was indirectly involved at other stages. But Nirex's programme is of national importance and is being promoted in the very long term public interest. Although national policy is that a compelling case must be made for compulsory purchase, in my experience the procedure is utilised to provide land for development projects some of which are much less significant than this one. Also Ministers have reserve compulsory purchase powers if local authorities are unwilling to use theirs. I find it extraordinary that some land was eliminated from further consideration for this national project, which should benefit millions of generations to come, merely because of a deficiency in the powers of the body conducting the search.

6B.91 Since I have concluded that there should be further public consultation on the main alternative sites before this RCF could proceed in any event, I consider most of the debate about the lack of rigour in the simulation of public views during the MADA exercise to be rather academic now. The public could again express its views at first hand. But for the public to be meaningfully engaged in this way, it is important to be clear about the relative objectivity & robustness of the values which were fed into the exercise. Although the previous consultation round was incomplete when the MADA group started work, there is no doubt that the Nirex Board was aware that the public regarded safety as paramount when the Board considered the group's recommendations. Yet the Board treated another, vague factor of local support as crucial instead, and did not fully implement its advisory group's suggested geological factors, which might have been regarded as a proxy for safety. The very different application by the Board of the discriminative powers of local support & geology without referring the exercise back to the MADA group for re-assessment casts doubt on the consistency & credibility of the entire exercise, in my view.

6B.92 Also, whilst the MADA group's estimates of individual post-closure safety are now thought by Nirex to have included some very conservative assumptions about engineered barriers, hydraulic conductivity & heavy metal containment, it has become clear to me from the detailed scientific & technical evidence summarised throughout the Assessor's report that these factors are still essentially unknown variables. The critical alteration for individual dose estimates was not Nirex's re-working of the doses, but the ICRP 60 revision of the dose-risk factor. The Assessor confirms Cumbria's point that, on the information available to Nirex in 1989, only the BUSC Sites & the Offshore West Site would have met the new regulatory target for post-closure safety to the individual.

6B.93 This shows to me that the MADA group made a basic error in attaching little importance or weight to the different margins by which the sites seemed to meet the then regulatory target. Whilst the geologically-related attributes were realistic & constructive for site comparison if the geological criteria had been applied rigorously & consistently in the

earlier stages of the process, the group did not deal fully with the underlying uncertainties. As Greenpeace points out, the group failed to distinguish between optimising site selection and optimising at the selected site. Although the group showed awareness of the limited confidence which could be gained from its predictions of individual post-closure safety, it failed to comply with what is now called the precautionary principle, and take this uncertainty forward into the ranking of the sites, unlike its approach towards other Attributes related to safety. In other words, the group regarded Post-Closure Safety as assured at most of the Sites when really it was not. It seems that the previous sifting had not been completely rigorous & consistent. The Offshore Sites for example had come through even though the West ones were hardly investigable and the East one failed to meet the old regulatory target.

6B.94 To be fair to those involved, this is not altogether surprising given the Assessor's views that the quality of the available data was bound to be uneven, with the areas least likely to be subject to human intervention also the least likely to have been explored. But this cannot detract from the point that, on the information available, only the BUSC Sites appeared both really investigable and likely to meet the new regulatory target. The retention of Sellafield A was in any event surprising in the light of the history of mining the host rock. This highlights another basic point - that too much importance was assigned to costs in my view since, whilst for instance assumed to be particularly low for transport from Sellafield A, costs are only a transitory factor compared to post-closure safety. I consider that the high weighting of costs was contrary to what is now the principle of sustainability, and resulted in their having grossly excessive discriminative power.

6B.95 This compounding error seems to have stemmed from feeding into the exercise a notional value for a life. Valuing a life which is involuntarily lost to a perhaps unsuspected hazard is almost always a very controversial calculation, in my experience. Again, I agree with Greenpeace that, if anything, MADA-type exercises should be used to try to resolve such controversy, rather than by-pass it with an assumption. The age of, and the caveats within, the NRPB document on which the MADA group apparently relied do not persuade me otherwise, especially in the light of comments by the regulators as in the THORP authorisations that any calculation of fatalities is a notional statistical one, with the deaths unattributable to any particular individuals, any particular country or any particular time [GOV/632, para.61].

6B.96 Although in this relativity exercise safety could not be allowed to be paramount to the extent of virtually devaluing every other potential discriminator, I consider that the shifts needed, according to the sensitivity analysis, for Sellafield B to lose the highest weighted preference score were very modest given the 1988 public consultation response. Indeed, it would not have been unreasonable, in my view, to drop the costs weighting to below 30%. On the other hand, whilst minimising the risks associated with the transport of waste accords with the guidelines & the consultation response, the particular emphasis on it is rather difficult to reconcile with the official view of the UK regulators [GOV/633, para.3.119] & Nirex itself [COR/205, p.12] that the arrangements for radioactive materials transport ensure the public's safety and that therefore any associated risks are extremely small.

6B.97 Looking at the Attributes directly related to geology, Sellafield scored badly on Predictability or Certainty, tending to correspond with the Assessor's view that Sellafield B would not have survived the full series of geological checks in the reduction process if it had

been included from the start. Judging by his advice, it should have been obvious that there were particular complexities involved with Sellafield B, given its location along the boundary between the Irish Sea Basin & the Lake District Dome, and where regional hydrogeological conditions & groundwater heads are poorly mapped; plus the known inconsistencies in the lithology of the BVG; and the presence of the Carboniferous limestone layer. I draw a strong inference from this that special consideration was being given to Sellafield B as land adjoining existing nuclear facilities. Even though such a consideration would individually conform to modern international guidelines, the Assessor's view is that it was always likely to be unproductive in the UK; and in this instance its introduction disrupted the methodical site identification approach which he strongly favours.

6B.98 As for the preferred geological areas, I accept the Assessor's advice that there is a strong case for the selection of a BUSC site for detailed investigation, in accordance with the MADA group's recommendations. On the information available to us, there do seem to be areas of England further to the south-east where both the basement rocks & overlying sedimentary strata are favourable for a repository location. The simple point is that whilst BUSC Site 6 for example could be as faulted in its basement rocks as the PRZ, this is quite unlikely. Moreover, it appears to me that the scientific case for investigating the leading BUSC site instead of Dounreay was overwhelming. Virtually the only reason for taking the opposite line was local support [as summarised in COR/204, para.1.3.16 & Table on p.13].

6B.99 Returning to Sellafield B in this context, there seems to be little strength in the belated argument that Sellafield B is itself a form of BUSC site. The claim tends to confuse the description with the basic concept. The BGS has not mapped any BUSC area in West Cumbria. The hydrogeological region around Sellafield has too great a variation in elevation compared with its limited horizontal extent to provide the requisite low hydraulic gradients & long groundwater flow-paths. The sedimentary layers would not necessarily be a barrier to upward flow, but might well instead act in part as a diluent, notwithstanding the presence of a significant potable aquifer carrying a risk of human intrusion.

6B.100 Considerable weight has nevertheless been attached by Nirex to the argument that Sellafield B was nearly always amongst the leading Sites in the MADA analysis. This was always rather surprising in the light of the previous rejection of other special sites: and in my judgement the remaining strength of this point has been further reduced by the revelation that the current PRZ is not Sellafield B. The switch from Sellafield B to the current PRZ has been explained by Nirex as due to a fresh appreciation of the hydraulic conductivity of the Carboniferous limestone layer under Sellafield B. But, as pointed out by the Assessor, the likely properties of such layers were known to Nirex and its advisors before Sellafield B was introduced into the site selection process. Although it may well be that the cost of a drift from Sellafield Works to Sellafield B or the PRZ would be broadly the same, and I suspect that the increase in DWR construction costs is due more to better estimating than a shift in site, again it was rather inconsistent & secretive not to return to the selection process.

6B.101 This episode not only raises questions about the quality of the inputs to the MADA work, but also suggests again considerable determination to stay near Sellafield, as is implicitly acknowledged in the ES. It also shows how towards the end of the site identification process Nirex was effectively treating the Sellafield vicinity on something like a grid basis, despite having opted at the start for potential site delineation. Even now the

preliminary safety case seems sensitive to a precise location within the PRZ. Although the Assessor advises that there should be space in the PRZ for both the RCF and the DWR, there is some force in FOE's reservations, since this would be subject to laying out the repository vaults in an irregular pattern in the rock so as to avoid the main faults, which seemingly Nirex is still struggling to characterise.

6B.102 Leaving further examination of the PRZ to subsequent Chapters, and turning briefly to the Environmental Node in the MADA exercise, although Cumbria has not attached much importance to this Node this is consistent with the authority's approach that it is concerned particularly with better prospects of limiting radiological risk. I note that, in turn, Nirex's reference to the environmental screening stages in the sieving process tends to confirm my view that Nirex is capable of supplying outline environmental information on the 12 Sites, although there is now an outstanding point that the impact on the marine environment must be considered.

6B.103 It is not for me to comment on the adequacy of the resources available to Nirex for its programme, but to my mind its claim that it can only afford to concentrate on a couple of sites is another reminder of the importance of reviewing now the appropriateness of its original choice, for socio-economic as well as other reasons. Also I agree to some extent with Cumbria that Nirex has blurred the distinction between the guidelines' site identification (or "characterisation") and confirmation stages, even allowing for the 2 different meanings of "characterisation". Difficulties like this might have been avoided if a plan for the site selection procedure had been agreed with the various regulators as recommended by the guidelines.

6B.104 I do consider that it was legitimate for the Board to take into account local support for its enterprise, no matter how vaguely defined or expressed, for it must be a type of political consideration contemplated by the guidelines. However I also accept that such support cannot be a material planning consideration in its own right; and note that it was not favoured as a criterion in the 1988 public consultation response. Local support, despite its smack of voluntariness, is in my view at the most a transitory advantage in relation to such a long-term project, and may well be merely an ephemeral one. Although it might, for example, be a ground for preferring one BUSC site to another, it cannot be a powerful enough point for deferring indefinitely further investigation into any BUSC site. In any event, whilst Greenpeace seems wrong to imply that Suffolk was publicly mapped as a BUSC area in 1988 [see COR/204, Map 1], it is by no means clear that there was no support from the then mapped areas [idem, compare Maps 1 & 4].

6B.105 Putting on one side the factor of local support, it seems likely from the Assessor's analysis that some potential BUSC sites could be located well inland from the sea. In that case there is too a cogent argument of international law that they should be examined before any relatively coastal site such as the PRZ. It also now seems unfortunate that the generic environment of inland basins was discarded so readily, albeit presumably because of their frequent association with minerals exploitation. This tends to typify the short-cuts made within the rationale of the site selection process, which actually ended with an arbitrary identification of the PRZ regardless of potentially greater public benefits elsewhere. The remaining Chapters of this Section of the report examine whether the PRZ nevertheless shows promise.

## 6C. SCIENCE & TECHNICAL PROGRAMMES

6C.1 The science and technical programmes are designed to enable the production of a safety assessment within regulatory guidelines. Sufficient understanding of the geology and hydrogeology of the site is needed to provide an input to the conceptual and mathematical models and hence lead to a reliable probabilistic safety assessment for the DWR as designed. Good engineering, good science and best practicable means are required to be employed [GOV/208, paras.75 & 78]. Decisions should be based on the best possible scientific information and analysis of risks [idem, para.50]. The precise timetable will depend on the granting of planning consent and compliance with regulatory requirements, including the establishment of a sound safety case [idem, para.101]. This Chapter describes progress to the time of the inquiry, and considers whether it has been good enough for the RCF to start.

### The Multi-Barrier Concept

6C.2 The programmes are based upon Nirex's disposal concept of a multi-barrier containment system, briefly outlined at 6A.2 above. The components of the concept are the disposal inventory, physical and chemical containment and the natural barrier [explained in COR/528, Chapters 2 & 3].

6C.3 Nirex regard the disposal inventory referred to at paragraph 6A.4 above as being broadly subdivided into relatively short lived fission products (eg  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$ ) or neutron activation products (eg  $^{63}\text{Ni}$ ), having radioactive half lives of around 100 years or less (as distinct from the GOV/507 Glossary definition), and the long-lived radionuclides [see para. 6A.4]. The latter are of great importance to DWR performance, especially some 'daughter' radionuclides (eg  $^{226}\text{Ra}$  of 'parent'  $^{238}\text{U}$ ).

6C.4 Potential waste streams have been identified as the source of radionuclides. About 65% of the total 16.6 Tbq of  $^{36}\text{Cl}$  (50,000 m<sup>3</sup> approx) are calculated to arise from 7 streams with small quantities likely in many other waste streams.  $^{129}\text{I}$  from nuclear fission would be present in small quantities in a wide range of wastes but 4 waste streams are estimated to contribute some 50% of the projected total of 0.92 Tbq (500 m<sup>3</sup> approx).  $^{238}\text{U}$  from reactor fuel is expected in seven waste streams contributing about 55% of the total 36 Tbq (37,000 m<sup>3</sup> approx).

6C.5 Most ILW would be packaged in unshielded stainless or carbon steel drums or boxes, immobilised by a cement-based grout. Shielded ILW would be principally packaged in concrete boxes and similarly immobilised. LLW would make a very small contribution to the radioactive content of the DWR and would be packaged, but not immobilised, in carbon steel boxes. 99% of the radioactive disposal inventory would be unshielded.

6C.6 Physical containment of the wastes is intended to be achieved by the initial prevention of access of groundwater to the radionuclides in the wastes and subsequent limitation of the movement of groundwater containing radionuclides away from them. The integrity of the containers is to be the principal containing feature coupled with the immobilising grout. Corrosion of steels is expected to be reduced by the presence of alkaline water chemistry and the anaerobic conditions prevailing once the initial volume of air has

been displaced by inflowing groundwater, organic matter in the wastes degrades, and the residual oxygen has been consumed by aerobic corrosion. Research work has indicated to Nirex that the average time for a metal container to be corroded through at Sellafield ranges from 9,000 to 16,000 years [NRX/15/1, p.16]. More than 95% of the radioactivity is predicted to have decayed after 300 years and about 99% after 1,000 years [NRX/15/43/Fig.5.1] and it is the 1,000 year figure which Nirex assume for design purposes at present although not for the risk assessment in Chapter 6E.

6C.7 Chemical containment would be principally achieved by the Nirex Reference Vault Backfill (NRVB) surrounding the emplaced waste containers in the disposal vaults but leaving a crown void. High integrity seals would be located in access tunnels and shafts [COR/528, p.4]. Rock fissures would be pressure grouted to inhibit water flow into, or out of, the DWR. The NRVB is designed by Nirex to achieve long term maintenance of both a high alkalinity (pH) in the groundwater chemistry and a high active-surface-area for sorption of radionuclides, together with relatively high permeability and porosity for homogeneous performance and to permit gas escape. Thus the effects of leaching of reactive components by groundwater flow and reactions with groundwater constituents are important to DWR performance.

6C.8 Nirex seeks to maintain the NRVB porewater at a pH value above 10 to achieve extremely low solubilities of several important radioelements, such as plutonium, in the conditions of the DWR which Nirex believes are chemically reducing ("low Eh"). Calcium hydroxide in the NRVB is calculated by Nirex to maintain the required pH conditions for many millions of years and conservatively for one million years [COR/522/Vol.3, sub-section 2.3, p.2.12]. During this period the chemical barrier is estimated to contain 99% of the 1% of the radioactive waste inventory not contained by the physical barrier [NRX/15/43/Fig.5.1].

6C.9 Experiments suggest to Nirex that the NRVB has high sorption capacity due to its favourable pore surface area. Chemical containment of some radionuclides by reduction of solubility and by sorption is calculated by Nirex as being good [eg  $^{239}\text{Pu}$  - NRX/15/43/Figs.5.2]. On the other hand,  $^{36}\text{Cl}$ ,  $^{129}\text{I}$  are considered by Nirex to be highly soluble and not subject to a high degree of sorption in the DWR near-field and  $^{238}\text{U}$  half life is very long at some 4,500 million years so raising uncertainties. It is these 3 radionuclides, the last of which is particularly active, which Nirex calculates are likely to be released, despite the engineered physical & chemical containment, in quantities that result in significant contributions to the peak risk either from natural discharges or from well abstraction.

6C.10 Nirex thus needs the natural barrier afforded by the BVG rocks in the PRZ as well as the engineered containment in order to ensure a very low fractional, and radiologically insignificant, release of most of the surviving radionuclides. Then the most significant component of the residual risk is from the small number of longest-lived radionuclides as they find their way through the geosphere into the biosphere and eventually enter the food chain.

6C.11 Groundwater flow models predict extended timescales for groundwater to return to the surface in the sediments below the Irish Sea, or to a terrestrial environment if climate change has caused a lowering of the sea level [COR/522/Vol.3, Sub-section 9.1(d)-(h), pp.9.1-9.2]. Nirex estimates that radionuclides would be considerably diluted and dispersed by the groundwater flow and geosphere spreading [eg idem, Sub-section 2.3, p.2.12] and,

perhaps, further diluted by streams, lakes or the sea [idem, Sub-section 9.1(f)-(g), p.9.2]. They would also be subject to sorption and rock matrix diffusion in the geosphere. Low flows of groundwater are necessary through the DWR so that the physical and chemical barriers can operate to retain short-lived and most long-lived radioactivity, yet high dilution is required in the overlying rocks of those radionuclides that escape into the geosphere in order to limit concentrations reaching the surface and so meet regulatory requirements. The groundwater pathway is thus central to the DWR system and requires to be well understood.

6C.12 Nirex calculates the greatest risk from gas migration to arise from the incorporation of <sup>14</sup>C from the disposal inventory in methane from microbiological degradation of wastes in the DWR and subsequent entry of the methane into the food chain [COR/509, Section 4.1, p.20]. After extensive local investigations on mineral resources [NRX/15/2, Sub-section 3.1, pp.9-12], and on the basis of the scenario of borehole drilling at some time in the future when records of the DWR no longer exist [COR/501, paras. 5.6.11 to 5.6.14], risks from inadvertent human intrusion are considered by Nirex to be low.

### **Main Components of Programmes to the Time of the Inquiry**

6C.13 In 1989 preliminary drilling investigations were commenced at Dounreay [COR/506] and Sellafield but from 1991 efforts of the Nirex Science Programme have been concentrated at Sellafield alone. The programme has obtained basic geological, hydrogeological and hydrochemical data on the Sellafield area from surface-based and laboratory studies as part of Nirex's site characterisation and safety assessment research programmes (NSARP) [eg COR/500 series]. It will also assist in locating the RCF development, establishing baseline conditions and monitoring perturbation effects [paras.2B.5 & 6 above].

6C.14 At the time of the 1989 decision to focus attention on Dounreay and Sellafield there was confidence that a limited drilling and testing programme, supported by geophysical work, would be sufficient before a repository planning application could be made, based on a preliminary safety case. After the first few drill-holes and 2-D geophysical surveys had been completed, Nirex considered there was already sufficient information to make a preliminary safety assessment but anticipated that its continued geological investigations would involve approximately 20 deep boreholes (up to 2,000 metres deep) plus shallow groundwater investigation holes, geotechnical boreholes and a 3-D seismic survey [NRX/12/2, paras.4,6,7]. A PCPA was voluntarily submitted to HMIP in 1992 for a DWR in the current PRZ [COR/120, para.3.1].

6C.15 The scope of investigations since then has however been much more extensive than that anticipated earlier. Geological, hydrogeological and hydrochemical results are summarised in COR/517 (1993), COR/518 (1995), COR/525 and in NRX/14/13/Tables A.1-13. The investigations have included geophysical surveys, regional surveys, deep boreholes, core description and characterisation, borehole geophysics, hydrogeological testing, geochemistry studies, groundwater pressure monitoring, acoustic emission monitoring, earthquake, fracture and geotechnical studies and interpretation and modelling [NRX/14/13/Appendix 1].

6C.16 During and since the compilation of the preliminary PCPA [COR/522], for which COR/517 (1993) was the starting point [COR/522, Vol.I, Preface], further information

resulting in revisions of the geological interpretation of the PRZ has been acquired in the form of modelling studies, geochemical and other data from boreholes including from testing programmes, 2-D PRZ surveys, regional surface mapping and hydrogeological studies of the BVG, seismic tomography and vertical profiling.

**6C.17 Site Characterisation.** The main effort in the site characterisation programme has been directed towards achieving an understanding of groundwater flows and conditions in the fractured rocks essential to support a PCSA/PSA. The establishment of baseline conditions prior to development of the RCF is a necessary element of this work. Geological and hydrogeological surveys have been made using a range of surface based techniques within an area of about 60 km by 65 km centred on Sellafield [NRX/14/12/Fig.4.1]. The investigations have comprised studies at regional (about 4,000 sq.km), district (about 600 sq.km) and Site (about 50 sq.km) scales. Observations have been ground-based and made from the air, on and off-shore.

**6C.18** Surface and airborne geophysical surveys have been extensive using conventional and new techniques including a 3-D seismic reflection trial over the PRZ to achieve detailed interpretation of the deep geological structure [NRX/14/13/Table A.1]. Deep drilling has been carried out in 22 locations, 12 of which are in the PRZ, to obtain mostly NE/SW and NW/SE cross sectional geological and hydrogeological data [NRX/14/12/Fig.4.2]. Rock core samples have been analysed to determine rock types and their properties and cross hole seismic tomography undertaken [NRX/14/13/Table A.6]. Hydrogeological testing has been undertaken to gain data on groundwater pressures and hydraulic conductivity of the rock including testing of fracture networks [idem/Table A.7 & 8, COR/517, COR/518 & COR/518A].

**6C.19** Regional surveys have included studies of the catchments of the Rivers Calder and Bleng extending to old mineworkings [COR/521/Figs.3.6 & 4.12]. Watercourses have been monitored and data collated from many old boreholes [NRX/14/13/Table A.2; NRX/5/1] and from information on water abstractions [COR/521, p.4-14] and water resource investigations over several years including aquifer pumping tests [COR/501, paras. 4.4.1-4.4.5]. The NRA have also supplied information on the quality of shallow groundwaters at a number of observation boreholes (all less than 150 metres depth) and a spring in the vicinity of the RCF [NRX/5/2]. Data on deeper groundwaters (200-1600 metres) have come from the Nirex drilling programme [COR/101].

**6C.20** Groundwater samples have been comprehensively analysed for their chemistry [NRX/14/13/Appendix 1, Section A.8.1 & Table A.9]. Of particular note are the isotope and inert gas studies, relevant to estimations of the residence time or 'age' of the groundwater [NRX/17/1 (extract from COR/525), 5.2], and the reduction-oxidation potential ('Eh' or 'redox' potential) of the groundwater, relevant for its control over chemical reactions within the water system and its effects on sorption.

**6C.21** The presence of drilling fluids in borehole water samples inhibits reliable determination of the Eh in the laboratory although the use of chemical tracers in the drilling fluids has allowed some correction to be made for contamination. Noble gases (neon, argon, krypton & xenon), indicating the climatic and/or altitude effects at the time of recharge, have been sampled, measured and plotted [COR/518, Drgs.010180-010195]. Helium ('He)



abundances, produced in the rocks through the radioactive decay of naturally occurring uranium and thorium minerals, have been determined for borehole water samples [COR/518, drgs.010180-010191; NRX/17/1, paras 5.7 & 5.10]. Water salinity and density measurement has been carried out in order to identify and characterise the Saline Transition Zone (STZ) in the Sellafield area and assess its implications for groundwater flow.

6C.22 Safety Assessment Research work has included the development of NRVB [COR/529], preliminary design of DWR storage vaults and packaging [idem], modelling [COR/528, COR/529 & COR/522] and elements of the preliminary PCSA, "Nirex 95" [COR/522 (1995)]. These studies involve prediction of climate states, landform evolution, radionuclide transport, uptake by plants, identification of local communities and critical groups and a wide range of models [COR/526 (1994) & COR/527 (1994)].

6C.23 Conceptual and numerical models have been extensively used in Nirex's evaluation of post-closure safety performance (see Chapter 6D). This has involved application to biosphere assessment, chemical processes, geological structure and hydrogeology facilitating the preliminary analysis of the groundwater pathway for a DWR at Sellafield [COR/522]. Considerable quantities of field and laboratory monitoring and test data are required in order to develop models and validation of the models requires additional independent field and experimental data against which model predictions can be systematically compared.

6C.24 Research on radionuclide transport includes investigation into radiolytic reactions due to irradiation of water [COR/528, p.12]; slow recrystallisation and other ageing processes affecting the retardation or immobilising performance of NRVB [COR/528, s.3.2.2(b) & COR/529, p.19]; solubility and reactions of radioelements at high alkalinity [COR/529, s.3.2]; the process of colloid formation and stability and their effects [COR/528, s.3.2.3]; and effects of gas generation and migration of  $^{14}\text{C}$  in methane and of gas-water interactions [idem & COR/509, s.3.3, p.16].

6C.25 Biosphere Research databases are large and the existence of well-established values for many parameters means that fixed parameters have to date been used in the biosphere part of PCPA calculations rather than sampling from Probability Density (or Distribution) Functions (PDFs) mentioned further below [COR/605, s.9.2], however, work is progressing to refine and validate these modelling inputs.

6C.26 Local earthquake data have been intensively researched and documented by Nirex from historical records together with data from studies of mineralogy, stratigraphy and structural geology. A continuous flow of new data is coming from Nirex's ongoing instrumental monitoring; from the network of seismographs in Britain and NW Europe; and from the BGS Cumbrian Microseismic Network capable of recording very small events within a radius of about 60 km of Sellafield [NRX/14/13, Appendix 1, s.A.11].

6C.27 Future climate states and land form evolution studies [COR/527, s.2 & 3] have resulted in the formulation of 4 representative conditions for the purposes of the preliminary PCPA involving either terrestrial or marine discharge from the DWR over a period of  $10^8$  years as sea levels change [COR/522, Vol.3, s.6.36. & Figs. 6.6-6.18]. These studies cover such effects as glaciation and global warming and the predicted consequences for changes in topography, climate, and patterns of human and animal habitability and alternative scenarios

are being worked up [COR/527, p.23]. A fifth (Mediterranean) state is predicted as possible in the event of global warming. Of particular note is the predicted scenario where Sellafield is occupied by a self-sufficient subsistence community under Boreal and Temperate conditions [idem, s.5].

### International Co-operation

6C.28 Nirex plays a leading part in international research into aspects of radioactive waste disposal of which climate change is an example [COR/527, Box 6]. The work falls into 2 broad categories: firstly, practical investigations, mainly underground, predominantly in generic rock laboratories or mine-like excavations, with development of logging, sampling, in situ testing together with associated mathematical modelling; and, secondly, laboratory based and surface experimental work and testing, much of it related to fundamental chemistry, geochemistry and hydrochemistry.

6C.29 Nirex is a participant and financial partner in several of the principal international underground research facilities. It participated in the 13 year Stripa Project in Sweden in which useful experiments were performed in a disused iron ore mine to develop techniques for investigating deep crystalline rock and to study engineering means of enhancing the post-closure safety of deep repositories. The principal achievements at Stripa have been to provide experience for new methods, characterisation strategies, modelling and data on rock properties that could be applied to further rock laboratory work [FOE/6/15, Ps.29 last para.& GNP/4/10, s.3.1].

6C.30 It is closely involved in the ongoing Äspö Hard Rock Laboratory, Sweden, and in the underground rock laboratories (URL) at Grimsel, Switzerland and Lac du Bonnet, Canada, all in saturated fractured granites. Experiments at Äspö include comparison of rock disturbance produced by tunnel boring with that by drilling and blasting; characterisation of the zone of excavation disturbance (ZEDEX); performing multiple well tracer tests (MWT); and investigating the effect of air on the geochemistry of the surrounding rock [COR/605, s.4.3.1-4.3.4].

6C.31 International projects promoted by the EU include a general programme on migration of radionuclides through the geosphere (MIRAGE); specific research on basic validation of geochemical codes (CHEMVAL) and on colloids and complexes (CoCo); a project on gas generation and migration from underground storage facilities (PEGASUS) [COR/605, s.4.2.3 & COR/529, pp.62, 64 & 66]. DECOVALEX is an important collaborative project to develop coupled thermo-hydro-mechanical (THM) models [COR/605, s.8.2.5].

6C.32 A number of international collaborative studies have been funded by Nirex and their Swiss and Swedish counterparts (Nagra & SKB) on natural analogues, that is to say occurrences of materials or processes which resemble those expected in a proposed geological waste repository and which can be studied to give useful indications of the possible properties and behaviour of parts of the disposal system over long timescales. These include, for example the Oklo uranium deposit of Gabon [mentioned in 6A.46 above], and the highly alkaline groundwater system at Maqarin in Jordan which is in near equilibrium with naturally occurring cementitious minerals at a Ph of about 12.5, comparable to that planned for the

Sellafield repository [COR/529, pp.62 & 65]. HMIP has helped with some funding of international programmes [GOV/630].

### **Data Availability & Elicitation**

6C.33 Data elicitation is achieved by the formal application of expert judgement to arrive at quantitative input parameters for use in repository performance assessments and in preliminary numerical models [COR/529, section 7]. Safety assessment parameters whose values are uncertain are expressed as PDFs rather than individual fixed values. The PDFs are then sampled randomly in, for example, the MASCOT computer analysis.

6C.34 Some parameters relating to the physical properties of the geology are derived from measurements & others by elicitation [COR/522, v.1 tables 5.1-5.19]. There are up to 14 parameters expressed as PDFs for each of the geological units used in the Nirex 95 groundwater flow modelling. Fracture orientation was characterised by field data and elicitation of PDFs was used for parameters such as fracture spacing, fracture length and channelling fraction, taking account of borehole observations and outcrop studies. However, fracture transmissivities were derived by requiring models to be consistent with field (environmental pressure) data [idem, v.1, p.5.4, 1st & 2nd paras.].

6C.35 In the near-field, formal elicitation was undertaken to derive PDFs for parameters used in source term calculations such as solubility limit (in the repository pore water) and sorption distribution ratio (in relation to repository materials) of several elements [COR/529, s.3.3 & s.7.2], including the solubility of key radionuclides [idem, s.3.2.1 & Box 13].

### **Transparency, Quality & Peer Review**

6C.36 Nirex has published over 500 scientific reports and papers and has made many more available for reference after application of its quality assurance process [eg those listed in NRX/12/7]. Many of the reports which Nirex has submitted to the inquiry [Appendix 3 - COR/500 series; FOE/5/19] were not published until 1995.

6C.37 Nirex has used a selected group of experts as a Review Panel to periodically review selected parts of their work prior to publication, advise on strategy and approach for geological characterisation of Sellafield as an input to the PCSA and to provide ad hoc specialist advice [COR/516, para.1.2]. The RWMAC has maintained surveillance of progress of DWR development, as part of its terms of reference to advise the Secretaries of State [GOV/407/Annex 1], issuing a series of Annual and Special Reports [GOV/401-415]. The Royal Society responded to Nirex's invitation in 1993 to review the scientific aspects of assessing the likely long-term performance of a DWR, focusing upon work at Sellafield, in its 1994 Report [COR/605].

6C.38 The **RWMAC** recommended independent peer review of the safety case as a standard practice in 1989 [GOV/402, para. 2.26] and has maintained that view [GOV/407, para 4.22]. It regards the field work and interpretation of site data being carried out by Nirex and its contractors as being of the highest quality [GOV/407, para.4.6]. The RWMAC (May) 1995 Annual Report suggests that attention be paid, inter alia, to the time necessary for establishment of base hydrogeological conditions, the monitoring of microseismic activity,

natural gases, and thermal regime [idem, para.4.12]. It emphasises issues highlighted by the Royal Society which the RWMAC have also raised such as the complexity of the hydrogeological conditions at Sellafield, the limitations of the groundwater modelling programme, the important role of groundwater geochemistry, gas generation and the significance of chemical containment within the multi-barrier approach [idem, para.4.22]. These matters were aired in the RWMAC 1994 Report [GOV/406, Chapter 3] where it noted indications that upward groundwater flow takes place in the PRZ and concluded that inconsistencies between computer-based modelling and observed groundwater flow systems need removal. Also, it considered that a very significant amount of work needed to be done before the state of knowledge of the Sellafield area could be sufficient to provide a confident basis for a PCSA [idem, paras.3.34 - 3.36].

6C.39 In its 1994 Report [COR/605], The Royal Society identified 3 concurrent operations in preparing for the DWR at Sellafield, namely:

- a. characterising the site to establish relevant geological, geochemical and hydrogeological features;
- b. developing appropriate engineering designs for the DWR;
- c. undertaking studies to assess potential leakage of radionuclides from the DWR to the surface [idem, s.1.2, p.2].

6C.40 It pointed to the need for quantification of uncertainties and for elicitation. Key scientific issues it identified were groundwater flow, gas generation and migration, long-term evolution of geosphere and biosphere conditions including climate change, and chemical containment [idem, pp.3-5].

6C.41 The Royal Society expressed the widely held view that, although Nirex participates in underground research in other countries, none of the sites is very similar in geological setting to Sellafield [COR/605, s.4.4].

6C.42 Observing that much background information was becoming available, the Royal Society study group commented that Nirex had not yet published details of the assumptions, site specific models and input data used in the Sellafield PCPAs, nor of the actual results and sensitivity analyses. In consequence it was unable to judge the adequacy of Nirex's synthesis and use of research and site characterisation findings, or to appreciate fully the importance of any scientific issue to the PCPA. [COR/605, s.5.9].

6C.43 On elicitation, the Royal Society noted that because the number of sorption distribution ratio (Rd) values required is large (at least one for each radionuclide and geological unit, making over 100 in all), Nirex have tended to elicit PDFs of Rd values only for some radionuclides and units, and derive the remainder directly by judgements from one or two scientists [COR/605, s.8.4.1].

6C.44 It foresaw the possibility of programme set back if research and assessment at Sellafield does not provide for early exposure to peer review.

6C.45 In relation to technical and scientific achievement, the Royal Society observed that contamination had been reduced to less than 1% in a significant, and increasing, proportion of borehole water samples, which demonstrated the capability of Nirex to obtain high quality samples from existing boreholes [COR/605, p.105]. However, the Report noted that there were no adequate models for 2-phase gas/water movement in fractured rock; no definition of scenarios for future evolution of conditions in and around the DWR; and a lack of truly quantitative predictions of the behaviour of chemical containment [idem, pp.3-5]. It points out that much of the science is new [idem, s.1.6, p.6].

6C.46 The Royal Society comments on solubility and reactions at high Ph that "the design of the near-field, with its high Ph and complex metastable mineralogy poses an extremely difficult problem for the chemist. The thermodynamic properties of many of the phases present are not well known and little information is available for surface properties or reaction kinetics. This means that an experimental approach must be adopted and the number of experiments needed to describe behaviour adequately will be large. Many such experiments have already been undertaken by Nirex and other groups internationally, and these programmes are on-going" [COR/605, p.121, foot of left column].

6C.47 The Royal Society study group noted that the mainland of the UK is not close to an active crustal plate boundary and the historical record is very short in relation to the PCSA timescale for a DWR. It observed that, although only moderate to small earthquakes have been recorded over the last few hundred years, this may not always be the case [COR/605, para.10.1.2].

6C.48 In 1994, the Nirex Review Panel was involved with technical reviews and workshops on geochemistry, hydrogeology conceptual model development, fracture characterisation, validation strategy, RCF structural geology, RCF3 pump test design and assessment modelling [COR/516/Appendix B]. This was supported by visits to Sellafield and site facilities [idem/Appendix C]. It regards much of Nirex's work as being at the leading edge of science [idem/Appendix C, para.4 & Appendix D, para.2.3]. The Panel recommended that the Nirex strategic programme and the results of the scientific work should be subjected to peer review [idem/Appendix D, paras.2.2, 3.3, 5.4 & 5.9]. Ad hoc advice was given through an open approach between Nirex staff and Panel members [idem, para.2.10]. Key issues were identified as being future climate change and changes to the geosphere with seismic risks and earthquakes being of importance though not a major issue regarding safety performance [idem, paras.3.5-3.7].

6C.49 The Panel identified a number of activities which it considered should be included within the forward programme of work. These included correlation between flowing fractures and mineralisation episodes; incorporation of key aspects of structural geology into hydrogeological studies; relating behaviour of smaller scale features into the large scale geological structure; Quaternary, earthquake and seismic studies; improvement in hydrogeological modelling to accurately reproduce the observed salinity distribution and incorporate temperature effects, and scaling effects related to the conductivity of the sandstones and the BVG [COR/516/Appendix D, paras.5.1-5.11]. For 1995, the Panel sought specialist expertise in modelling, early information on the results of studies on <sup>36</sup>Cl, thermodynamic geochemistry and Quaternary strategy, and improved communication with the wider scientific community.

## **Current Understanding of Scientific and Technical Issues**

**6C.50** Areas of uncertainty still to be addressed with the help of the RCF are groundwater flow & radionuclide transport; natural & induced changes to the geological barrier; and DWR design & construction. Key uncertainties are BVG fracture network flows, the properties of flow channels, rock matrix diffusion, colloid transport & gas migration; and the validation of the stability of the hydrogeological system over extended timescales, plus the effects of both excavation and chemical disturbance. Also identification of geological and hydrogeological features would enable the depth, location, layout and orientation of the DWR vaults to be refined. Sealing experiments in the RCF would assist in satisfying post-closure safety requirements for the DWR and perturbation effects require to be assessed.

**6C.51** Groundwater monitoring has yielded evidence of gravitational, barometric, seasonal and synoptic effects and to support climatic and tectonic effects in the longer term [NRX/14/13/Appendix 2, pp.B5 & B6].

**6C.52** The STZ represents the boundary between the fresh waters of the Coastal Plain Regime, present in the shallower strata, and either, the deeper saline waters of the Hills & Basement Regime inland, or the hypersaline (brine) groundwaters of the Irish Sea Regime present below the sea and at depth below the coastal plain [COR/507, S.2, Figs.1 & 2]. Since the PRZ is located in the Hills & Basement zone the nature of the contact between the freshwater and the saline waters in that area is of most interest. It is common ground that there are relatively rapid flows in the Sherwood Sandstones.

**6C.53** Nirex's most recent flow zone characterisation of the RCF area concludes [COR/523, s.7] that flow zones are not associated with a single, consistent geological signature in the boreholes studied, the strongest observations being that flow zones in the Sherwood Sandstone Group are largely matrix flow with some contribution from bedding-plane fractures. In the Brockram flow zones are associated with either matrix or fracture flow, and in the BVG they are discontinuity dominated, mostly associated with "vuggy veins" or part mineralised fractures. Overall there is a wide variation of orientations observed with a SW dipping tendency in the Sherwood Sandstones and a NE dipping bias in the BVG.

**6C.54** Flow zones tend to be associated with distinctive discontinuity characteristics compared with those above and below. In the BVG generally, 20% of the flow zones seem to occur within fault rock and 47% within 5 m of a fault [idem, s.4.18]. However, in deviated boreholes (RCF2 & RCM3) it was found that a far greater (90%) association of flow zones to faults exist in the BVG compared with the 9 boreholes as a whole [idem, s.4.19]. In the BVG fracture flow is thus dominant but a broad relationship between flow zones and ME6 mineralisation is apparent. However, not all mineralisation is associated with flow. Although flow zones are associated with proximity to faults, there is a more variable association between faults and ME6 mineralisation leading to a clustering of mineralisation. A strong relationship was found between flow zones and ME9 late calcite mineralisation, post-dating all observed fault structures observed in borehole cores. The calcite morphology seems to be related to salinity of groundwater. These features suggest to Nirex a conceptual model in which flow in the BVG is related more to the larger-scale distribution of ME6 within the rock mass, rather than type, orientation or intensity of individual candidate flow features.

6C.55 Of the 42% of flowing features in the BVG, 74% are within the Fleming Hall Formation, an association most marked in Borehole RCF3 [idem, para.5.6]. However, flowing zones in Boreholes RCM1 and RCM2 were found predominantly in the Brown Bank Formation in Borehole 2, notably concentrated in the Broom Farm Formation [see COR/518, Vol.2, Drgs.010147-9, left & central columns]. As the relationships are not ubiquitous, Nirex considers it likely that partial correlations exist between many factors rather than that there are any full and consistent correlations. Nirex also considers that the apparent linear relationship between flow zone transmissivities and measured depth requires further investigation.

6C.56 The deep groundwaters in the PRZ appear to contain no significant tritium (hydrogen isotope  $^3\text{H}$ ) and therefore cannot contain any modern (post 1953) water [NRX/17/1, 5.4]. Interpretation of the content of deuterium (hydrogen isotope  $^2\text{H}$ ) and heavy oxygen ( $^{18}\text{O}$ ) is in contention, as is the data on noble gases,  $^{36}\text{Cl}$  and  $^4\text{He}$ , but it is common ground that all the groundwater in the strata relevant to the Sellafield project, in each of the three groundwater regimes, had a meteoric origin because it originally fell as rain or snow. However the stable isotope ratios for groundwater in the deep BVG of the PRZ are lighter than present day rainfall and lighter than water in the overlying sandstones which could indicate a cold temperature of precipitation at the time the water entered ('recharged') the ground. On the other hand, the highly saline groundwaters of the Irish Sea Basin regime have relatively heavy stable isotope signatures, in some instances heavier than modern meteoric groundwater. It is generally accepted that the basinal brine component must be of great age, and probably dates from well prior to the Pleistocene glacial epoch. [NRX/17/1, para.5.8]

6C.57 It is common ground that analyses of borehole water samples are subject to significant uncertainty due to contamination by drilling fluids and other sampling difficulties. However, the samples with least contamination appear to contain no modern carbon,  $^{14}\text{C}$ , other than can be accounted for by traces of drilling fluid. If uncontaminated samples can be shown to contain no  $^{14}\text{C}$  then the groundwater in the PRZ basement must more than 30,000 years old [NRX/17/1, 5.5].

6C.58 **Potential of Natural Geosphere Barrier.** It is common ground that the host rock is complex.

6C.59 Nirex has been carrying out a range of experimentation both at standard laboratory temperatures and at the maximum anticipated repository temperature of  $80^\circ\text{C}$ , into changes in groundwater chemistry, radionuclide solubility and sorption, degradation of organic wastes and metal corrosion. Microbes are expected to survive the period of elevated temperatures and may continue to break down the wastes. Provision for the dispersal of gas arising from accelerated corrosion reactions may need to be considered in more detail [COR/528, p.8 Box B]. However, leaving aside local variations and solubility and reactivity of radionuclides where there is some uncertainty, the general chemical composition and patterns of groundwater are now understood [COR/529] subject to sampling difficulties already mentioned above. This area of experimentation is acknowledged to be difficult and is carried out mainly in the laboratory simulating predicted DWR conditions such as ageing, extrapolated timescales and interpolating results from crushed rock to represent true rock surfaces. Similarly, uncertainties exist in scaling up laboratory results to determine diffusion

coefficients of dissolved radionuclides and the accessible porosity of PRZ rocks for field conditions.

**6C.60 Chemical and Engineered Barriers.** [COR/528 & 529] Interactions of the wastes with the chemical barrier of the NRVB would be complex but, once the integrity of the containers is breached, the alkaline conditions of the NRVB should dominate. Soluble complexing agents produced by degradation of organic materials in the waste can enhance the solubility and reduce sorption of some radionuclides, notably plutonium. The prospective repository waste contains paper, wood and similar cellulosic matter, plus plastics, rubber, resins and other organic wastes which would produce organic degradation products. Such breakdown would also liberate large volumes of gas. A significant programme of research has been started, particularly into cellulose degradation and its effects, and into plutonium solubility and complexation with organic compounds [COR/529, s.4.2.1]. Nirex have been concentrating on what it regards as key compounds and fractions and expects future research to focus on achieving a better understanding of the underlying mechanisms [idem, p.76, (iii)]. HMIP has commissioned its own research into the presence of organic acids in natural groundwaters and the effect of organic compounds in the transport of metals [HMP/1/2]. The physical and chemical characteristics of NRVB require more experimentation. On chemical behaviour, the interrelationship between solubility and sorption behaviour of some of the residual radionuclides and Eh/pH values [COR/529, p.5 Box 2 in brief; COR/528, sections 3.1.1-3.1.3 in more detail] is a novel area with few data previously available at such high pH values since these are very rarely encountered in the natural environment [COR/605, s.7.2].

**6C.61 Sealing and grouting experiments** have been undertaken as collaborative international URL projects in Canada [FOE/6/29 & FOE/6/30] and in Sweden (Stripa) [FOE/7/20]. However, it is necessary to verify results from generic work in the intended host rocks under conditions comparable with that of the DWR. It is accepted that requirements for repository sealing go beyond standard civil engineering and mining practice. Possible deterioration of seals and sealing materials has not yet been addressed.

**6C.62 Gas Generation and Migration.** Corrosion and decomposition of the waste and containers in the repository will generate substantial quantities of gas, equivalent to many times the volume of the repository. This will be principally hydrogen, carbon dioxide, methane and perhaps hydrogen sulphide, a very small proportion of which is radioactive. [COR/509, section 2] The gas must be released, otherwise the resulting pressure build-up could generate cracks in the repository and surrounding rock which would provide additional groundwater flowpaths. Even in the absence of rock fracturing, gas pressures might speed the movement of contaminated groundwater from the repository. NRVB has been designed to permit the escape of gas and there is an engineered gas vent in some designs of waste container. The surrounding rocks need to be sufficiently gas-permeable to permit its controlled escape but not such that gas could reach the surface in flammable or radiologically hazardous concentrations.

**6C.63 Potential Excavation Disturbance.** A knowledge of the geotechnical properties of the rocks and superficial strata is necessary to assess the ease or difficulty of construction of the shafts and galleries of the RCF and potential repository, their optimum orientation and layout for stability and the effects on groundwater flow and geochemistry. Nirex's



geotechnical studies to date [NRX/14/13, Table A.13], include core testing supplemented by geophysical logging [idem, Table A.4, p.A.21 & COR/518, v.2, drgs 010156 to 010177]. In addition to measurements specific to the Sellafield area, for example measurement of in situ rock stresses, Nirex has made comparison with excavation disturbance measured in mined openings elsewhere, as at the Canadian URL and Stripa [eg. FOE/6/29-31].

6C.64 Uncertainty remains as to scaling up from borehole samples to full size repository vaults and whether the BVG will behave in a similar manner to rocks from other sites.

6C.65 **Physical and Chemical Properties of Individual Radionuclides.** Colloids are taken, in the context of the RCF and DWR, to be mostly extremely fine particles, organic or inorganic, dispersed in aqueous fluid (repository porewater or groundwater) that cannot readily be filtered out like ordinary suspensions [see COR/529, p.39 Box 19]. It is possible that radioactive materials in the waste may form colloidal particles or be sorbed onto other colloidal material and then be transported away by flowing water, particularly by fissure flow in the BVG. Field experimentation is prone to difficulties of achieving uncontaminated groundwater sampling at depth [GOV/630, p.247 1st para.] including during RCF drilling.

6C.66 **Climate & Tectonics.** Nirex's main approach has been of studying past geological and climatic events as a guide to future evolution to investigate whether such effects could adversely affect the DWR over the required period of limitation of risk. Nirex continue to investigate the shallower (Quaternary) deposits for evidence of geologically recent earth movements using pits, boreholes and geophysical methods [NRX/14/12, Table 6.3]. A few possible sites in the onshore district of faults that cut both the bedrock and the Quaternary deposits have been identified for further study.

*[Reporting of cases begins on next page]*

## **The Cases of the Participants**

6C.67 In its draft guidance, **HMIP** sets out technical information supply requirements [HMP/1/1, Chapters 7 & 8]. Of particular note are the contingency for an adverse interpretation of an element of the disposal system taken in isolation [idem, para.7.3]; the need for adequate characterisation, understanding and analytical capability of the geological environment, including the potential for seismic events [idem, para.7.6]; the requirement for the limitation of migration of radionuclides by the physico-chemical and geochemical characteristics of the geological environment combined with construction materials of the facility [idem, para.7.7]; the separation from geological media of less suitable characteristics [idem, para.7.11]; implementation of methods of construction of a DWR to avoid undue disturbance of the geological environment and containment properties of the host rock [idem, para.7.12]; demonstration that a criticality incident is not a significant concern [idem, para.7.18]; undertaking monitoring during the investigation and pre-construction phases, without compromising the long term safety of the facility, to provide a baseline for monitoring in later phases - the developer should show that the changes in and evolution of the monitored parameters are consistent with the safety case [idem, paras.7.21-23].

6C.68 In supply of information, treatment of uncertainty would entail maintenance of a detailed audit trail and modelling studies should include continuing peer review [idem, paras.8.17 & 8.19].

6C.69 Nirex would decide when it had collected sufficient data to support the development of a safety case [COR/120, para.4.4]. However the quality assurance regime should meet a national or international quality assurance standard and enable data to be traceable back to source [idem, para.4.7]. HMIP confirms the value of experimental studies in URLs in improving understanding and provision of geotechnical and engineering data for DWR design [idem,para.4.11].

6C.70 HMIP says that Nirex would have to provide a scientifically and technically robust interpretation of the geological and hydrogeological conditions at the site taking account of uncertainties arising from an incomplete knowledge of the full system and its future evolution [idem, para.4.10]. The construction of the RCF would alter the hydrogeological and hydrochemical regime of the site so these effects and consequences must be demonstrated prior to the construction of an RCF [COR/120, paras.4.10, 4.16 & 5.5].

6C.71 HMIP regards the PRZ as having a complex geological structure and the PCSA as relying heavily upon geological and hydrogeological data [idem, para.4.8] and a sound understanding of its behaviour, especially on a regional scale [idem, para.4.9]. This extends from the recharge of the groundwater which passes through the PRZ to its discharge point downstream, likely to be measured in some tens of kilometres from the DWR. HMIP sees a need to reduce uncertainties about the physical and chemical processes which might influence the migration of radionuclides through the geosphere. It has in mind examination of fracture networks, rock permeability and fracture conductivity; experiments on excavation damage, chemical tracer tests, gas migration and colloidal transport [COR/120, para.4.13], on which HMIP commissioned its own research [listed in HMP/1/2]; and gaining a better understanding of the capabilities and limitations of models [idem, para.4.15]. Oxides or metal particles may be transported as well as colloids.

6C.72 Nirex considers that its scientific and technical programmes have yielded sufficient quality and quantity of material through research and investigation to demonstrate that the PRZ holds good promise to host a DWR and has reached the point where an RCF is necessary. It regards comparisons made by FOE and Greenpeace with practices in the oil industry in terms of timescale and approach as misplaced albeit relevant technical experience and expertise is of course used. Nirex's investigative programme is longer in duration to those cited by Greenpeace for the oil industry. It refutes the claim by FOE that the scientific information gained so far, and referred to below, is not "best possible" citing in support the praise given by RWMAC, the Royal Society and from some witnesses for the objectors for the quality of information arising from the programme and the extensive experience of their main contractors. The Nirex 95 PCPA report [COR/522] and supporting documents address the issues raised by the Royal Society Report [COR/605]. Much new information has been brought forward since the publication of the report.

6C.73 International Co-operation. Although there is no substitute for actual testing in an RCF, Nirex regards the results of international research as considerably valuable in generic terms with the Swedish and Canadian rock laboratories having the greatest application to Sellafield. Because the RCF is intended to be site-specific and not a generic facility comparable with a URL there is not proposed to be international co-funding and setting of joint objectives in the project but the same international expertise will be used to devise the science programme.

6C.74 Data Availability & Elicitation. Nirex stresses the importance of a methodical, structured process within a meeting of a group of experts to arrive at a defensible output when dealing with uncertainties in field data and contrasts it with the erratic assessments frequently made by individuals. Formal elicitation has been used to derive data to cover the 21 elements considered to be of greatest interest to PCPAs performed to date [COR/529, p.69]. Within each 'element' there may be many PDFs requiring to be defined. It does not accept that a complete understanding of all processes is essential to assessing system performance but that uncertainty is either dealt with explicitly, within a range of models, or through the use of appropriate parameter distributions in a probabilistic assessment. More data would not necessarily improve modelled predictions in its view.

6C.75 Transparency, Quality & Peer Review. Nirex describes their science programme as being founded on the principles of having a knowledgeable and experienced management team and interdisciplinary teams of specialists; thorough quality assurance procedures; and independent peer review and challenge. Proper independent peer review of all work critical to radiological safety, as required by BS 5882, is carried out by Nirex staff, by contractors, by consultants not engaged on the programme, the Nirex Review Panel, and by publication of reports articles and conference papers. It invited the Royal Society to make its 1994 report. The quality of its work has been widely recognised, for example by the Royal Society [COR/605, Ss.1.9 & 6.8] and RWMAC [GOV/406,para.3.10 & GOV/407, para.4.6]. Nirex regards information made available to the scientific and local communities as being important in promoting public understanding and confidence but complementary to, and not part of, the peer review process required for a nuclear safety case to satisfy the regulators. Nevertheless, noting the Government's wish for transparency of decision making [GOV/208, para.110], a biennial Project Review would be produced in future [NRX/12/6];

and it has been decided to supplement this with daily or weekly releases of site investigation data.

6C.76 Groundwater. Nirex believes that a high level of understanding of the groundwater conditions at Sellafield has been achieved and the favourable prognosis of the site conditions it made in 1989 has been confirmed. It describes the amount of data obtained so far as vast and sees the question of sufficiency of information as being the essential difference between it and objectors.

6C.77 On groundwater monitoring, Nirex points to its own programme of boreholes plus 16 boreholes in the Triassic sandstones and superficial drift deposits with data from 1974 and at least 17 boreholes in the drift with more than 9 years of data. Some data is in excess of 20 years duration. It feels it will be able to distinguish RCF construction from other effects with confidence including using the information to test and develop models of the site and to interpret the properties of the PRZ within the context of regional groundwater flow and hydrochemical models from the database on undisturbed conditions [NRX/14/13/Appendix 2]. It believes that the borehole programme at Sellafield compares favourably with the larger schemes mentioned by FOE.

6C.78 A further 4 to 5 years of relatively stable or predictable environmental heads and geochemistry proposed by FOE is unrealistic and inappropriate in its view particularly bearing in mind that monitoring is continuing. Similarly, it refutes Cumbria and FOE suggestions that boreholes additional to those planned [NRX/14/12/Table 6.3] are required because confidence in the PCSA would not be enhanced. There is therefore no technical objective to increase them further. Observed settle-down effects in several boreholes up to October 1995 indicate that baseline conditions have been established [NRX/14/13/ Appendix 2, para.B2.16]. Nirex points out that RWMAC thought that 18 months was likely to be sufficient time [GOV/408, para.19, GOV/414, para.14] and its own independent expert concluded that a comprehensive baseline pressure head distribution had been obtained [NRX/14/3]. More 3-D seismic surveying may be carried out if the information is necessary and not obtainable from the RCF.

6C.79 It regards the chemical characteristics of the groundwater conditions as being sufficiently well defined and understood to facilitate monitoring and interpretation of RCF perturbation during construction, particularly bearing in mind that a further 2 years results would be available from October 1995 before RCF construction could begin. Information on geochemical conditions is "fit for the purpose" in Nirex's view although Eh and Ph cannot be definitively measured from the surface. Sampling has progressed as far as possible without an RCF and the data have been deemed to be of high quality by The Royal Society Study Group. It has not been necessary to modify the conceptual model of hydrochemical conditions in the light of new data. The BVG groundwater is considered by Nirex to be in a reducing state, buffered (controlled) by a combination of pyrite ( $\text{FeS}_2$ ) and haematite ( $\text{Fe}_2\text{O}_3$ ) and dissolved sulphate at a value of about -230mV [COR/525, paras. 6.7-6.9, p.33]. Pyrite remains stable under these conditions, as does haematite, but, unlike haematite, pyrite is likely to lose its stability under oxidising conditions [NRX/15/43/Fig.7.1]. It points out that it is the presence of a mineral that is important in establishing in situ geochemical equilibria and not the amount. Furthermore, redox conditions in the near-field would be controlled by the components of the engineered structure. Also, geochemical modelling has

shown that such conditions are not dependent on the redox condition of the inflowing groundwaters with redox potentials within the realistic range of +400 mV and -400 mV [NRX/15/10, p.19].

6C.80 Nirex identifies 3 regional regimes, namely the Hills and Basement, Coastal Plain and Irish Sea Basin Brines. It suggests a relatively simple pattern inland of the Irish Sea Basin Brines regime and claims that the Saline Transition Zone is relatively sharp, particularly in the PRZ where it is said to be within the lower permeability North Head Member of the St Bees Sandstone. It does not accept that upward flow can necessarily be inferred from the STZ when the PRZ STZ dataset is viewed in the context of the larger dataset and prevailing hydraulic conditions. Although salinity is a key indicator of the 3 different groundwater regimes, the regimes are not defined simply on the basis of salinity but with the support of a range of independent data sets.

6C.81 On an expanded site scale Nirex also recognises 3 layers in the groundwater system from monitoring environmental heads. It concludes that there is an upward though predominantly shallow coastward flow of freshwater in the SSG in and west of the PRZ; a zone in the upper part of the BVG, in the Brockram or the lower part of the SSG with little, if any, vertical gradient; and a deeper zone in the BVG with upward head gradients [NRX/14/12/Fig.6.8].

6C.82 Recharge conditions for BVG groundwaters in the PRZ were colder in Nirex's view than for the fresher waters in the sandstones, and this indicates recharge of the PRZ basement rocks under colder climatic conditions during the Pleistocene, sometime between 1.6 million and 10,000 years before the present, when the climate was predominantly glacial, periglacial or boreal. [NRX/17/1, para.5.3 & NRX/14/12/Table 6.2]. Whilst oxygen isotope ratios could be due to altitude differences, this would not explain the different ratios now recognised in different parts of the Triassic sandstones. This argument also applies to isotopically lighter groundwaters in the lower part of the Permo-Triassic sandstones west of the PRZ (at the base of the Coastal Plain flow regime) in Borehole 10A and perhaps also 11A [NRX/14/13/Fig.B.3.2] which are also interpreted as indicative of recharge more than 10,000 years ago. Groundwater studies of Triassic sandstone aquifers elsewhere in the UK show that lighter isotopic compositions can be specifically associated with the last glacial maximum advance about 18,000 years ago [NRX/17/1, para.5.9]. The noble gas ratios in the BVG of the PRZ are distinctly different from those in the overlying sandstones and support the interpretation of recharge in a glacial period.

6C.83 Nirex considers  $^{36}\text{Cl}$  to be a useful indicator of solute residence times because the high salinity of the groundwater means that contamination is not a significant concern. Naturally occurring common chlorine ( $^{35}\text{Cl}$ ) can be converted to  $^{36}\text{Cl}$  by neutrons from the surrounding rocks. There is a consistent  $^{36}\text{Cl}/\text{Cl}$  ratio of about  $22\text{-}28 \times 10^{-15}$  for the BVG water in Borehole 2 [COR/518, v.2, drg.010181], which is what would be expected for water in equilibrium with the *in situ* neutron flux in the BVG. To reach this equilibrium it is necessary for most of the chloride in the groundwater to have been resident in the BVG or host rock with similar high neutron flux for at least 1.5 million years [NRX/17/1, 5.6 & 5.11].

6C.84 By making assumptions, for example about the average abundance of uranium and thorium, rock porosity, and ignoring the possible migration of <sup>4</sup>He gas from deeper in the earth's crust, Nirex estimates that the water at great depth in Borehole 2 in the PRZ could have been resident for 1.3 million years and beyond the PRZ (in either hole 7A or 12A) for up to 1.6 million years [NRX/17/1, 5.7 & 5.10].

6C.85 Whilst it is possible that recharge may have taken place near ice sheet margins where meltwater under the ice may be forced under pressure into the underlying strata, it is only speculation that there was preferential and enhanced recharge of the BVG during glacial periods. The climate at the time of recharge did not have to be glacial, but merely colder than now, as was the case during most of the Pleistocene [see COR/527, p.22].

6C.86 Groundwater residence times have not been over-interpreted, but merely placed in context with each other to build confidence in overall conclusions despite uncertainties prevailing with any individual method. Greenpeace's suggestion that rates of sub-surface flows could be much more rapid in the future than any inferred today is again speculative. Furthermore, the contribution from joints far outweighs that from pores.

6C.87 Potential of Natural Geosphere Barrier. There is no evidence to suggest that the PRZ is located near an Ordovician caldera margin as suggested by FOE, and BVG deformation structures, although abundant, are generally healed and are not hydrogeologically significant. Particular complexity of the rock may add somewhat to the difficulties of characterisation but is being addressed thoroughly by focusing strongly on those features relevant to obtaining a sufficient understanding of the system and a capability to predict its behaviour. The state-of-the-art geostatical techniques using a stochastic description of the flow system built on a programme of some observations and experiments, are generally accepted as appropriate for evaluating flow and transport in heterogeneous systems. The degree of complexity at Sellafield is now sufficiently characterised, including Faults F1, F2, F3 and F202, to be likely to meet the regulatory safety requirements, as demonstrated by the preliminary PCPA [COR/522]. It is the safety assessment which is crucial to site acceptability, not geological or hydrogeological criteria which can be selectively identified and exaggerated. Nirex regards objectors' treatment of technical issues such as hydraulic conductivity of the BVG, interpretation of salinity profiles and patterns of groundwater flow as failing to appreciate this critical distinction.

6C.88 Based on results to date Nirex concludes that in the central part of the PRZ at least there is little connectivity between the BVG and the overlying sandstones and in the RCF South Shaft area hydraulic conductivity shows an apparent linear increase with depth. Head gradients at the site have been recognised for some time [COR/501, para.8.14.5] and have been examined in Nirex 95 [COR/522]. Lateral and upward components of flow are a natural part of the hydrological cycle and are only relevant when taken in the context of hydraulic conductivity in order to make estimates of groundwater flow. Low hydraulic conductivity in the BVG coupled with the potential for dilution in the overlying cover rocks leads to an acceptable performance of the site.

6C.89 When considering large-scale properties of rock, fractures are less significant in the case of a DWR than, say, for landfill sites with a liner. The treatment of hydraulic conductivity in the 2 types of installation is not comparable. For the DWR, fractures would

need to be well connected, with high hydraulic conductivity, to permit significant groundwater flow. Preliminary modelling of the results of the RCF3 Pump Test indicates a lower connectivity within the BVG than that predicted in Nirex 95 [COR/522], because it includes variation in fracture apertures within the Type II features not modelled in Nirex 95.

6C.90 Nirex regards criticisms of its geochemical modelling as being misplaced because the work was carried out some years ago [eg. FOE/8/51, abstract] and recent work is greatly improved in quality. For example, measured data specific to the host rocks are being used for PDFs and with solubility data. Furthermore, sorption is much less important than dilution and spreading effects. Validation of existing modelling work (see further Chapter 6D) is best treated by a programme of laboratory experiments and natural analogue studies integrated with in situ experimentation on, for example, colloid transport and alkaline plume/rock interactions.

6C.91 Chemical/Engineered Barriers. Nirex considers that it should be relatively easy to meet a shaft fill permeability criterion of  $10^{-12}/\text{m}^2$  and to return the hydraulic conductivities of openings to values equal to or less than those of the rock [FOE/7/20, p.199 mid. para].

6C.92 Slow ageing processes will cause long term transformation of amorphous hydrosilicate matrix minerals into crystalline minerals with probably reduced sorption potential, although in the very long term permanent sorption by 'mineralisation' might immobilise much of the remaining inventory of some long lived radionuclides, allowing them to decay in situ and giving much greater retardation than currently modelled. Rates of chemical reactions at  $80^{\circ}\text{C}$  would be speeded up but not to the significant detriment of overall repository containment properties.

6C.93 Gas Migration. Nirex participates in international work on gas migration through rock and its effects [COR/605, 8.2.6] and has been carrying out its own experimental programme at Reskajeage Quarry in Cornwall. It calculates that the risk of release of radioactive gases into the biosphere, principally  $^{14}\text{C}$ , is so small as to be of no concern.

6C.94 Simplified calculations on migration of  $^{14}\text{C}$  in methane, which Nirex believe are conservative, indicate an equivalent to annual risks to an individual of about  $10^{-7}$ . However, studies continue on the possible significance of gas-water interactions on radionuclide transport [COR/509, Sub-section 3.3, p.16] although Nirex claims that much of the required information is now available.

6C.95 Excavation Disturbance. Nirex considers it has been highly conservative in repository modelling by assuming that excavation disturbance could increase hydraulic conductivity parallel to the excavation walls by up to two orders of magnitude for a distance of up to twice the excavation diameter. The Canadian URL tunnel experiment [FOE/6/29, p.9], for example, showed that the increase in conductivity from excavation extended only 0.26 m into the rock wall [FOE/6/29, p.8]. Excavation for the RCF (Phase I) would adequately facilitate groundwater model validation of perturbation effects for the DWR in the light of experience in the ZEDEX project and contribute to the international DECOVALEX exercise. Nirex Report 560 [FOE/5/19] was simply a preliminary scoping study on RCF impacts. Furthermore, Nirex regards the permeability of the backfilled and sealed shafts as being so insignificant in relation to the scale of the DWR that it could safely be ignored in

the MASCOT modelling for Nirex 95 [COR/522] but would be checked by the regulators in due course.

6C.96 Individual Radionuclides. Nirex says that difficulties of defining uranium solubility and reconciling equilibrium relationships with thermodynamic data are not relevant to the low ionic concentrations of the groundwater in the BVG at Sellafield and that in considering the chemical behaviour of the near field system it is the actual experimental data replicating the anticipated conditions that are important. In any event it claims that more recent research now gives a good definition of U solubility at high pHs [COR/529, p.22 Fig.3].

6C.97 Nirex does not expect significant colloid populations in the natural groundwater and does not believe colloidal transport will be an important mechanism in practice at Sellafield. It expects the NRVB to produce many colloids but anticipates they will assist retention and sorption of radionuclides. It points out that any change to the proposed waste inventory, which was reduced in September 1995, would need to meet regulatory requirements.

6C.98 Climate & Tectonics. In relation to future glaciation, Nirex expects to be able to demonstrate that glacial flushing has not taken place in the past, by the utilisation of 3-D modelling if necessary.

6C.99 Nirex has been looking for evidence of seismic activity in the region in the form of earthquake-induced faulting or slumping of glacial deposits both onshore and in the Irish Sea Basin. It has investigated a number of such possible "neotectonic" features but at present considers all to have more reasonable alternative explanations. It believes that the last major episode of faulting in West Cumbria occurred over 100 million years ago, and there is an absence of evidence for significant perturbation of the site by seismic activity over the last 100,000 years or more.

6C.100 Nirex takes the view that the stress regime at seismogenic depth in the Sellafield area is not extensional but generally compressional or intermediate ("strike-slip") similar to the rest of Britain and NW Europe. It believes that ambiguous references in an HMIP report on tectonic hazards for UK nuclear waste repositories [GOV/613] have misled Greenpeace. The 1979 Carlisle (Longtown) and the 1993 Grange-over-Sands earthquakes were strike-slip, the latter with a small component of reverse movement. Their effects were minor and do not suggest any risk to a DWR in the PRZ as modelled through near-surface permeability changes in COR/522. Similarly, the historical record of British events [GOV/613/Appendix B] reveals limited effects, including Rampside which was not associated with ejection of deep groundwater but shallow liquefaction of beach sands. The examples quoted by Greenpeace of widespread seismically-induced groundwater changes [GNP/3/28/Figs.7.5 & 7.6] resulted from large earthquakes on normal faults in an extensional regime and are therefore no guide to potential effects at Sellafield in a compressional regime [GOV/613, Section 2.2]. In any event, the range of permeability assumed for near-surface strata in PDFs used in Nirex 95 modelling more than covers the enhanced transient values that might result from earthquakes.

6C.101 Moreover, earthquake activity in the UK is low and is not expected to have a significant effect on the physical stability of the site in terms of its potential to host a repository [GNP/3/27], a view supported by the Nirex Review Panel. Nevertheless, Nirex conducts earthquake and acoustic emission monitoring to supplement the accumulated



historical data and seeks access to the rock mass at depth to provide information on how the rock mass is evolving.

6C.102 Nirex says the sharp kink in the contours of estimated regional uplift [COR/517 v1, fig 6.2] is largely an artifact of the sparse data offshore, and also a feature of the method of estimating uplift based on dating using mineral fission tracks. It is not an indication of tectonic activity in relatively recent geological time as claimed by Greenpeace.

6C.103 Further Work. The planned surfaced based programme of further investigations [NRX/14/12/Table 6.3] mostly complements the work in the RCF. More boreholes are intended to obtain a better understanding of the saline interface and its influence on groundwater flow; of groundwater recharge conditions; of the significance of the Seascale Fault Zone; and for monitoring and DWR construction planning. Laboratory testing of rock and groundwater is, and will, continue together with earthquake and acoustic emission monitoring, 3-D seismic, electro-magnetic and other surveys to further understanding of conditions and models. This programme includes most of the recommendations made by objectors and can be scheduled to end before RCF development or work in parallel with it.

6C.104 Of the Opposing Parties, Cumbria points out that the long, costly and scientifically novel investigative programme prior to development of the DWR is consistent with international experience. The investigation is taking longer than expected and estimates have been dramatically wrong eg in 1989 the DWR inquiry was expected to take place in 1994 [NRX/12/1, p.7 News Release 6/12/89]. On the other hand, Nirex has now acquired so much information about the PRZ that its scientists are already claiming that comparisons with other sites are impossible.

6C.105 FOE do not regard Nirex's scientific information as the "best possible" as insufficient data has been gathered, baseline models are not available, perturbation effects cannot yet be assessed, validation and peer review of work have not been properly carried out.

6C.106 International Co-operation. Nirex accepts that the results of the generic underground experiments carried out in other countries are inadequate for a full characterisation of the rock volume under consideration at Sellafield and that there is no substitute for actual testing in an RCF. Unjustified inferences have been drawn from experience gained in relatively massive, uniform and fracture-free crystalline rocks in Canada and Sweden in FOE's view. They have similar reservations particularly at the Grimsel and Stripa Migration Experiments [NRX/15/35 & NRX/15/36] and work at Stripa about the applicability of the effects of mechanical disturbance or stress changes on hydraulic properties [FOE/7/31, NRX/16/11 & FOE/6/31]. Objectors express general concern at a lack of practical progress in generic experimentation in preparation for RCF development.

6C.107 Data Availability and Elicitation. FOE claims that undue reliance has had to be placed on the use of elicited data instead of measured data. For example, in the case of geochemistry Nirex has utilised non-conservative elicited data resulting in serious under-estimation of the doses that would arise from the DWR [FOE/8/27, pp.ii-iii]. Data inputs have been unreliable. Before 1995 the expert elicitation group failed to take into account

the different conductivity of the Brockram from the BVG in their modelling of groundwater. Data have been frequently "adjusted" to make theory and experiment agree and the basis for elicitation of geochemical data is inadequate because, for example, the experimental procedures used to generate data are based on a methodology of uncertain reliability [FOE/8/51, pp.20-21, para.5.5]. Furthermore, the expert group for Nirex 95 preliminary PCPA contains people very close to the project, only one chemist and no geochemist [COR/522/Vol.1, Table A1].

6C.108 Transparency, Quality & Peer Review. Nirex accepts that its experimental programme has not been subjected to rigorous peer review and **Greenpeace** points to the lack of an open independent review of the overall scientific strategy as being a particular failure. **The Rt Hon Dr J Cunningham MP** regards open, independent peer review of all scientific papers as appropriate. FOE draw attention to the recent Royal Society paper assessing recent developments in peer review [FOE/1/6] and contend that Nirex's process has been deficient in both its completeness and its independence.

6C.109 Groundwater. FOE assert that a much longer monitoring period is required before baseline hydrogeological conditions will have been established. This is based on experience at other important sites, notably Canada, where insufficient record of baseline climatic fluctuations has been reported [FOE/4/5]. Furthermore groundwater flow in the Sellafield regime discharges on the near offshore area, where there are no boreholes, and key data on groundwater recharge from infiltration are lacking, bringing into question Nirex's interpretation of the hydrogeology of the superficial cover and shallow bedrock conditions as well as the overall regime.

6C.110 FOE define baseline conditions as when relatively stable or predictable environmental heads and geochemistry have been observed over a period of 4 to 5 years at all existing and proposed monitoring points. This would allow identification of natural seasonal and annual fluctuations which may occur. They observe that boreholes in the PRZ continue to exhibit signs of perturbation and instability.

6C.111 Nirex's reliance on the active groundwater system in the overlying sandstones for dilution of the DWR porewater puts the potable water supply at risk [COR/522.Vol.3,Figs.2.7 & 2.12]. FOE point out that derogation of water resources was a matter of concern to the NRA. The FHFZ is within a few hundred metres of the PRZ [COR/518, drg.010067] and Nirex concedes that it may have the potential to operate as a pathway for upward flow [COR/522.Vol.3, Fig.2.6(b)] with a short groundwater return time of 4,000 years [COR/522, Vol.3, p.6.19]. Environmental head measurements, for example in BHs 5, 10C, 11A, 12A, 14A, RCM1 and RCM2, indicate the presence of a strong upward head gradient within the overlying cover rocks and in some sections of the BVG below the proposed DWR (eg BH 2, 4 and 5) where heads at depth are extremely high. The relatively low environmental heads at about 800 m bOD within the BVG at BH 2 and 4 and at 600 m bOD at BH 5 could be attributable to a hydraulic connection with the cover rocks [COR/518A, Drgs.010111-010113], a feature remarked on by RWMAC [GOV/405, para.4.20 & GOV/406, para.3.27], also pointed out by Cumbria and not challenged by Nirex. However, the RCF area also shows inconsistent environmental head profiles in the upper part of the BVG even in adjacent boreholes.

6C.112 FOE regard their hydrogeological concerns as being confirmed by recent testing. They interpret the Cross-Hole Hydraulic Testing as indicating marked connectivity in the upper 200 m of the BVG, immediately above the proposed DWR [COR/518, Vol.1, Drg. 010090]. The RCF3 Fracture Network Testing shows that there is occasional vertical connectivity within the BVG over distances of at least 100 m [idem, Drg. 010089] although in other sections of the BVG little flow and connectivity were observed. The RCF3 Pump Test [idem, Drg. 010092] and groundwater monitoring in the other deep boreholes [idem, Drgs. 010111-010131] reveal definite connections between the base of the St Bees Sandstone, the Brockram and the upper part of the BVG. This view is shared by Cumbria, which points out the connection between the North Head Member (lower part of the SSG), Brockram & the upper part of the BVG, and some correlation with Fault F2 [COR/524, para.7.29]. It regards the evidence of vertical connectivity between the SSG at the surface and the BVG at 750 m in the area of BH 2 as strong [COR/608].

6C.113 Nirex agrees that south and west of the PRZ the Saline Transition Zone is more diffuse than in the PRZ [COR/525, para.3.10]. Cumbria argues that the saline transition is more gradual across the SSG and Brockram into the BVG, and that this clearly suggests an upward flow from the BVG into the SSG. Nirex accepts that mixing between freshwater and brines is taking place over a significantly wider zone than is indicated by its narrow definition of the transition from brackish to saline.

6C.114 Nirex's conclusion that hydraulic conductivity of the BVG is low may be relatively correct from the standpoint of water supply flows but hydraulic testing reveals conductivities 2 orders of magnitude or more above the typical waste disposal permeability threshold of  $1 \times 10^{-9} \text{ms}^{-1}$ . Moreover, the RCF3 BVG pump test was unreliable and insufficiently extensive.

6C.115 Nirex concedes that hydrogeological modelling so far (Chapter 6D) has failed to account for some significant process or feature at great depth below the PRZ, which could be geothermal flux, which is probably affecting system performance. Cumbria submits that Nirex's variants to date demonstrate the great sensitivity of modelling to small changes in hydrogeological assumptions and elicitation, showing the importance of further work in this area.

6C.116 The conceptual model is simplistic in Cumbria's view. It does not account for the complex interrelationships between the various groundwater regimes and ignores the presence of high hydraulic heads at the base of the BVG, the northward hydraulic gradient in the Carboniferous Limestone and the fresher water which occurs within it, the isotopically younger recharge in the upper part of the BVG near borehole 10A and the freshwater/seawater interface along the coastline. FOE find the vertical section model and modelling of fracture flow inadequately validated. Predictions and field data do not match [NRX/15/16]. FOE also suggest that the regional 3-D hydrogeological model should be of a minimum of 10 km x 10 km, with perhaps more for boundary conditions, and faulting modelled to 10m accuracy. Greenpeace points out that the safety case is reliant upon low flux through a DWR but that the information so far available is insufficient to be confident about the assumption. For example, groundwater flow from the fells converges on the PRZ and existing faulting is likely to result in increased flows during future glaciation maintaining the same pathways.

6C.117 Cumbria asserts that the difference in oxygen isotope ratios between the BVG and SSG groundwaters of 1.5 per mil equates to an average temperature difference at recharge of only 2°C and could be explained by a difference in altitude (of about 600 m) between the respective recharge areas rather than pointing to a period of colder prevailing climate. Thus recharge to the SSG may have been by precipitation on the West Cumbria Coastal Plain and recharge to the BVG by precipitation originating on the higher Cumbrian Fells to the east.

6C.118 The difficulty of sampling and measuring noble gases [CCC/4/4, p.216] and the uncertainties in the values actually obtained are reflected in the error bars on the plotted results [COR/518, drgs.010180 to -195]. The plotted graph of estimated recharge temperatures for Borehole 4 [idem, drg.010183] shows no difference between BVG and SSG groundwaters, and there is little difference in Borehole 2 [idem, drg.010181] if the error bars are taken into account. Furthermore, Greenpeace and others contend that borehole water samples from the BVG cannot be interpreted to yield single ages because they must inevitably represent a mixture of water from joints, where water may be flowing, and from pores, where the water may be more or less static. They suggest Nirex recognises this by quoting ages as mean residence times. Greenpeace considers that data for hydrogen and oxygen isotope and noble gases could be interpreted to suggest that recharge of the BVG was restricted to glacial periods when there may have been increased heads under the ice, and the regional BVG transmissivities may have been much enhanced due to opening of fractures under the effect of ice loading. On this basis, future rates of regional subsurface flows could be much more rapid than any inferred today. HMIP's contractors accept that glacial loading has the potential to alter substantially the pattern of groundwater flow [GNP/3/16, p.58 penult.para.].

6C.119 Cumbria says that it is not acceptable to consider <sup>36</sup>Cl readings in Borehole 2 in isolation because the data from other holes, namely Boreholes 3, 7A & 10A [COR/518, v.2 drgs.010182, 010185 & 010188] suggest shorter residence times so the overall picture is very difficult to interpret. It also criticises Nirex's interpretation of long residence times from sampling of <sup>4</sup>He for the same reason as for <sup>36</sup>Cl, pointing out significant variations between holes [see COR/518, v.2, drgs 010180 to 010191]. Nirex accepts the uncertainties inherent in the calculations and stresses that the results cannot be used in isolation.

6C.120 Natural Geosphere Barrier. The objectors, with few exceptions, express serious concern that the region is characterised by heavy faulting [COR/518, Drg.010070], is a complicated volume of volcanic rock by its nature and the PRZ is a poor site for a DWR. 50% of the BVG is potentially within the influence of a fault structure [CCC/4/2] and controls on groundwater flow are inherently difficult to define. Flowing fractures are linked in a complex and unpredictable manner with no exclusive geological control [FOE/2/2, Fig.17 & FOE/2/3, Summary & s.4]. This militates against achieving an overall understanding of groundwater flow in the PRZ. Understanding is far too limited to proceed to an RCF and is likely to remain inadequate for a reliable safety case to be made, even with an RCF, because of the unpredictability and complexity of the PRZ in 3 dimensions. FOE suggest that the PRZ constitutes part of an infill of a complicated topographic depression ("a piecemeal caldera") that formed by the collapse of part of a volcano in response to catastrophic removal of underlying molten rock by eruption and which was then subject to deformation [FOE/2/2 & FOE/2/3]. They assert that the random complexity associated with this phenomenon is not confined to the caldera margin as suggested by Nirex.

6C.121 They point out that there are significant inconsistencies between surveys and between models of the BVG structure and borehole data potentially causing errors in the interpretation of major faulting. An example of this is Nirex's failure to treat fault F2, which is the most prominent fault cutting the PRZ, as a type III feature and to identify and map its important strands in the model. Faults F1, F2, F3 and 202 have not been robustly defined in their view.

6C.122 FOE submit that cooling joints within the ignimbrites in the PRZ have not been recognised but say that even if they could be mapped from an RCF tunnel they could not be predicted probabilistically, as with the structure generally.

6C.123 FOE say that the acknowledged complexity of the behaviour of the geochemical barrier makes prediction of radiological doses arising from a DWR extremely difficult leaving aside the complication of RCF construction impacts which would exacerbate the problem. They point out that HMIP have already been critical of Nirex's geochemical work [FOE/8/27, pp.32-33; FOE/8/51, pp.20-21] and question the cogency of Nirex's geochemical evidence. They estimate that some 5 years of laboratory work will be needed to support field testing of the geochemical barrier. A good understanding of geochemical processes is required in order to establish a sound basis for PDF application. Data are inadequate on temperature, ionic strength effects, precipitation kinetics, speciation of fluids in contact with the DWR and understanding of secondary minerals for example. FOE believe that their view is supported by the qualifications made, and the variabilities contained, in the results of the Grimsel and Stripa Migration Experiments [NRX/15/35, p.770 & NRX/15/36, pp.vii-ix] and in measured sorption coefficients ( $K_d$ ) [FOE/8/21/Tables A2-A4] and the fact that databases for  $K_d$  values are discarding the isotherm approach in favour of thermodynamically modelled values [FOE/8/34, pp.86-88, 93 & s.5.5.1].

6C.124 FOE observe that allowance does not appear to have been made for changes in geochemical conditions in the far-field beyond the alkaline plume. Over long periods of time significant changes in groundwater flow and redox state could occur. Greenpeace points out that a characteristic of the region is the presence of large amounts of iron ore, and sporadic traces of iron pyrites, both affecting groundwater chemistry. Cumbria add that, until recently, Nirex was unable to estimate the composition of in situ groundwater for the purpose of water/rock interactions because of uncertainties over natural temperatures, pH and Eh [CCC/4/7, p.2].

6C.125 Greenpeace submits that the BVG groundwater is likely to be oxidising at DWR depth and not reducing as Nirex suggests, albeit reducing at greater depth [GNP/3/28/Fig.3.8]. As a consequence there would be increases in uranium solubility and NRVB retardation and waste container corrosion would be affected. Nirex has changed its theoretical approach to chemical buffering [NRX/15/10] but this has not been tested by chemical simulations. It points out that Nirex are using a value of uranium solubility in modelling the near-field 4 times higher than in the Nirex 95 base case.

6C.126 Nirex's results in Nirex 95 [COR/522] are within a factor of 2 of breaching the  $10^{-6}$  target, or, actually breach it [COR/522, Vol.3, Fig.6.19], and, amongst other uncertainties, the fraction of the radionuclide discharge going to deep soils in the biosphere assessment calculations [idem, p.6.9] is accepted by Nirex as needing amendment in the light of research [NRX/15/4].

6C.127 Chemical & Engineered Barriers. The degree of uncertainty associated with host rock performance in the PRZ gives extra significance to the performance of the engineered barriers in the view of FOE. They contend that the NRVB concept is fundamentally flawed because it fails to limit groundwater flow; and it is inconsistent with international research [FOE/7/25, pp.7-8; FOE/7/11, pp.13-14] and Nirex's patent description [FOE/7/17]. The high permeability of NRVB could give rise to higher, and more variable, canister corrosion rates and gas generation and migration than those predicted, so increasing the rate of escape of radionuclides. It also makes the chemical barrier fundamental to DWR safety. Leaving the crown area of the waste vaults unfilled could lead to inhomogeneous chemical conditions. They regard the model used to quantify the behaviour of NRVB is unrealistic and unreliable. South Cumbria Citizens emphasise the great complexity of the chemical systems in the DWR and the huge amount of research that would need to be done: they question whether the problems would ever be resolved.

6C.128 Preliminary work at Stripa to verify any link between mechanical disturbance and hydraulic properties was unsatisfactory [FOE/7/31, p.148] and so this remains a fundamental uncertainty, particularly in relation to sealing and grouting.

6C.129 Mrs M Higham expresses great concern about the behaviour of plutonium dioxide particles released from a waste repository. Although she does not regard PuO<sub>2</sub> as a colloid, she maintains it behaves in a similar manner to a stable colloid and therefore can be transported readily through the geosphere with the flow of groundwater. She and others relate this to the risk of a criticality incident [see 6A.46 above].

6C.130 Gas Migration. FOE say there is still only poor understanding of the potential of the geosphere to attenuate hydrogen and methane, both poorly soluble and sorptive gases, on their migration towards the surface. There is also the possibility that gas bubbles can increase the mobility of radionuclides by attracting colloids and other small particles [COR/528, S.3.2.3, p.14].

6C.131 Potential Excavation Disturbance. FOE and others highlight inconclusive and sometimes contradictory results from experiments carried out in other underground rock laboratories to relate excavation disturbance and flow, and also related experiments on the sealing of excavations. They believe there is a significant risk that induced pathways with potential for radionuclide transport will be created by excavation and that proposed sealing and grouting techniques are not reliable. They point to shortcomings in modelling which are purported to justify inadequacies in construction standards. Of particular note is the failure to account for transmissivity at the interface of fill and lining, possible extent of rock disturbance, backfill permeability and effects of vault voids. FOE regard it as essential for Nirex to have a proper understanding of the impact which the RCF would have on the PRZ, on the region, and on the long term performance of any future DWR, before RCF development commences.

6C.132 By way of example, although theoretical predictions might show a regular relationship between stress changes and rock mass hydraulic conductivity [NRX/16/11, Figs.A1.1 & A1.2], experiments at Stripa, where boreholes were pre-drilled into an area that was then tunnelled out by extremely careful blasting, gave unexpected results, notably a significant permeability reduction akin to a skin forming around the drift but of unknown

cause [FOE/6/31, p.296 last para.]. Possible explanations were shearing of the rocks, blast damage, drilling debris, gas entering the water flow system, and chemical precipitation [idem, pp.290-295]. Similarly in the Canadian URL attempts were made to measure increased fracture flow as result of excavation disturbance surrounding a shaft and narrow ventilation shaft using groundwater tracer tests [FOE/6/30, Figs.3 & 4] but the results were erratic, especially in Fracture Zone 3 where the flow reduced [idem, s.3.1.3 1st para; B12 1st full para & last; B15 1st para.]. Likewise the results of excavation disturbance around a horizontal tunnel in the URL found little direct correlation between hydraulic and mechanical properties [FOE/6/29, Conclusion p.9].

6C.133 Nirex Report 560 (1994) [FOE/5/19] assessed the impact of the RCF on groundwater flow, indicating that it could be significant. In the light of this scoping study, FOE are concerned that the impact of the RCF on baseline conditions has not been rigorously modelled and suggest that impact prediction can only be reliably undertaken once baseline conditions have been re-established. Moreover, unless construction impacts are clearly understood and dealt with, the RCF could provide misleading data and compromise a reliable PCPA. They see sampling of entirely undisturbed conditions as impossible after construction of the RCF. Also the backfilled RCF shafts could provide an express route to the surface for radionuclides. Fresh fractures may dominate absorption for up to 1,000 years. In addition, Greenpeace submits that the collection of data to demonstrate that glacial flushing has not taken place in the past would be compromised by RCF construction.

6C.134 FOE and Greenpeace suggest that the RCF should be sited and designed as an integral part of the final DWR in order to limit excavation disturbance effects and optimise groundwater flows through the DWR. Although Nirex accept that there should be some commonality in the shafts and galleries to minimise disturbance and costs, and best practicable means would be applied to engineering and chemical barriers, FOE and Greenpeace say the RCF is not currently so designed; the engineering standards applied to it by Nirex are inadequate and not best practicable means for a DWR; optimisation of shaft location needs a validated regional hydrogeological model which is absent; and Nirex fails to recognise the significant risk of damage to the PRZ. Best practicable means and quality objectives should be applied at every step in the view of Greenpeace and FOE, and not just to the final safety case.

6C.135 Properties of Individual Radionuclides. FOE point out a number of examples of difficulty in the physical and chemical properties of individual radionuclides. Discrepancies between predicted solubility and experimental results for uranium ( $U^{VI}$  &  $U^{IV}$ ) [FOE/8/31, figs.7 & 9] led to adjustments being made to the HATCHES database to match the experimental results, yet this was regarded as the definitive data source for thermodynamic modelling [idem, S.3.13.1 & 3.13.2, last paras.]. Greenpeace adds that chemical containment is crucial to providing a sufficient level of safety for uranium yet Nirex may have underestimated its solubilities and there is no long term natural barrier to higher solubilities should the chemical conditioning of the DWR fail. Some written representations also express concern that the waste inventory could be altered to include other waste such as MOX plant arisings [WR/MED/2] which would produce actinides with even longer half lives than plutonium (eg  $^{239}\text{Np}$ ) with a greater propensity to escape than others.

6C.136 FOE contend there are inadequate data on equilibrium relationships at different temperatures to allow confident extrapolations to be made from standard laboratory temperatures [FOE/8/31, p.13 final conclusion, and final remarks s.3.8, 3.14 & 3.16] and thermodynamic data from which chemical equilibrium predictions are made are critically dependent on the ionic strength of the system [FOE/8/43, abstract & FOE/8/34, s.3.1 1st para.] but it has been necessary for Nirex to extrapolate from one ionic strength to another and adjust the data. FOE argue this is unsound as there is not a constant relationship between concentration of species and ionic strengths [eg FOE/8/43, fig.1] and there can be great disparity between predicted equilibrium constants and experimental data [eg for CuSO<sub>4</sub> & NpNO<sub>3</sub> in idem, Table 2].

6C.137 Climate & Tectonics. Although 4 climate scenarios have been postulated, no modelling of the process of climate change has taken place. Cumbria contends that this is an important omission on the basis of trials in "Dry Run 3" [CCC/5/1, p.101, para.7.2]. Nirex concede the importance of future climate change. Greenpeace submits that, as in the past, glaciation and earthquakes could each increase the groundwater flow rate through the BVG and so could adversely affect safety of the DWR. Nirex do not preclude the possibility of recharge of deeper waters during a glacial period and accept that future glaciations are expected to occur over the next 10,000 to 100,000 years.

6C.138 Greenpeace claims the Lake District Boundary Fault zone (LDBFZ) has been active within the last 60 million years. It interprets the sharp kink in the contours of estimated regional uplift [COR/517 v1, fig 6.2] as suggesting differential movement between the Lake District massif and the rocks of the coastal plain during that period. There are unconformities and discontinuities within the glacial sediments indicative of tectonic activity within the last 100,000 years. Nirex identified from onshore and offshore seismic reflection data a number of locations where there may be faulted offsets of rockhead and Quaternary sediments [COR/517, Vol.1, p.11].

6C.139 Greenpeace adds that radiometric dating of minerals in a small number of samples taken from fault rocks gave ages of 118-146 million years, and a single sample from another fault zone gave a minimum age of 212 million years. An estimated age of 60 million years for another sample was ascribed by Nirex to a geothermal episode rather than faulting although this date is about the Cretaceous-Tertiary boundary when Nirex says regional and wider uplift occurred. The HMIP report GOV/613 [p.79], specifically describing the tectonics of the Sellafield site, considers that from regional tectonic evidence the most recent phase of compressional and strike-slip deformation may have been in the Oligocene, 40-30 million years. However, it believes Britain is now in an extensional tectonic regime possibly caused by the effects of isostatic rebound following the last ice age.

6C.140 The Sellafield seismological database [GNP/3/27, sections 4.5 & 4.5.1] shows that the surviving record is limited to about the last 350 years and, despite the large body of data, may provide only a sample of the total number of felt earthquakes that have actually occurred in the region. Greenpeace submits that observations confirm the general impression that the northwest is one of the more seismically active areas of England. New UK seismic hazard maps compiled by BGS [GNP/3/24] show that the areas of highest hazard are western Scotland, northwestern England and Wales, albeit with a 90% probability that Intensity VI MSK will not be exceeded in 50 years.



6C.141 Greenpeace draws attention to the largest and most damaging local event, namely the Whitehaven earthquake of 1786, at Intensity VI, magnitude  $4.7M_{sA}$  although there have been other events of comparable intensity (Irtton 1755, offshore Irish Sea 1843) [GNP/3/27, pp.22 & 23]. It says these events, observed on a very short timescale relative to geological times, are not a good indicator of what might be less frequent larger movements on the Lake District Boundary Fault. The recent historical record shows that there are likely to be at least hundreds more such events during the lifetime of the DWR on any reasonable interpretation, a view shared by South Cumbria Citizens [SCC/5/1] and many of those writing [eg WR/S/242 & WR/W/155].

6C.142 Greenpeace claims that large earthquakes in extensional tectonic regimes can pump large quantities of water to the surface [GNP/3/7, Abstract; GOV/613, sections 2.2.4, 2.3.3 & 2.4.1]; and earthquakes of this extensional fault type and magnitude could easily influence subsurface water flows at Sellafield up to 50 kilometres from the site to produce several cubic kilometres of water discharges. The 1959 Hegben Lake, Montana and 1983 Borah Peak, Idaho earthquakes were both large events (Magnitude 7) on normal faults in an extensional regime, and the 1865 Rampside, S.Cumbria event caused water spouts in the beach sand. The 1884 Colchester earthquake changed water levels in wells up to 25 km away and seemed to be in an area of local extensional stress.

6C.143 Nirex concedes that there is no international consensus on hydrogeological effects of earthquakes and that all theories should be taken into account.

6C.144 Further Work. FOE make the following recommendations without prejudice to their doubts as to the site's suitability and susceptibility to reliable characterisation. They estimate the work other than f. (RCF impact) would take 5 to 6 years to complete but that 9 to 10 years should be allowed overall and the work should precede RCF development.

- a. A 3-D seismic survey over a minimum 7-10 km<sup>2</sup> as essential to stand the best chance of supplying an adequately predictive 3-D sub-surface model.
- b. Up to 3 more boreholes offshore and up to 7 further deep and shallow boreholes in the intermediate areas of the site to further define the geological sequence and hydrogeology in 3 dimensions.
- c. Repeat the RCF3 BVG pump test over at least 12 months together with other tests, if feasible, in boreholes 5,7A,8A,11A,12A,14A,RCF1 & 2, and RCM1 to 3, and perhaps tracer testing, to further test the connectivity of strata and fractures.
- d. Continue monitoring and sampling until relatively stable or predictable environmental heads and geochemistry have been observed for a period of 4 to 5 years to demonstrate the achievement of "baseline conditions" (as normally understood).
- e. Refine the modelling to enable it to adequately replicate existing groundwater conditions and the effect of any field testing.

- f. Model the impact of the RCF construction on baseline conditions (once established) and on the PCPA.
- g. Peer review of the results of the above work.
- h. Assess the effectiveness of sealing techniques before RCF construction.
- i. Develop improved safety case modelling (see Chapter 6D).
- j. Progress laboratory and field work on characterisation of the geochemical barrier.

6C.15 6C.145 **My conclusions** on the current state of Nirex's scientific & technical programmes rely considerably on the Assessor's careful evaluation, and concentrate on what seem to be the most important points highlighted by the parties. Generally Nirex's work so far has been of very good quality, and has made extensive use of the available information. I consider below the significance of any alleged important departures from this generalisation. The expansion in the scope of the work over the last 5 years or so has also been very impressive, but does indicate amongst other things that the practical difficulties of the deep disposal option were originally under-estimated by the international consensus. Also Nirex's emphasis on the chemical containment element of the mixed artificial & natural barrier in spite of the relative novelty of the concept rather confirms that a difficulty is perceived in identifying a suitable UK part of the geosphere for the implementation of the deep disposal option.

6C.14 3A.11 6C.72 6C.146 In 1989 Nirex was confident that a limited drilling & testing programme, supported by geophysical work, would be sufficient for the compilation of a preliminary safety assessment which could support a repository planning application. Since this turned out to be far too optimistic, Nirex should have entered into a period of serious doubt about the promise of this location, no later than 1992. However, Nirex is claiming once more that there is sufficient information to show that the PRZ holds good promise, and now that its programmes have reached the point where an RCF is necessary. This implies that any really serious doubts have been allayed: and it is the persistent questioning by others of this implication which to my mind is the issue underlying most of the themes in this Chapter.

6C.17-21 6C.22-7 6C.147 The site characterisation programme is of course the main programme which is directly related to the promise of the PRZ: but NSARP is relevant also, for example to any evaluation of the robustness of the PSAs. It is also necessary to be clear about the relationship between the RCF and the various components of the programmes, particularly when considering plans or recommendations for further investigatory work. Some work would seem to have little direct connection with the RCF investigation - an example would be establishing the boundary conditions of the hydrogeological region. Other work might appear not to be directly related to the RCF, yet their timings would need to be co-ordinated - for instance, for the drilling & baseline monitoring of additional regional boreholes within the area of possible hydrological influence of the RCF. Further categories of work would rely on the RCF as an integral part or phase of the work - such as model validation, and sealing designs. Then there would be some work which could only take place in an RCF-

type development, since it would basically depend on direct observations of relatively large portions of the potential host rock & associated physical matter.

6C.148 A wide range of disciplines is involved in these programmes. There is some novel & fundamental science: there are taxing problems of complex mathematical modelling: and there are potentially fresh applications for some existing technology. Sometimes there is a tension, both within Nirex and amongst its opposers, between a general academic, theoretical & cautious approach on the one hand and a more practical, pragmatic & venturesome one on the other. This distinction is not to do with quality of, or care over, work, but with basic personal dispositions. However, most approaches have also been conditioned by some preconceptions, which tend to surface in some inconsistent treatment of secondary evidence, such as arguments from first principles, unpublished research, & preliminary scoping studies.

6C.28-32 6C.149 International Co-operation has provided Nirex with considerable amounts of comparative data on rock properties & responses. There are also the benefits of some experience with methodologies, equipment & techniques passed on to help the planning & implementation of the RCF, and of exchange of personnel. Whilst FOE in particular draw  
6C.132 attention to the poor or unexpected results from some international experiments and are concerned about possibly misplaced confidence in them, a positive way of looking at such results is that they provide lessons to be learnt. In addition there have been international  
6C.31-2 inputs to NSARP on topics like radionuclide migration through the geosphere; validation of geochemical codes; colloids & complexes; gas generation & migration; coupled thermo-hydronechanical models; and natural analogues.

6C.41 & 73 6C.150 However, it is clear that none of the experimental sites in other countries is very similar in geological setting to Sellafield. This raises yet again a query about the choice of Sellafield; and means that a full characterisation of the rock volume here has really had to start from scratch. In turn, this underlines the crucial importance of the RCF, and I share some of the general disappointment at the apparent lack of progress in applying the results  
6C.106 of generic experiments to practical preparations for the RCF.

6C.34-5 6C.151 One of the basic problems in judging the promise of the site is that, notwithstanding the international input, Data Availability for the relevant scientific & engineering requirements has been notably limited. The juxtaposition of this judgement with expressed concern about the relative amount of data being amassed on Sellafield is not a paradox, in my view, but merely a reflection of the profound novelty & complexity of the deep disposal, multi-barrier concept. In any event, although data on Sellafield continue to be accumulated from other site-based studies & experimental work, the RCF itself would of course be a large & crucial stage in data collection.

6C.107 6C.152 Whilst I appreciate FOE's concerns about some aspects of Data Elicitation, the Assessor advises me that its use has been, and is, proper & appropriate; and that broadly it was the only practical way of carrying out preliminary safety assessments. Seemingly there has been no adequate substitute for relying on human expertise so far. Whereas some of FOE's specific examples are from HMIP's review of Nirex's 1992 PSA, the Assessor has naturally concentrated on the more recent 1995 PSA. Data elicitation has been retained notwithstanding that some experimental values could presumably have been generated by NSARP.

6C.153 Inasmuch as Nirex continues to rely on data elicitation, any more data production by 1 or 2 individuals rather than by a group which is complying with a formal methodology would presumably be unsatisfactory to the regulators. But the fundamental points for the future are that data would remain of variable quality, and that some parameters would always have a wide spread of values. In relation to matters such as the solubility & sorption of radionuclides, these points are more directly relevant to the safety assessment; but the extent of knowledge of geochemical parameters, for instance, could well have a bearing on the detailed timing of, & experiments within, the RCF.

6C.154 Transparency of the scientific & technical programmes has also been a problem in the past, with for example HMIP being unable to follow important arguments in the 1992 PSA because of inadequate references & documentation, echoing the difficulties over understanding of the 1988-9 site selection exercise. The Assessor's judgement is that the situation is much better now, so that a more integrated & coherent story is emerging, and a good deal of openness is being exhibited in the best scientific & engineering tradition. Nevertheless Nirex's steep learning curve has meant that scientific papers & background documents have become available more recently in an almost indigestible surge. Real transparency is hardly improved, in my view, by flooding people with more information than they can cope with. The proposed Project Review, and rapid release of site investigation data, should both contribute to a better flow of information.

6C.155 Quality assurance has been rigorously applied, so I am advised; and the consequential delays in publication are warranted by the resultant quality, accuracy & completeness of interpretive reports. Nirex's practice is to classify reports as "Commercial in Confidence" until they have passed successfully through the quality assurance procedures. However, the Assessor's view is that only a small proportion of them would usually be thought of as having commercial value: and consequently I regard the practice as misleading & inimical to Nirex's long-term credibility. If a report is being withheld because it is still subject to quality assurance, then that fact should be simply stated.

6C.156 The kind of Peer Review which is distinct from quality assurance has tended to be treated in this case, wrongly in my view, as a rather amorphous concept. The starting point is that Nirex is essentially a developer, and a developer's work is not normally subjected to peer review, as opposed to quality assurance. The draft regulatory guidance seems to explicitly require peer review only for model development. Nevertheless, Nirex is undertaking much research which is at the leading edge of science, and that would usually go through the standard peer review practices of the scientific community. In the case of learned papers, these take the form of well understood refereeing procedures. For other programmes or aspects of work, there are in fact definitions of peer review in the draft regulatory guidance and in the Royal Society's assessment cited by FOE.

6C.157 The White Paper & the draft regulatory guidance require the employment of good science, and the basing of decisions on the best possible scientific information. In my judgement, science can only be good if it has been subjected to proper peer review. As the Assessor points out, the involvement of so many outsiders in Nirex's programmes does mean that they are being subjected to continuous wide scrutiny. However, I cannot accept the terms of part of Nirex's submission, that some proper independent peer review is carried out by Nirex staff, contractors & the Nirex Review Panel. There cannot be confidence that staff

or contractors would meet the definitive requirements of being experts not directly involved in the work whose judgement can be accepted as impartial & disinterested; whilst the Review Panel has made clear that it does not regard its own contributions as detached peer reviews.

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6C.158 Accordingly, I consider that there is an implicit policy requirement that Nirex's scientific work should be subject to peer review, which has not always been fulfilled so far. Therefore I particularly welcome Nirex's assurance to the Secretary of State, reported in full in Chapter 7B, to submit an independently peer-reviewed baseline report to the regulator before RCF shaft sinking begins. To my mind, this would be a good start to settling some of the issues on peer review. However, I would respectfully disagree with the incipient consensus on seeking a peer review of Nirex's overall strategy. For I consider that this should be directly reviewed by the regulators instead. They are unarguably impartial & disinterested; and there could be a more focused review by them than by an ad hoc group, in the general public interest & in accordance with the spirit of international guidelines.

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6C.159 Turning from these procedural matters to crucial substantive issues, I consider that the central question, of the state of Nirex's current understanding of the Groundwater, is a good example of difficulties which may well stem from the lack of strategic guidance, in this instance on the requisite quantity & quality of hydrogeological information. For it is my view, on clear advice, that Nirex has an insufficient understanding of the groundwater conditions for a favourable prognosis to be given. The scientific & technical challenges it faces in these respects have not been fully appreciated by it. Starting with the data available from monitoring existing boreholes, there is information from a useful number of holes over an extended period, but this is predominantly in the sandstones and drift deposits, with sparse information on the limestones and only recent Nirex data for the BVG. The number & distribution of data points are certainly inadequate at the geological District scale, and may even be so at the geological Site scale at present. Also the monitoring period in the deep BVG has been too short to demonstrate slow trends.

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6C.160 Consequently there is considerable uncertainty about flows in the deeper rocks, particularly the BVG. Whilst it is agreed that there are relatively rapid flows in the upper part of the SSG, and that there is a marked tendency for horizontal flow towards the coast, more localised interpretations have been inclined to over-simplify the probable situation. Also Nirex's claim to recognise a 3-layer pattern with depth is still unsubstantiated in relation to the critical middle layer of the upper 400 m of the BVG & above, and its allegedly virtual lack of a vertical gradient.

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6C.161 A fundamental point which pervades the hydrogeological assessment, in my view, is that the area is extensively faulted but that there is a considerable amount of speculation as to the influence which any local fault has on groundwater flow. Nirex does not know whether the faults in general or particular increase or reduce or deflect flow. It has simply assumed for the purposes of its PSAs that the major faults conduct flow. An important follow-up point agreed by the Assessor is that, whilst geophysics can give some assistance, there are not enough boreholes in the right places to check for indicators of flows across any of the faults. Thus Nirex not only lacks fundamental knowledge about the relative transmissivity of faults, but also has not taken all of the orthodox steps to find out.

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6D.10

6C.80 6C.162 On the other hand, there seems to be little quarrel with Nirex's concept of the local  
groundwater as being divided into 3 regimes, comprising the Irish Sea Basin Brines under the  
sea & deep under the coast; the Coastal Plain Regime of fresh waters in the shallower  
6C.52 strata; and the saline Hills & Basement Regime at depth inland. The PRZ appears to be in  
the Hills & Basement zone, but close to the junction of the 3 regimes. Hence, even though  
the regimes may have been identified well, again it transpires that there is a complexity, this  
time in the local hydrogeology, so that the PRZ lacks in another respect the theoretical  
simplicity of a true BUSC location. Fortunately, the Assessor considers Greenpeace to be  
6C.116 incorrect in suggesting that the PRZ is also on the main subsurface axis of potential flow  
from the Lake District fells to the sea.

6C.109 6C.163 However, there are further difficulties, in understanding groundwater conditions to  
the west. At the shallower levels, it seems clear that significant amounts of water flowing  
through the Quaternary deposits & the upper SSG discharge at the coast or a little offshore.  
But, in the Assessor's opinion, too little is known about the locations & relative volumes &  
proportions in comparison with discharges into watercourses or elsewhere. At deeper levels,  
the Assessor's considered judgement is that, notwithstanding Nirex's views about the  
6C.113 boundaries between the hydrogeological regimes in terms of the Saline Transition Zone, the  
margin of the Irish Sea brine mass is sinuous & irregular, and the vertical distance of  
transition from fresh water in the SSG to fully saline water in the BVG is 200 m or more.  
This is another indication of the possible presence of vertical features, in turn suggestive of  
upward flow from close to the PRZ. Also, whilst the Assessor's views effectively reinforce  
6C.78 Nirex's proposals for more boreholes to the west of the PRZ, there is in addition his  
judgement that further, offshore boreholes not planned by Nirex are in fact required. Thus  
there is an underlying doubt about the overall utility of the RCF if requisite, complementary  
investigations further to the west are not to be completed in any event.

6C.79 6C.164 Moreover, there are considerable uncertainties about groundwater Eh, pH & ionic  
strength, especially at the preferred repository horizon. I adopt the Assessor's detailed  
conclusions on the essence of this topic. An adequate working knowledge is to be expected  
as part of the requisite generic understanding of the PRZ & the geological Site, and at present  
6C.125 it is lacking. Some of the deficiency would hopefully be made good by the RCF, but for its  
investigation to be effective a certain degree of comprehension has to be achieved  
beforehand. An overwhelming & prolonged effect of the chemical barrier might conceivably  
make an understanding of the conditions in the near field less important, but the barrier is  
6C.7-9 itself an unproven concept. Emphasising a maximum ionic strength in the vicinity of the  
repository tends to overlook the 1995 variant cases, plus dispersion & diffusion in the  
6A.6E geosphere away from the notional path-line in the base case. The base pathway of a PSA  
cannot simply be assumed to be representative of the final safety case. The eventual risk  
6C.11 assessment will form only part of the overall safety case, together with several other lines of  
reasoning, and analyses of all significant features of the disposal system. The redox state of  
6A.21 the groundwater is fundamentally important because of the control it exerts over chemical  
reactions within, or equilibrium involving, the water, whether in the natural geosphere or the  
6C.124 artificial repository.

6C.86 6C.165 The residence time of the groundwater in the rocks is also important because it can  
6C.118 be a strong factor in assessing regional groundwater flow rates. The presence of isotopically  
6C.56 lighter waters in the BVG & the lower sandstones is more likely to be due to recharge during

6C.82-4 a colder climate than at a higher altitude. Indeed there are a number of indicators which are strongly suggestive of a long residence time for the BVG groundwater in the Hills & Basement Regime. This is encouraging for the safety case because it is some evidence of low flows through the potential repository horizons.

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6C.98 6C.166 I consider this to be one of the most promising features of the work at Sellafield; and of course research continues to try to establish a simple & consistent overall picture. However, many more determinations are needed over a wider territory, and yet there seems to be no firm programme to achieve all these. There is also a possible pitfall for the safety case in that an attribution of the long residence time to a previous glacial cycle would favour a hypothesis that another glacial cycle well within the risk assessment period might flush out & recharge the groundwaters. In my view this embryonic hypothesis is no more speculative than some of the scenarios which Nirex wishes to promote on other topics.

6C.121 6C.167 Moreover, in turning from groundwater conditions to an examination of the Potential of the Natural Geosphere Barrier, there is an immediate reversion to over-optimism in Nirex's understanding of fundamentally important information. Although the bedrock geology is better known now in 3-D as a result of the greater coverage by geophysical surveys, this is at a coarse scale except in the vicinity of the RCF shafts. Also the BVG is difficult to characterise seismically because it has relatively few reflective surfaces. The distribution & variability of faults in the PRZ is obviously great; and it has not actually been possible to identify definitively during the inquiry the location of the fault which is probably the most significant of those traversing the PRZ.

6C.87 6C.168 The claim that nevertheless the main faults in the PRZ have been adequately characterised has by no means been substantiated either, in my judgement. Although continued data collection & modelling should be gradually improving understanding, Nirex's mapping & interpretation of the faults has been shifting; and the Assessor & I have been given too little cause to believe that this crucial aspect of the PRZ's geology has now been satisfactorily determined. Indeed there is a latent self-contradiction in the argument that it is the latest stochastic descriptions which have resolved the difficulty, since that implies a relative lack of deterministic data. Not every uncertainty can be over-arched by stochastic calculations, for the PDFs must have an initial credibility derived from acceptable data. The probabilistic modelling needs a realistic input of stratigraphic understanding at a relatively fine scale for its output to carry much weight with an impartial observer; and then there are the draft regulatory requirements for multiple lines of reasoning & analysis of all significant features as well.

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COR/530, 6C.169 Any lingering doubts that this judgement is too negative are in my view dispelled by a brief consideration of the geological history of the PRZ. BGS has plainly advised, after evaluating a range of borehole information, that the deposition of the BVG is considered to have been within an actively subsiding basin, probably a caldera complex. This is regarded as having had an episodic history, with periods of caldera collapse following eruptions during which an evolving magma chamber was tapped. My distinct impression is that, nevertheless, the implications of this have not fully realised until FOE have elaborated upon them for the benefit of the inquiry. The Assessor's advice, very briefly, is that, in addition to the basic volcanic characteristic of inherent variability, a caldera collapse would have introduced further faulting, slumping & deformation. Whilst some of the super-complexities probably

p.3.14 resulting from this appear to have been observed in the PRZ, they have been categorised as very localised phenomena rather than as typical of the multiple heterogeneity of a caldera.

6C.170 The difficulties in describing the detailed structure of the deep rock could theoretically be overcome to some extent if at least the flow characteristics & conductivity were adequately understood. The Assessor considers that an appropriately wide range of testing & monitoring for a borehole-based investigation of these has been carried out so far. In particular he believes that the results of the relatively recent RCF3 Pump Test tend to support the provisional conclusion that there is little vertical connectivity between the rock layers near the centre of the PRZ: but he has some reservations over the period of pumping, and there is a possible anomaly as to a slight response in the BVG some distance away from the RCF3 sandstone pumping.

6C.111 6C.171 Elsewhere, the testing & monitoring has implied in places a direct hydraulic connection between the shallow Sherwood Sandstones and the BVG, with only part-reassurance obtained from extra cross-check boreholes: and other responses have suggested definite connections between the BVG, the Brockram & the base of the SSG, but not the main body of the last. Thus more conclusive information is required; and, although further borehole investigation should assist, one of the main benefits of an appropriately planned RCF would be a powerful indication from its drawdown of the nature & extent of local hydraulic connections between the BVG and overlying strata.

6C.54 6C.172 The RCF is intended to provide much more information on flow zones too, especially in the BVG, where flow is already known to be principally through fractures but only a small proportion of them. The current explanation is that partial correlations exist between flow zones and many of the geological characteristics. This is the situation to be expected, in my view, with very complex rock; and the relevant RCF observations & experiments would have to be very carefully designed & controlled to pick up the threads. Since there are strong statistical associations between the locations of flow zones and faults, and between the frequency of flow zones and different Members of the BVG, a concentration of activity on the characterisation of the fault systems & on the Town End Farm Member might have been expected.

6C.90 6C.123 6C.59 6C.173 The sorptive capacity of the host rocks is theoretically relevant to the passage of radionuclides; and I consider that the regulators would expect it be thoroughly analysed even though Nirex is currently relying more on dilution & spreading. Sorption behaviour is nevertheless very complicated; and the uncertainties over groundwater regime transitions, redox conditions, & data elicitation are all involved. Sorption processes are very difficult to measure in the field, and the laboratory work programme for the BVG has been rather short so far, in addition to having to rely on artificial ageing. Tracer studies in the RCF on the connected topic of diffusion would be helpful in following up relatively good progress in the laboratory, but again the timescales would be incomparable with the natural system.

6C.3.8 6C.10 6C.6 6C.60 6C.174 The Proposed Chemical & Engineered Barriers are, together with the disposal inventory itself, the artificial part of the multi-containment concept. This implies, of course, that the natural barriers cannot be completely relied on. In the Assessor's judgement, there should be good confidence in the research work into the performance of steel & concrete. Also the processes resulting from corrosion & from the degradation of the waste seem to be



6C.24 fairly well understood, subject to a review of the significance of radiolytic reactions. However, the novelty of the chemical containment concept unsurprisingly throws up a wide range of problems.

6C.60 6C.175 Notwithstanding the patent on the NRVB, there is a need in the first place for a better understanding of its short-term physical & handling characteristics. Also, in order to support the theoretical estimates of the maintenance of a high pH over a long period, more work is required on the effects of elevated temperatures, particularly in relation to gas dispersal and the survival & activity of microbes. The artificial ageing difficulty also applies to experiments on NRVB's retardation or immobilisation of radionuclides. Another fairly fundamental problem to be addressed is the possibility of cracks forming in the NRVB, with the discovery that the reaction layers within the cracks have different compositions with widely varying effects.

6C.7 6C.12 6C.62 6C.12 6C.130 6C.50 6C.94 6C.176 This kind of work is partly generic & partly concerned with the natural physical & chemical properties of the PRZ. Consequently, whilst it relates to some extent to the promise of the site and can be assisted by more data from the RCF, it also relates to the practicability of the UK deep disposal concept. Another matter with which both the promise and the concept have to grapple is Gas Generation & Migration, for the gases arising from the degradation of the waste & its containers have to be allowed to escape to avoid serious damage to the DWR; and yet they would form another potential radionuclide transport medium to the biosphere, and may well have favourable or unwelcome inter-actions with other media. The Assessor advises me that there seems to be a good understanding of the production of the gases, but that there is greater uncertainty about what happens thereafter. Apparently some Nirex research on gas-water inter-action is awaiting peer review & publication: but the RCF would be a unique opportunity to experiment with & investigate gas migration through the intended host rocks.

6C.133 6C.95 6C.177 The Potential Disturbance from RCF Construction itself is another crucial topic, in my view. The 2 main areas of obvious potential impact are on baseline hydrogeological conditions due to drawdown, and on the long-term safety case due to the introduction of transmissive features through the rock. I regard it as a significant defect in Nirex's case that it has not presented reasoned predictions of these effects to the inquiry. It seems that to date Nirex has only completed a preliminary scoping study, which was left for FOE to draw to the inquiry's attention. However, the Assessor advises me that it is unreasonable for FOE to go on to criticise the study in principle for using a number of different modelling approaches, since that was reasonable at such a preliminary stage.

6C.133 2B.9 6C.133 6C.178 There is also the circular point on the hydrogeological impact that a primary purpose of the RCF is indeed to observe the drawdown as a means of validating water flow models. However, Nirex's preparations should be ready to obtain the full benefits of such observations, and yet neither a calibrated model nor predictions of the drawdown are so far available in anticipation of the start of the shaft sinking, on a tight timetable. This might not have been of much concern if the scoping study suggested that the RCF itself would have only a minor impact. But, on pessimistic assumptions, significant changes in the BVG groundwater were predicted, with a certainty of altering baseline conditions and a probability of drawing into the immediate locality water of a different geochemistry.

6C.131 6C.179 The study also suggested that the creation of additional conductive features through  
FOE/5/19 the rock could be relevant to the safety case. Although it worked on an earlier, smaller  
3A.11 design of the RCF than the present one, it included an assumption that drifts would directly  
6C.133 connect the RCF and the subsequent DWR. This is further confirmation that the line which  
Nirex has sought to draw between the RCF and the DWR on the planning merits is untenable  
as a matter of fact, and therefore in law. Moreover, some of the preliminary indications  
were that variations in the permeability of the backfill in the RCF's drifts & shafts could  
substantially alter the times of peak annual entry into the biosphere of radionuclides from the  
DWR. I agree with the Assessor that it would be a fair inference from this work that the  
RCF could potentially affect the safety case by introducing additional hydraulic conductivity  
into the hydrogeological regime.

6C.95 6C.180 Nirex's view is that the scoping study showed that if certain permeability levels were  
achieved in backfilling & sealing then the presence of the RCF excavation would have no  
detrimental effect on the transport of radionuclides from the DWR. The sealing requirements  
6C.91 involved in achieving the requisite permeability are not regarded as onerous, and so the  
permeability factor was treated as insignificant for the purposes of the latest PSA. The  
regulator could be satisfied in due course by, amongst other things, the results of the sealing  
2B.17 experiments in the RCF itself. However, I consider that whilst this may seem a measured  
6C.103 approach towards the final safety case it is really a rather high-risk strategy for coping with  
the effect of the RCF excavation after the event.

6C.7 6C.181 This is because it is part of the basic containment concept to instal high integrity  
6C.59 seals, but it is agreed that possible deterioration of seals and sealing materials, not covered  
by standard civil engineering & mining practice, has yet to be addressed. Also Nirex has  
produced no answer so far to FOE's reasoned anxieties in particular about heightened  
6C.131 transmissivity at the interface of fill & lining. The presently programmed sequence of events  
2B.15-8 would leave open the distinct possibility of Nirex discovering too late that it has not designed  
6C.50 the RCF excavations in the most appropriate manner for subsequent backfilling & other  
sealing. Nirex seems to be under the impression that this would not be detrimental to the  
final safety case so long as it could continue to show that the sealed excavations were  
probably not a preferential pathway; but this overlooks the point that regulatory policy  
6C.1 requires Nirex both to aim for the risk target and to adopt best practicable means, rather than  
allows it to choose between the two.

6C.131 6C.182 On the other hand, the Assessor advises me that Nirex's position is more secure on  
6C.63 other aspects of the general topic of Excavation Disturbance, notwithstanding the several  
kinds of reservations strongly held by FOE & others. Nirex is believed to now have a good  
understanding of the basic mechanical properties of the Sellafield rocks, adequate to make  
preliminary excavation designs. Whilst of course there are many uncertainties about the  
likely extent & behaviour of large & deep zones of excavation disturbance, it is of the very  
essence of the RCF to explore these by close observation. Also the vertical stresses and  
directions of maximum horizontal stress seem now to be known with some confidence, with  
the best preliminary estimate of the latter consistent with published data.

6C.132 6C.183 The erratic or unexpected experimental results elsewhere emphasised by FOE are not  
really surprising to the Assessor. There is not a wealth of data on the changes to  
groundwater flow induced by excavation, but the effects are much more variable than those

of mechanical strains. Two basic points are in Nirex's favour. The indications are that any excavation disturbance zone is very site specific, thereby emphasising the crucial role of the RCF in this aspect of the continuing investigations: and, on the other hand, results to date suggest that Nirex's modelling has been very conservative in assuming that excavation disturbance could increase hydraulic conductivity parallel to the excavation walls by up to 2 orders of magnitude for a distance of up to twice the excavation diameter.

6C.184 But, in turning to the understanding & modelling of the Physical & Chemical Properties of Individual Radionuclides, Nirex still has a number of difficult problems to surmount. The anticipated post-closure conditions in the engineered repository would greatly affect the solubility & reactivity of individual radionuclides, often beyond the range of conditions for which there are much previous research data. FOE seem to us to have made out their case on discrepancies between predicted solubility and experimental results, and on inadequate data on equilibrium relationships at different temperatures & ionic strengths. Whilst it is appreciated that it is the experimental results which have been used as modelling inputs to date, it appears that there is still relative uncertainty over solubility at fairly standard conditions, let alone more extreme ones. The Assessor & I also feel that Nirex needs to understand too reactions outside the repository, across all the potential salinity variations.

6C.185 Although Nirex is fairly sanguine about the low incidence of colloids in natural groundwater, and about the several conservatisms involved in the assumption that radioactivity could be transported on colloids from the DWR to the biosphere, the facts remain that cementitious colloids would be generated by NRVB, and that research in this area is less well advanced than many other lines of study. Understandably Nirex has been concentrating on the behaviour of cementitious colloids in the varying water chemistry of the near-field/geosphere boundary, but it accepts that broader areas need to be investigated. Another series of topics that the Assessor advises should be researched is the possibility of other fine particulates being released from the DWR.

6C.186 A significant programme of research has also been started into reactions with organic matter, because some of the degradation products would increase the solubility or reduce the sorption of radionuclides. This is a wide field in itself, and much of the work seems to be novel. Due to the many organic species in the waste leachate, the research has to concentrate on potentially key compounds & fractions, and focus on understanding the underlying mechanisms.

6C.187 Recalling the distinctions between various components of the research programmes made in para.6C.147 above, the Assessor remarks in particular that work on the influence of organic matter would be necessary regardless of the location of the repository. Therefore it has little direct connection with the RCF investigation. The same would apply to much of the work on fine particulates, assuming that the inventory would remain the same whatever the location; to some of the work on cementitious colloids, presuming that Nirex intends to use NRVB in any location; and to much of the work on solubility & reactivity. However, the RCF should make it rather easier to sample groundwater colloids; and it would improve knowledge of the geochemistry of the local groundwater for the whole range of site specific aspects of the understanding & modelling of the properties of radionuclides.

- 3A.13 6C.188 The theme which underlies much of the opposition on this score is scepticism about the pace & co-ordination of Nirex's research programmes. There are doubts that sufficient understanding would have been developed across the full range to obtain the best value from the nature, design & implementation of the observations & experiments in the RCF. There are concerns that the research may be rushed to try to keep up with the RCF project timetable, or, conversely, that the RCF work might be premature and truncate optimisation. My judgement from this brief review of the state of research into the properties of individual radionuclides, and from others of my conclusions in this Chapter, is that there is some cogency in this line of opposition. I am particularly struck by the way in which Nirex may have handicapped itself from the scientific point of view by deciding not to emplace any radioactive waste whatsoever in the RCF for any experimental purpose.
- 6C.137 6C.189 In the light of the Assessor's advice, the opposition's similar worries about the evolution of Nirex's understanding of the Longer Term Geological Processes tend to have less force, in my view, with the exception of the possible implications of successive glaciations. The most significant weaknesses of this specific Sellafield DWR project in relation to the long term geological context seem to be to do with the past, albeit that subsequent Chapters of this Section of the report refer to the deep disposal concept's generic difficulties in predicting the distant future. Thus I am advised that this location should not be especially prone to further volcanism, but I have already concluded that past volcanism has made this a very difficult site to characterise because it is very probably within a collapsed caldera complex [6C.169].
- 6C.138 6C.190 A less clear-cut matter is that, despite a conclusion in principle that a location along the boundary between the Irish Sea Basin and the Lake District Dome must be questionable [6B.97], the evidence of activity in the LDBFZ within the last 60 million years is apparently weak. However, doubt remains and further research could be done on the dating of faults and the evolution of fracture systems, for example by studying mineral fission tracks & fluid inclusions. But this would require the sampling of fault & fracture infill materials; and the RCF would afford only limited access to fault zones.
- 2B.15 6C.139 6C.191 The situation on seismicity is particularly interesting. Surprisingly, there is expert disagreement on the basic tectonic regime of the crustal rocks of the British Isles. The Assessor tends towards the view of Nirex & its advisors that the regime is strike-slip, but suggests that the analogy of a local extensional stress pattern in the SW Scottish Highlands indicates that the Lake District could be similarly affected as a result of glaciation. This is partly a locational point but emphasises that Nirex's research should endeavour to form a clear view of the local effects of glaciation, particularly groundwater flushing.
- 6C.98 6C.136 6C.140 6C.47-8 6C.141 6C.192 Nevertheless, there has been very detailed research on seismicity in the Sellafield region, now with a continual flow of new data from instrumental monitoring. As is to be expected from the structural geological setting, West Cumbria is amongst the more seismically active areas of England. This is understandably a matter of great concern to some of the lay people who have made representations, and seismicity is a topic on which the expert groups have called for more research. The period of systematic observation is, however, minuscule in relation to  $10^8$  years. Whilst the objectors infer strongly that activity could be much worse & of greater magnitude in this much longer term, and an expert group has expressed doubts, I am advised that this is not what the local stress regime suggests inasmuch as it is understood so far. The deep disposal concept would seem to be much more

6C.101 robust against seismic shock waves than surface installations; and the Assessor is not  
6C.142 persuaded from the examples given that there could be a large-scale pumping up of  
groundwater from deep below within the timescale in question.

6C.193 In contrast to the disagreements over seismicity, there is broadly a consensus on what  
6C.40 is to be done about Climate Change, albeit that this is another matter on which the expert  
6.48 groups have stipulated further research. The importance of specifying the postulated climate  
state has been acknowledged in the PSAs carried out so far, so that it has been possible to  
make a basic comparison between the predicted incidence of peak risk and the climate. This  
is to be enhanced in the form of alternative sequential scenarios for the next 125,000 years,  
with the probable capability, so the Assessor advises me, of providing a more continuous  
COR/527 representation if required. This kind of work, together with the clarification of "critical  
groups" which must be made to grapple with shorter term problems like the agricultural wells  
scenario [see Chapter 6E], would enable the plausibility of earlier work such as HMIP's Dry  
6C.137 Run 3 to be reviewed. There would of course have to be a different, qualitative approach  
towards the longer term, but the main relevance of the RCF to this would be in picking up  
6C.51 further clues as to what happened in the past.

6C.194 Although it is not possible to come to final conclusions about the Further Work Programme until completing this Section of the report, the Assessor's comments and FOE's submissions are useful indicators for taking stock so far. There is a need to improve the detail & interpretation of geological structure & stratigraphy across the PRZ, and to extend investigations to greater depths. Whilst some of this work could be in parallel with the RCF, some of it would be required before the RCF starts in order to confirm that the RCF is in the best position; in order to be clear as to the impact of the RCF on the important features of its geological setting; and in order that the RCF is implemented in the least harmful & most effective manner. It is apparent that Nirex did not fully appreciate these points when it prepared its application, for example because it is now relying on the delay in the final determination of that application to carry out some of the requisite work.

6C.195 Even though Nirex is planning to sink more regional boreholes, especially along the coast, they would not be enough to obtain a clear understanding of the regional hydrogeology. All the additional regional boreholes would probably be outside the drawdown influence of the RCF, but there would be little point in going ahead with the remainder of the Sellafield DWR programme, including the RCF, until Nirex changes its mind & agrees to remedy the deficiency. Also, in order to end its undue reliance on limited data, controversial interpretations & extreme stochastic modelling of the PRZ, Nirex needs to sink more boreholes in or close to the PRZ itself. Almost certainly all these would be within the drawdown zone of the RCF; and so they should be sunk, monitored & allowed to settle down again before the RCF starts.

6C.196 In relation to this settling down, whilst Nirex is close to establishing baseline head data for existing boreholes, some more years monitoring of trends in the BVG are required. Also general advances need to be made in fields such as the local coverage of hydrochemical data. Investigations like these relate back directly to the needs for more boreholes & monitoring. In turn, there is some work which is particularly important in investigating exceptionally complex rock like the BVG but which must await the RCF, such as the large-

scale drawdown; direct observation & logging of the rock; tracer tests; high-quality groundwater sampling; and experiments on gas migration, excavation disturbance & sealing.

6C.197 In addition much more laboratory work and modelling development are required on matters such as radionuclide solubility, sorption & thermodynamic relationships. These may not seem to be directly related to the RCF, but the experiments must be focused on chemical conditions & temperature ranges relevant to a DWR in this PRZ. For example, sorption data need to be specifically related to the local rock types, and the natural colloids actually in the local groundwater have to be identified. It is not apparent to the Assessor & myself from Nirex's direct evidence on its programmes that all the important deficiencies are to be made good and all the requisite activities properly timetabled. One of the main tasks in the subsequent Chapters of this Section of the report is to conclude whether the requisite remedies can nevertheless be inferred from Nirex's other scientific & technical evidence.

## 6D. MODEL DEVELOPMENT

6D.1 Modelling is at the heart of any reliable PSA for the DWR, and the conceptual and mathematical models employed require sufficient understanding of the geology and hydrogeology of the site for their input [6C.11]. The assessment identifies and models the processes and pathways by which radionuclides from the DWR may subsequently return to the biosphere and to people. People would be affected by radionuclides entering the food chain through complex pathways, by their consumption in drinking water or by inhalation in dust particles [COR/526, Figs.1 & 3, pp.8 & 12]. Nirex has developed models around transport of radionuclides in groundwater, migration of radionuclides in gases, and return of radionuclides to the environment as a result of natural disruptive events or inadvertent human intrusion and this work continues [6C.103]. Modelling, together with research and investigation work, needs to address the areas of uncertainty in safety assessment [6C.50]; and some of the vital models would undergo crucial tests in the RCF programme.

6D.2 Gases. Modelling of migration of radionuclides in gases has not yet progressed to the stage of assessment of the overall gas pathway [COR/509, s.5]. The GAMMON mathematical model and associated computer program has been developed to model gas generation in the DWR by the coupled processes of metal corrosion and microbial degradation of cellulosic wastes. Further work is addressing the coupling of the operational and post-closure phases, a modelling approach to assess the implications for gas generation rates of an extended aerobic period, the treatment of heterogeneities in the near-field, gas-water interactions on colloid transport, surface gas release and combined theoretical-experimental studies and field work. Once gas reaches the biosphere, the multi-compartment model RIMERS simulates  $^{14}\text{C}$  migration into soil [COR/526, s.4.4] and is considered by Nirex to be robust to within a factor of 2 except in respect of the first transit of  $^{14}\text{C}$  through the soil-plant system where further studies are being carried out [idem].

6D.3 Human Intrusion/Natural Disruptive Events. The probability of return of radionuclides to the environment as a result of natural disruptive events or inadvertent human intrusion is considered by Nirex to be low, but such risks are being taken forward into future assessments through a combination of deterministic and probabilistic calculations and modelling. Nirex intends that, in performing individual risk calculations for human intrusion scenarios the underlying assumptions and models should, as far as possible, be consistent with those adopted in assessments of the groundwater pathway [COR/526, s.4.5, pp.17-18]. However, direct and indirect exposure gives rise to different assessment modelling requirements. The former, for example the risk from drilled core materials in the DWR, may be derived using exposure models while the latter, such as risk from extracted material then incorporated into surface soils, is modelled within the groundwater pathway. The groundwater pathway includes the definition of potential critical groups and their exposure to contaminated water from wells, irrigation and river augmentation.

6D.4 Nirex regards the main natural disruptive event for a DWR as an impact by a large meteorite, assessed to occur with very low probability [COR/501, para.5.6.16]. Possible hydraulic consequences of seismic events are currently modelled within the range of permeability assumed in near-surface strata in PDFs used in the hydrogeological model employed in Nirex 95 [COR/522] [6C.100].

6D.5 Groundwater. Because groundwater could transport each of the radionuclides in the wastes, Nirex regards it as the most important pathway. Nirex 95 [COR/522] reflects the most recent and comprehensive assessment and state of model development presented to the inquiry [6C.16]. Although later interpretive work has been published in COR/530 (3-D geological structure of the PRZ) and COR/518 & 518A (geological investigation drawings) this is not the result of further model development. Nirex 95 does not purport to be a comprehensive safety assessment but a preliminary analysis of the groundwater pathway for a DWR at Sellafield [COR/522, Vol.1, Introduction para.1].

6D.6 Nirex regards its conceptual model as not just a description of the behaviour of the system, but as including a definition of the processes within the system and the parameters required to model the system. The conceptual hydrogeological model, based on simplifications and other studies, thus provides sufficient information to enable the construction of numerical models. Nirex intends its numerical models to treat important aspects of the system in a realistic way but without unnecessary detail [COR/510, s.2]. Models facilitate cross-checking and sensitivity analyses and provide input for other models.

6D.7 The main tool used by Nirex for calculating radiological risk from radionuclides carried to the biosphere via the groundwater pathway is the MASCOT computer program and its output processor MOP. MASCOT employs the "Monte Carlo" method of random sampling from PDFs of uncertain model parameters, so providing estimates of the mean and distribution of calculated doses and associated risks. Sub-models describe such processes as release of radionuclides from waste packages, their mobilisation and migration from DWR vaults, transport through the geosphere and biosphere and consequent doses to individuals [COR/522, v.3, Figs 1.1 & 4.1 & para.4.4]. Sub-model input data are derived from other more detailed models, from the Site Characterisation Programme [see 6C.17-21 above] and from the Nirex Safety Assessment Research Programme [see 6C.22-27 above].

6D.8 The "source term" sub-model calculates the concentration of radionuclides in solution in the DWR vaults (near-field) groundwater as a function of time. Supporting sub-models such as RARECAN, CRACK 2, CHEQMATE, and HARPHRQ address the key physical and chemical processes of physical containment by the waste packaging, radioactive decay and ingrowth of decay products, solubility limitation, and sorption onto the NRVB backfill. Near-field groundwater is available for transport into the geosphere at a rate dependent on the flow of groundwater through the DWR volume. Work is continuing on the INHOMOG computer program [COR/529, Box 24, p.58] to model the chemical interactions between waste packages and their effect on radionuclide transport [idem, s.5.2.3].

6D.9 The behaviour of radionuclides transported in the groundwater flowing through the fractured rock of the geosphere is described by 2 sub-models, NAMMU and NAPSAC, which provide important inputs to the geosphere spreading term sub-model in MASCOT. NAPSAC also provides input data of DWR through-flow for the source term MASCOT model, and inputs into NAMMU. NAMMU models the flow system at the regional scale (10 km x 10 km [COR/522, Vol.1, s.4.3]) using a continuum porous medium (CPM) to approximate the behaviour of fractured rock larger than the representative elemental/elementary volume (REV); whereas NAPSAC models use a more detailed local scale of about 3 km x 4 km [idem, Vol.3, s.2.2.1, p.2.7] and a discrete fracture network (DFN) computer code. Reliable geosphere flow path lengths and water transit times are required as



well as the rate of groundwater flow through the DWR volume [eg idem, Fig 2.7]. Two dimensional modelling has been necessarily supplemented by some 3-D characterisation of PRZ fracture flow in Nirex 95 [COR/522, Vol.1, s.4.4 & NRX/14/12, Figs.5.3 & 5.4] although uncertainty remains in the representation of flow zone connectivity. The models take account of radionuclide decay and ingrowth, advection, diffusion, hydrodynamic dispersion, and retardation by sorption and by diffusion into the pore space in the rock matrix [COR/510, p.10].

6D.10 The extent of faulting, fracturing and other discontinuities of the rock has led Nirex to employ stochastic modelling [6C.87; COR/522, Vol.1, s.5.1.1]. In Nirex 95, the conceptual model recognises 4 categories of permeability or organised structures of fractures [COR/522, Vol.2, s.2.2 & Figs 2.1 & 2.2]. Type 0 is the rock matrix porosity whereas Type III fractures are associated with major fault zones and have lengths measured in kilometres. The most recent characterisation of the PRZ has drawn on new data to obtain the currently best possible lithostratigraphic and structural 3-D model of the PRZ [COR/530, paras. 1.2-1.5] to inform further mathematical modelling.

6D.11 The biosphere sub-models of MASCOT are essentially a series of compartments containing soil, sediments and water between which radionuclides become distributed. The biosphere has been modelled as a system of homogeneous compartments assigned time-invariant values based upon assumed environmental characteristics and constant flux of each radionuclide from the geosphere [COR/526, s.4.1]. Flux-to-dose rate conversion factors enable the geosphere calculations of time-dependent radionuclide fluxes into the biosphere to be converted into doses and risks to individuals [COR/507, Fig.3, p.7 & COR/526, Fig.2]. A full probabilistic analysis has not been attempted [COR/526, s.5.5] but a somewhat simplified approach has been taken within a pragmatic strategy [idem, s.3.1]. The NRPB-developed BIOS model has been used to simulate the processes contributing to radionuclide transport and accumulation in terrestrial and marine environments for most radionuclides [idem, Fig.2, p.11] but for some, such as  $^{36}\text{Cl}$ ,  $^{129}\text{I}$  and  $^{238}\text{U}$  and its daughters, a more detailed heterogeneous resource area model has been developed. This development has been guided by a more physically realistic catchment model generated by the computer code SHERTRAN-UK which is also able to model mixing processes occurring at depth in the Quaternary sediments [idem, Fig.4, p.13 & s.4.1, p.12 & COR/522, para.5.2.1].

6D.12 Biosphere modelling includes definition of critical groups which have been taken by Nirex as representative of those members of assumed future communities that incur the largest annual Effective Dose from radionuclides present in the environment. Effective dose and potential health risk calculations have been derived from ICRP models. These have resulted in a series of risk calculations in Nirex 95 [COR/522, Vol.3, Figs.6.6-6.19] and its conclusions [idem, Chapter 9].

6D.13 Nirex now sees a need to develop a new dynamic model for the biosphere to replace the compartment modelling based on the BIOS program, allowing for alterations with time according to future evolution and the building of a formal "audit trail" to justify models and scenarios [COR/526, s.5.1 & COR/507, p.9] as required by the regulators [6C.68]. In addition, Nirex intends to develop stronger links between the understanding of biosphere processes emerging from the NSARP, the Site Characterisation programme and the overall groundwater pathway assessment, and address the implications of parametric uncertainty in

biosphere assessment modelling [idem]. This requires development of SHETRAN-UK to provide a suitable tool for use in hypothetical catchment modelling and climatological and landform related studies [COR/526, s.5.2]. The implications of this for groundwater modelling can be gauged from the prediction of a 40 m or more fall in the sea level leaving the entire bed of the eastern Irish Sea exposed [idem, s.5.4]. Nirex regards the removal of the restriction on models to be independent of time as the most important current development of the PSA methodology [COR/507, s.7]. This requires a greatly expanded definition of the system requiring modelling and greater model interface complexity [idem].

6D.14 Radionuclide-dependent parameters are large in number though the general characteristics of many are known from other models. A data-base is being established to facilitate expert elicitation of PDFs for key parameters. However, exploration of the implications of notional PDFs is considered by Nirex only to be capable of being undertaken in the context of specific future assessments, because changes in the near-field and geosphere components of the system can profoundly influence the relative significance of particular radionuclides and pathways in the biosphere [idem, s.5.5].

6D.15 Model Verification, Calibration & Validation. Verification of a mathematical model, or the corresponding computer program, occurs when it is shown that the program behaves as intended by demonstrating that it is a proper mathematical representation of the conceptual model and that the equations are correctly encoded and solved [COR/519, p.11]. The MASCOT program is said by Nirex to be verified [COR/507, p.6].

6D.16 Model calibration is achieved by correlation with a standard [COR/519, p.3] and is carried out by Nirex for each model against a sub-set of the available data prior to making predictions.

6D.17 The IAEA defines validation [COR/519, p.11] as

"..... a process carried out by comparison of model predictions with independent field observations and experimental measurements. A model cannot be considered validated until sufficient testing has been performed to ensure an acceptable level of predictive accuracy. (Note that the acceptable level of accuracy is judgemental and will vary depending on the specific problem or question to be addressed by the model)."

6D.18 The draft regulatory guidance contains a similar definition [HMP/1/1, p.8 & paras.8.18 - 8.19], and views model validation as an iterative process of building confidence in the fitness for purpose of models used in developing performance assessment for a DWR and in the predictions they make. The process involves testing model predictions against independent observations and evaluating them against a set of performance measures within a peer review framework. Nirex defines validation as a 12 step cyclical process repeated as necessary. It is also used to discriminate between alternative models.

6D.19 Performance measures must be defined on a model specific basis with knowledge of the model's intended use in advance of the tests and must take account of the wide range of possible uncertainties such as those identified in 6C.50. Blind predictive modelling is the favoured technique to match prediction against subsequent observations during repeated cycles

until the addition of new data does little for the ability to make predictions [FOE/6/11, p.290].

6D.20 Current validation cycles of the groundwater flow models are intended by Nirex to build on the understanding derived from regional boreholes and are geared to be completed by the end of RCF Phase 1. Nirex plans a similar process for other modelling such as gas generation [COR/509, p.5]. It regards the initial cycle of validation of groundwater flow to have been completed in 1994, centred on cross-hole testing between boreholes 2 and 4 [NRX/14/13/Table A.8]. The Borehole RCF3 Pump Test is under way, focusing on flow model validation in the PRZ rocks and is a precursor to the RCF Shaft Drawdown Experiments and Sector Tests in Nirex's next validation cycle. The RCF3 Test [NRX/14/13/Table A.8 & A.11] assisted the evaluation of various combinations of stochastic and deterministic properties in the models to assess their capability. Class A, B and C predictions were made. Class A predictions were blind with independent data before the test. Class B predictions were carried out after the start of the test but without knowledge of the outcomes gained to date. Class C predictions are those made after the event.

6D.21 By the end of RCF Phase 1 Nirex anticipates that validation cycles will permit definition of the most appropriate models to apply to flow in each of the formations and selection of preferred models for assessment purposes; definition of tried and tested upscaling rules for the preferred models; and definition of an updated flow model for use in the safety assessment work. Nirex sees forward predictions during the RCF excavation phase as validating modelling of hydrochemistry, excavation damage, rock stress and its distribution, spatial variability in key features of the rock mass and groundwater flow in the BVG and cover rocks.

6D.22 Modelling Uncertainty. Uncertainty in performance assessment of radioactive waste disposal systems could arise in 3 main areas: the choice and specification of scenarios; the formulation and actual computation of the conceptual and mathematical models; and the quality and appropriateness of input parameters used [FOE/7/46]. Nirex has developed the approach to assessment in which acknowledgement and treatment of uncertainty is central [COR/507, p.5] and incorporated into the risk, rather than considered separately, based upon Government endorsed advice [GOV/208, para.76]. As outlined above, probabilistic safety assessment addresses uncertainty by specifying parameter values as elicited ranges (PDFs) rather than exact values; and, in solving equations, values are selected from these ranges by a "Monte-Carlo" sampling technique resulting in a distribution of possible consequences [eg COR/522, Vol.3, Figs.6.11 & 8.3-8]. However, some values of dose or risk are more probable than others and the mean of all the realisations calculated as a function of time is "the expectation value" which Nirex normally compares with the regulatory target. Work is progressing to refine modelling inputs [6C.25, 6C.33-35, 6C.40, 6C.43].

6D.23 This technique was applied in Nirex 95 [COR/522] where calculations were undertaken for a base-case conceptual model of the hydrogeology of the PRZ. The base-case was developed by an expert group judging it to be the most probable model based on the information available at that time. Issues were also identified which were not addressed by the base case model and so were the subject of variant calculations. The group investigated the match between calculated and observed heads and salinity; uncertainties associated with

the representation of type III features; and a number of different representations of the hydrogeology [COR/522, Vol.3, s.7, p.7.1].

6D.24 Variability was experienced between calculated and observed heads and salinity in the base case [idem, s.7.2, p.7.4]. The reason for the high heads was not known and it was considered misleading to take as a base case a model in which heads were artificially imposed [idem, s.7.3]. As a consequence 2 variants were used: imposed high heads and imposed salinity distribution [idem] and a transmissive feature at depth [idem, s.7.4]. Observed environmental head data were not used. Type III feature uncertainty was explored by assuming that the Seascale Fault Zone preferentially diverts flow by increasing fault width [idem, s.7.5] and by representing the fault as being no more permeable than surrounding rocks [idem, s.7.6]. Hydrogeological uncertainties were represented by a less dense network of Type II features in the BVG [idem, s.7.7] and by the basal deep St Bees Sandstone as a barrier to flow [idem, s.7.8]. Some modification was made to variants for DWR performance [idem, s.7.9].

6D.25 **Nirex** regards the processes and features highlighted by objectors as being adequately addressed for the current stage of development of the programme. It does not accept that a complete understanding of all processes is essential to assessing system performance, and more data would not necessarily improve modelled predictions in its view [6C.74]. Uncertainty is dealt with in modelling probabilistically and with the assistance of an expert group, following regulatory and Government advice by incorporating uncertainty into the assessment of risk rather than dealing with it separately [HMP/1/1, paras.6.7 & 6.10; GOV/208, para.76]. Model uncertainty can be treated as parameter uncertainty. This process led to the base case model in Nirex 95 [COR/522]. Uncertainties are being comprehensively addressed in Nirex's contention. For example, in some instances and pending RCF investigation, a conservative assumption is made, eg sealing and grouting where flowing fractures are assumed not to be sealed in current models [6C.95], and in the selection of PDFs for geochemical processes. Nirex asserts that dealing with uncertainties in this way, together with Monte-Carlo iteration until such time as they can be better resolved, is in line with international practice and this work is progressing well [6C.90]. It has not been necessary to modify the conceptual model of hydrochemical conditions [6C.79].

6D.26 Cumbria's suggestion that errors need to be distinguished from uncertainty is misplaced and fails to appreciate the implications of the probabilistic method. For example, the employment of a pessimistic bounding calculation for sub-surface routing in the biosphere must be weighted for its low probability of occurrence. Similarly, the significance of extreme values of risk [COR/522, Vol.3, Figs.6.9 & 6.10] cannot be assessed without consideration of the low probability of occurrence.

6D.27 Theoretical modelling exercises carried out on behalf of HMIP [GOV/622, GOV/623, GOV/628] had limitations not present in Nirex's programme, such as an irregular mix of borehole data and limited time, undermining the cogency of any lessons learned. Nevertheless, the RCF would complement regional investigations to overcome any shortcomings in data, and models would be validated to achieve sufficient confidence against a range of data and not just hydraulic heads. Careful evaluation of uncertainty would overcome any errors in risk prediction in Nirex's view.

6D.28 Biosphere assessment modelling is designed by Nirex to ensure that there are no important omissions. Criticisms by Cumbria arise because of inappropriate comparisons with HMIP studies [eg CCC/5/1]; overstating the effects of climate change and the results from variant groundwater flow models for Temperate terrestrial discharge; overlooking the modelling of incised rivers and streams already carried out [COR/526/Fig.6, p.16]; and failures to appreciate that there is not strong sorption of significant radionuclides to submerged marine sediments, and that the risk from agricultural wells is not sensitive to the alternative scenarios posed (Chapter 6E). Furthermore, the wide range of radionuclides modelled in MASCOT [COR/522, Vol.3, Table 6.1] extends beyond the 4 which were found to make a significant contribution to risk in the biosphere (<sup>36</sup>Cl, <sup>99</sup>Tc, <sup>129</sup>I and <sup>238</sup>U and daughters), and objectors have misunderstood the explanations in Nirex 95 (Sections 6 & 8).

6D.29 Nirex regards criticisms of its approach to groundwater flow modelling, the results obtained and features modelled, as indicating that objectors do not appreciate or recognise important aspects of the work [6C.87]. The NAPSAC fracture network code and the NAMMU groundwater flow and transport code are well verified computer programs which are extensively used internationally, including in the Stripa [NRX/16/2, p.47 - NAPSAC] and HYDROCOIN [COR/510, p.6 - NAMMU] Projects. Fracture network models were used in the upscaling process to derive the regional-scale effective hydrogeological parameters for the BVG and the parameter distributions for the MASCOT sub-models of radionuclide transport in the BVG as well as modelling flow and transport through the PRZ. Two dimensional modelling in Nirex 95 has been carried out conservatively and 3-D modelling is intended at an appropriate stage as required by the Regulator.

6D.30 The conceptual model and parameters have been developed carefully to eliminate bias and unquantified uncertainty and to apply the appropriate type of model to the different regimes. Fracture network modelling is widely recognised as appropriate for modelling groundwater flow and transport in low-permeability rock such as the BVG [FOE/6/15, p.S29] and examples of purported shortcomings in DFN models based on earlier experience are misplaced. It refutes the suggestion that no sensitivity analysis of regional flow modelling was performed [COR/522, Vol.3, s.2.4.2], and that the modelled behaviour is suspect as between COR/505 and COR/522 when more site data became available. As regards modelling results, predictions of marine discharge of radionuclides are derived from modelling based on an understanding of the site hydrogeology in current conditions. They are not assumptions made for Temperate conditions where some level of terrestrial discharge is predicted [COR/522, Vol.3, p.2.12 & Fig.2.6b]. Upwelling in the Fleming Hall Fault Zone and reduced permeability across the Seascale Fault Zone are accounted for in Nirex 95 [COR/522, Vol.3, p.2.15 & Fig.2.12 & Vol.2, Fig.5.1 respectively], and the former may be a conservatism. Nirex submits that it is safe to ignore the permeability of the backfilled and sealed RCF shafts in the MASCOT modelling [6C.95].

6D.31 It refutes the suggestion that any physically realistic features have been excluded from the models and points out that Glasgow University's hydrogeological model, relied on by Greenpeace, is limited and does not model dilution. Nirex's predicted flow paths have been determined by the physics of the flow system which have been incorporated into the models representing the current understanding of the site. PDFs for such features as matrix diffusion and effective permeability are assigned probabilities in a structured way [COR/508, p.9, Box D & COR/522, Vol.1, Appendix 1]. The range of dilution factors used in Nirex

95 has been derived from an analytical calculation and only takes account of uncertainty in one of the effective hydrogeological parameters. As MASCOT realisations take account of the uncertainty in many more parameters, the range of effective dilution factors becomes potentially wider.

6D.32 Before construction of the RCF, a new regional coupled model would be available accounting for observed head and salinity distributions probably by incorporating geothermal effects at the bottom boundary of the model. A revised conceptual model of groundwater flow is planned for November 1996 and would be tested using new boreholes drilled prior to RCF sinking. The variants presented in Nirex 95 are not the only set of conceptual models for regional flow and alternative models have been appraised. For example, the RCF3 Pump Test has been used to compare 6 alternative conceptual models of groundwater flow within the BVG. Nirex asserts that its validation tests include comparison of model predictions with measurements of hydraulic properties other than heads [COR/510, s.2.4, p.18].

6D.33 Nirex refutes Greenpeace's contention that it is necessary to narrow the range of fluxes of groundwater through the DWR because the probabilities associated with different values of groundwater flux are sufficiently low for the calculated risk to be acceptable. It points out that lower fluxes are as probable as higher fluxes and that the RCF would test that the expectation value of groundwater flux through the DWR, derived from one or more conceptual models, gives an acceptable risk. The distribution of fluxes considered in the probabilistic calculations is a proper representation of the uncertainty in that parameter; and this distribution is acceptable in the context of regulatory requirements taking account of the probabilities of their occurrence. Furthermore, current modelling does not optimise the DWR location with respect to Type II features in the BVG with consequent reduction of groundwater flux.

6D.34 It regards Greenpeace's suggestion that the source term and geosphere spreading times [COR/522, Vol.3, Fig.8.8] are directly and proportionately linked as wrong because the controls on the flux and geosphere travel time calculated in Nirex 95 are well understood and different. Flux through the DWR is mainly controlled by the horizontal gradient of the freshwater head in the BVG at DWR depth and the horizontal component of the effective permeability of the deep BVG [idem, s.7.9, pp.7.9-7.10 & Table 2.3]. Except for the case of release from the small downstream section of a vault, the travel time in the BVG makes only a small contribution to the overall geosphere travel time. Geosphere spreading time for water leaving a DWR vault would be dominated by the time spent in the sandstone formations overlying the BVG [idem, Table 2.3], controlled mainly by the vertical gradient of the environmental head and horizontal gradient of the freshwater head in the sandstone formations and the effective permeabilities and porosities of the relevant sandstone formations. MASCOT provides a robust interpretation of these independently controlled but correlated parameters [idem, s.8.2.3, p.8.12]. Nevertheless, the RCF would make an important contribution to building confidence in the calculation of the geosphere spreading time in the Shaft Drawdown Experiment and the modelling of Type II features.

6D.35 Nirex proposes an extensive further programme for the cyclical validation of its models, covering a variety of scales including macroscopic, in a multi-staged process involving prediction and subsequent observation in relation to previously identified criteria together with peer review. Validation would focus on key uncertainties with the help of RCF

data and could continue through RCF Phases 2 and 3 if necessary, although it is intended that the regional scale models would be available for RCF Phase 1. The RCF would facilitate 3-D testing at greater length-scales and simultaneous testing and observations on specific features on the larger scale.

6D.36 Reservations about model development prior to commencement of the RCF are unjustified in Nirex's contention. The adequacy of safety assessment models would be a matter for the appropriate regulatory bodies. Also, the RCF is an essential facility for the calibration, validation and improvement of models to be used in PCSA and the validation process would incorporate appropriate peer review. Objectors have misunderstood the process of model validation and the integral role of the RCF in it. The INTRAVAL Project showed general international agreement that models cannot be validated generically but must be site specific [COR/605, p.88].

6D.37 Validation is not a matter of ruling out models that are inconsistent with data but a process of building confidence in the fitness for purpose of models, achieved through their refinement and development [COR/510, p.2] as set out by the regulators [HMP/1/1, para. 8.19]. Rejection of an imperfect model may discard potentially useful information so the results of different approaches should all be considered. At some stage in the validation cycles it may be reasonable to specify quantitative acceptance criteria (as are being considered for the RCF Shaft Drawdown Test). A good outcome of validation testing of alternative models would be increased confidence that the current judgements are correct and that alternative models, not consistent with meeting regulatory requirements, are of acceptably low probability. Uncertainties are not of themselves obstacles to establishing the safety case [idem, paras.8.15 & 8.16].

6D.38 Nirex's validation procedure has incorporated performance measures for some years [NRX/15/39]. The forward predictions for the RCF3 Pump Test to discriminate between, and refine and develop, conceptual models were held independently for comparison with relevant performance measures. Approaches to building confidence in the regional scale groundwater flow model and, in particular, the hydraulic model of the BVG are different, reflecting the different character of both the data and the uncertainties of importance to performance assessment which underlie the system concerned. At the PRZ scale a more detailed understanding and evaluation is required in order to evaluate the behaviour of the engineered barrier system and the source-term spreading time. A less detailed understanding of groundwater flow through the rest of the regional system is acceptable for evaluating larger scale geosphere transport. Predict, perturb and monitor tests are not required at a regional scale where, for example, palaeohydrogeological studies are more appropriate, although wherever possible comparisons of outputs from mathematical models with independent field observations have been used to refine the regional scale models.

6D.39 The application of quantitative performance measures to regional scale groundwater flow modelling has, together with the results from a number of other ongoing modelling studies, not yet been published but has been found valuable to assess the adequacy with which key features or processes are modelled and examine their treatment that may explain discrepancies. Full representation of the increase in hydraulic head with depth in the Nirex 95 base case, treatment of major fault zones as Type III features, the height of the water table to the north-east of the PRZ, the extent of sub-vertical fracture systems and related effective

permeability in the Deep St Bees Sandstone and variable permeability are all refinements likely to be considered to the regional scale models.

6D.40 As to fracture network model validation, in the RCF3 Pump Tests, Class B predictions became necessary for practical reasons, but were independent and are entirely consistent with its validation strategy. Nirex viewed the initial validation cycle involving Borehole 2/4 cross-hole testing as successful in meeting its objectives [NRX/15/16] and in particular enabling the construction of conceptual models for subsequent testing - a more meaningful test of outcomes of validation than adherence to a prescriptive approach as advocated by Greenpeace. FOE's criticism of the Stripa Test [FOE/6/15, p.S28] is misconceived because the test was only used to generate input values to another model using NAPSAC and not to predict flow.

6D.41 Nirex refutes the suggestion by Greenpeace that an assumption of uniform hydraulic properties is conservative in safety terms, pointing out that the inclusion of heterogeneous properties and fracture networks can lead to channelled flow and higher calculated risks than for an assumption of uniform properties [COR/522, Vol.3 Chapter 3]. Furthermore, the reduction with time of the solubility and sorption properties of chemical containment is modelled conservatively in Nirex 95, by assuming a reduction in performance by an order of magnitude from day zero.

6D.42 Cumbria regards the conceptual model as simplistic [6C.116]. It points out that, in Nirex 95, adjustments are required to account for the presence of some process or feature at great depth below the PRZ which has led to a variant model of a transmissive feature at depth with artificially imposed high heads being required in the preliminary safety assessment [6C.115 & 116] which Nirex acknowledges. Cumbria suggests that Nirex is being complacent about the effects of modelling change between climate states, referring to the conclusions of HMIP's "Dry Run 3" that the results of such modelling are unpredictable [CCC/5/1, para.7.2, p.101]. It regards the conclusion as relevant and salutary for the PRZ on this point even though the results may not be transferable from Harwell in other respects.

6D.43 Also, the Nirex 95 deterministic run takes no account of the range of uncertainty over the  $^{36}\text{Cl}$  present in the inventory, yet it would be spread widely across a number of waste streams. Cumbria expresses general concern about the large numbers of assumptions and uncertainties in the modelling and emphasises the need to discriminate between uncertainty and error in safety assessment [6C.116-9]. The regulators require reduction of uncertainty [6C.71]. Other participants support the point of principle [6C.107, 6C.121-122].

6D.44 As regards biosphere modelling, the approach of HMIP's consultants suggests that the critical group should be located above the maximum concentration in the plume [CCC/5/6, s.2.5, p.16]. Furthermore, the hydrogeological evidence suggests that upwelling [eg COR/522, Vol.3, Figs.2.6a, 2.11 & 2.12] could result in a significant radioactive plume reaching the surface well before presently predicted marine discharge, especially with landform evolution. Nirex accepts that biosphere assessment calculations need some amendment [6C.126].



6D.45 **Greenpeace** is concerned that fracture flow and regional models have not undergone blind prediction against quantitative criteria; there are inconsistencies between calculations and observations; and performance measures have not been properly defined or applied. Calibration has not taken place against hydraulic properties other than head data [WR/GNP/3, para.6.6]. The RCF drawdown experiment would be the first validation cycle for fracture flow models. Similarly, regional boreholes planned by Nirex cannot be utilised for model validation until regional flow models are sufficiently advanced to make blind predictions prior to data gathering. It points out that if data used to calibrate a model are not independent they are not appropriate for validation. It regards Nirex's work so far as simply the iterative processes of model calibration and model building, and does not accept that it is yet at the validation stage.

6D.46 It submits that confidence in groundwater modelling is essential in order to derive performance criteria for fracture flow models during validation in the RCF, especially in the light of experience of unexpected results in earlier studies for HMIP [WR/GNP/3, para.4.7]. Neither the fracture flow nor the regional models would have been through rigorous validation cycles before the RCF is built and the large perturbation caused by the RCF would prejudice the reliability of further modelling data. Furthermore, it appears that data from the deep BVG necessary for validation of the fracture flow models would not be available by the time Nirex anticipate submitting the DSA to the regulators; and a macroscopic groundwater model does not seem to be in sight, only component models.

6D.47 The data input to MASCOT [COR/522/Fig.8.8] and the conceptual model of regional groundwater flows in Nirex 95 reveal too many uncertainties in Greenpeace's view. Models inconsistent with data should be rejected. Nirex's models estimate that groundwater fluxes through the DWR could be up to 150 times greater than the central base case value [COR/522, Vol.3, s.2.3, p.2.13], giving rise to corresponding uncertainty in the source-term spreading time. Nirex recognises that the uncertainties about the properties of the BVG that would control the flux of groundwater through the DWR are currently too great to come to a decision whether to propose development of a DWR.

6D.48 In addition, DWR flux and geosphere travel times (therefore source-term and geosphere spreading times), assumed by Nirex to be independent, are more likely to be linked. This would materially affect the safety case, since achieving the risk target is highly vulnerable to even relatively small increases in groundwater flow.

6D.49 Validation necessarily entails narrowing the range of potential conceptual models. Greenpeace contends that, although validation does distinguish between models which do, and do not, agree with data, validation cannot assign probabilities as to whether one model is more realistic than another. Where alternative descriptions are consistent with data, they must be considered equally likely. Thus there is no process by which different probabilities can be attributed to alternative conceptual fracture flow models; and little confidence can be placed in qualitative comparison between model output and observations, except in model development. Over-emphasis on qualitative measures could lead to a model which looks plausible but is not valid. Nirex accepts that it may never be able absolutely to rule out or reject improbable alternative models, the predictions of which are inconsistent with meeting regulatory requirements.

6D.50 Greenpeace submits that the hydrogeological modelling carried out by Glasgow University [GNP/3/4] indicates different flows and a shorter timescale to reach surface than those suggested by Nirex, which would seriously prejudice the safety case [GNP/3/28/Figs.8.1a & b] (see further Chapter 6E). The permeability of the BVG is the controlling parameter. Furthermore, Nirex's models assume all faults to be dormant throughout the modelling period, whereas active faults cause progressive rock displacement which could substantially alter groundwater flows.

6D.51 FOE contend that a single comprehensive 3-D time-variant model of the Sellafield area of 10 km x 10 km minimum (larger if warranted by boundary conditions) [6C.116], supported by extensive sensitivity analysis, is an essential pre-requisite for a representation of the complex groundwater flow regime at Sellafield. Piecemeal modelling cannot be relied on, although sub-models would help. Faults should be explicitly modelled and to within 10m accuracy. Nirex recognises that a more realistic 3-D model needs to be developed.

6D.52 Likewise, the impact of the RCF on baseline conditions needs to be rigorously modelled, in the wake of the scoping study Nirex 560 [FOE/5/19], before RCF development commences, but the baseline conditions themselves first need to be re-established [6C.133]. Baseline conditions are being disturbed by cross-hole testing and the RCF3 Pump Test so Nirex's assessment of baseline establishment [NRX/14/3] was premature. FOE are sceptical that model validation can be achieved for some years, especially with peer review of the results [WR/FOE/24]. Nirex concedes that much of the modelling on which it relies is at an early and unproven stage yet it moves on from objectively unsuccessful experiments, claiming that sufficient has been learned.

6D.53 Models used to quantify fracture flow are in their infancy [eg FOE/6/21, s.6] and have not been validated in FOE's view. Nirex concedes that fracture flow modelling is very demanding, and progress has been limited by absence of data, particularly at the larger scale. FOE contend that upscaling from DFN to CPM models is also problematic. Nirex concedes that NAPSAC was used rather inappropriately in a Stripa test, and that a model relying on some NAPSAC inputs failed to predict a reduction of flow following excavation in a validation test [FOE/6/15, p.S28]. The only cross-hole testing reported by Nirex showed very little correlation with the predicted distribution of likely responses based on detailed assessments of the Environmental Pressure Measurement tests [NRX/15/16, s.6.3, p.136]. In view of the random and extensive faulting of the host rock FOE do not find this surprising and regard the PRZ as a very difficult site to model [6C.120]. They support Greenpeace's proposition that RCF excavation would exacerbate validation problems, citing experience in Sweden and Canada. In its turn, Cumbria doubts that modelling of Type III features would be validated by the RCF because it believes they need deterministic characterisation.

6D.54 FOE criticise Nirex's relative lack of sensitivity analyses and heavy reliance on estimates of parameter values critical to the safety case, suggesting that the modelling is prone to serious error. For example, although the existence of pathways through the Brockram has been considered possible since 1937, in 1994 the elicitation group viewed the Brockram as a low permeability formation in setting conductivity values. Also, the value given to the Latterbarrow Sandstone is below the normal textbook range for sandstones and has only been partly modelled in Nirex 95, and there is a failure to take into account in the base case the dominance of vertical features in the St Bees Sandstone. Modelling at a higher conductivity

would have helped explain the observed high BVG heads at depth, but have increased the volume of groundwater flow through the PRZ [WR/FOE/23]. The potential for additional vertical flow within boreholes themselves is a further omission from the models.

6D.55 FOE emphasise that the hydrogeological behaviour of the PRZ has had to be modelled so far on a base case and on variants, including those where high heads are imposed and a transmissive feature at depth assumed [COR/522.Vol.3,Figs.7.14 & 7.16], in order to reconcile observations and modelled predictions [COR/522.Vol.3,p.7.4].

6D.56 Nirex's near-field modelling is regarded by FOE as very preliminary and unsophisticated in its application to RCF construction and sealing [6C.131-2]. Important phenomena such as interface flow have been neglected and inferences have been unjustifiably drawn from experience in Canada and Sweden where there is a different rock structure [6C.105-106].

6D.57 FOE consider that the model used to quantify the behaviour of the NRVB is unrealistic and unreliable [6C.127]. Modelling, and the concept, have many shortcomings and the model has not been validated. For example, homogeneous chemical conditions are assumed within the backfill yet are unlikely; there are no measures to eliminate interface flowpaths between backfill and rock; the backfill would not impose significant delay in the saturation process or reduce flow through the DWR (eg for  $^{36}\text{Cl}$  and  $^{129}\text{I}$ ); and the assumption that NRVB would retain its anticipated physical and chemical properties over the required timescales is open to doubt. Also HMIP have already been critical of Nirex's geochemical modelling and data [6C.123], and the Royal Society have expressed concern [6C.45]. Some 5 to 10 years of work would probably be required before an acceptable geochemical model could be ready for the next cycle of safety assessment. These doubts are shared by Greenpeace [6C.125] and Mrs Higham [6C.129].

6D.58 On uncertainty, FOE point out that for PDFs to be effective the processes underlying the element of the system it is intended to model must be understood. That understanding is open to doubt, for example, in respect of radionuclide transport behaviour in the DWR vaults [COR/529, p.58] [6C.123].

6D.59 My conclusions in this Chapter relate to the vital roles played by conceptual & mathematical models in showing that the proposed DWR would be safe at the preferred location. It is agreed that the models must be based on a sufficient understanding of the geology & hydrogeology, and the main issue between the parties on model development is whether Nirex's understanding of these & related matters has advanced far enough to enable it to proceed effectively with the RCF.

6D.60 Most of the items of concern relate to modelling of the groundwater pathway, but it may be instructive first to look briefly at other potential pathways for the transport of radionuclides from the DWR to the human body. The lack of a model for gas migration through the geosphere, and its inter-action there with other media, seems an obvious gap in resolving this key uncertainty. The promised research results on gas-water inter-action would not completely fill that gap. The RCF would be a unique opportunity to investigate gas migration, and this is one of the specific research topics mentioned by HMIP to the inquiry.

6D.20 Yet there is no indication that Nirex would have a migration model, as distinct from a gas  
6C.92-3 generation model, ready for testing in Phase 1 of the RCF. Its evidence to the inquiry has  
relied simply on experiments elsewhere and its scoping studies.

6D.61 On the other hand, human intrusion or natural disruptive events are pathways which  
I would not expect to be fully susceptible to detailed modelling. In my judgement, they are  
6D.3 generally being approached in the right manner by the deployment of a number of techniques  
whilst being integrated with the main modelling where practicable. Nevertheless, the  
6D.4 Assessor advises me that a greater understanding of fracture flow through the BVG is  
required before serious attention can be given to transient seismic effects or the consequences  
of more permanent stress changes.

6D.62 Although the RCF should contribute to such understanding, this obstacle is also one  
6D.9 of Nirex's basic modelling problems, which frequently recurs in examinations of the core  
6D.47 modelling activities and their development for the groundwater pathway. Certainly I agree  
with Nirex that a complete understanding of all processes is not essential to the assessment  
6D.25 of system performance: indeed such an understanding is unachievable because the natural  
world is so varied & complex. Also I accept that the acquisition of more data does not  
necessarily improve the predictive ability of models. But this emphatically does not mean  
that Nirex's model development could successfully proceed without a robust grasp of the  
fundamental processes or without basic amounts of credible data. I am sure that these would  
6C.156 be expected by the continuing peer review which the draft regulatory guidance stipulates  
6C.153 uniquely for the model development programme: and the demands of objective data  
6C.154 elicitation & transparency would also militate against obscurity of concept or content.

6D.63 Chapter 6E carries forward the discussion on uncertainty, but a few underlying  
6D.43 points should be made at this stage. In some of the exchanges during the inquiry, one person's  
6D.26 error bar has seemed to be another person's uncertainty distribution range. Although this is  
a semantic point, it emphasises the analytical necessity to be clear about the type of  
6D.25 uncertainty under consideration. Nirex's probabilistic assessments & conservative  
assumptions are of course 2 main ways of treating some kinds of uncertainty, and yet they  
have their limitations like all such techniques. It seems to me that some of the resistance by  
other parties to the extent of Nirex's stochastic modelling may be due to a lack of awareness  
of the recent achievements of such methods in similar disciplines such as epidemiology. On  
the other hand, Nirex sometimes needs to be reminded of adages such as that the quality of  
6D.54 the output depends on the quality of the input, and that different averages should not be  
6D.49 averaged. The possibility of further human error should be considered when examining, for  
6D.26-7 example, the reliability of an elicited distribution range or occurrence probability value.

6D.64 Similar strictures could be applied to assertions such as that biosphere assessment  
6D.28 modelling has been designed to ensure that there are no important omissions. The fraction  
of the radionuclide discharge going to deep soils is actually conceded by Nirex to need  
6C.126 amendment. More generally, even if some of Cumbria's criticisms are over-stated, Nirex  
6D.13 also accepts that a new dynamic model for the biosphere needs to be developed. Yet I am  
advised that time-variant models incorporating climate change & other evolutionary driving  
forces seem to be still at an early stage, and that the numerical models have yet to be  
COR/507 developed. Whilst biosphere modelling is not directly related to the RCF, this situation

should be taken into account when considering claims of the promise shown by modelling work to date, or the realism of the timetable which incorporates the RCF programme.

6D.65 Nevertheless, I also agree with Nirex that some of its opponents have not always appreciated or recognised important aspects of its groundwater modelling work. The promotion by FOE of a unified 3-D time-variant model of the Sellafield area seems to be partly due to such a lack of appreciation, coupled with a counsel of perfection. Nirex is able to produce 3-D digital maps which synthesise available information. But so far as real conceptual & mathematical modelling are concerned, the advice to me is that practicability demands both a multiplicity of models and a frequent preference for 2-D models over 3-D ones. FOE appear also to have confused the development of one comprehensive 3-D model with the several needs for more 3-D modelling of various sorts.

6D.66 However, I am also advised that these needs are very strong. The topics to be covered are familiar ones by now, involving broad-brush 3-D approaches towards investigating the historical evolution of the groundwater system; towards a better understanding of present hydrogeological conditions around the District; towards coping with climate change & other transient driving force scenarios; and towards exploring the effects of varying the location of the DWR within the PRZ. The first 2 topics are indirectly related to the RCF inasmuch as they would enhance knowledge of its setting and might help focus the investigations & experiments within it, whilst the last topic is directly connected to the position & timing of the RCF, in my view.

6D.67 The advice to me adds, moreover, that the characterisation of the PRZ in the vicinity of the RCF would require more detailed 3-D representation of the geology & hydrogeology: and this brings us back to the crux of the contentions about the extent of Nirex's understanding of the fundamental uncertainties in both the relevant modelling and the host environment. In the first place there is a generic problem in that most of the fluid flow through the PRZ, especially the BVG, is believed to be through fractures, and yet the physics of such fluid flow is poorly understood. Models of the discrete network type ought to be best for rock hydraulic modelling, but even the sophisticated NAPSAC package cannot meaningfully represent a 3-D geometrical distribution of fractures.

6D.68 The similarly advanced CPM model, NAMMU, could be an adequate tool for the investigation of flow in the rock mass, but it cannot on its own determine whether short-cut flow paths to the biosphere are possible nor allow for changes in rock stress or temperature. Moreover, there is a difficulty with scaling up the parameter values of the BVG. Although the REV must always be site-specific, the borehole tests suggest particular problems at Sellafield due to the unusual complexity of the volcanic rocks, for instance the preferential channelling of the flow through only a small proportion of the fractures. The Assessor advises me that this exemplifies serious difficulties in applying NAMMU to the BVG.

6D.69 Nirex is developing a linked NAPSAC-NAMMU model, which appears to me to be a significant step forward, but for the moment it seems restricted to a simplistic representation of each individual volume of rock. Another very important advance in multiple models would be the thermo-hydromechanical model which would be able to incorporate deep geothermal effects as well as the heat generated within the repository. Nirex has intimated that the former might well help account for discrepancies with observed head & salinity

6D.24 distributions in its present regional-scale model, which the preliminary assessment modelling  
in Nirex 95 had to grapple with. However no description of this model was published by the  
close of the inquiry. Whilst making it available would, so I am advised, entail a revision  
rather than a replacement of the regional conceptual model, it seems that Nirex may well be  
6D.32 unduly optimistic about the work still to be done on such a coupled model and its  
incorporation into the overall set of models.

6D.42 6D.70 This is particularly important because the inability of the current concept & its  
6D.55 derivatives to match observed heads & salinities is a fundamental defect, in my view. The  
advice to me is that, in a coastal location like Sellafield, calibration of a broad groundwater  
model is typically based on obtaining the best fit between simulated and measured heads &  
6D.15-21 salinities. Debates at the inquiry about verification, calibration & validation have had a large  
6D.35-40 semantic element and been subject to preconceptions on both sides, not unlike the discussions  
6D.49-53 on uncertainty. But, even when adopting the strictly practical approach of fitness for purpose  
from the initial calibration stage, there is no escaping the fact that the current conceptual  
model at the core of Nirex's modelling cannot account for some basic processes & parameters  
of the hydrogeological system. The new model which is promised in order to cope with this  
problem is of completely unknown quality. The Assessor also considers that conditions &  
6C.194 processes going on at depths well below the proposed DWR are likely to have to be addressed  
6D.46 in due course.

6D.71 In my view, Nirex should not be contemplating a start, in the form of the RCF Shaft  
2B.15 Sinking, of what may be a long-term perturbation of the centre of the system before resolving  
6D.52 this matter. Although baseline conditions are effectively a mere snapshot in time and it is not  
6C.78 necessary to know that the system has returned to complete baseline conditions after any  
particular intrusion, as the Assessor points out, any imposition of stress for model testing  
6C.178 purposes must be done in a controlled & measurable way. This would be impossible for  
6D.53 other tests in the midst of a large drawdown experiment. Still taking the strictly practical  
6D.35 approach towards verification, calibration & validation, but allowing for the necessary peer  
6D.32 & 39 review, it is very difficult to see how Nirex would develop its models sufficiently in this  
2B.9 regard by the proposed start date. This would be even after delays in obtaining planning  
6C.103 permission not foreseen by Nirex until last year. The realisation that before then Nirex was  
planning to go ahead on a now plainly inadequate timescale for model development is of  
particular concern to me.

6D.34 6D.72 There are other basic modelling problems too. Although Nirex does appear to have  
6D.48 a better understanding than Greenpeace of the controls on flux through the DWR & geosphere  
6D.21 travel time, and of course the RCF should make an invaluable contribution to model  
6D.36 calibration & validation, Nirex has been evaluating no fewer than 6 alternative conceptual  
6D.32 models of groundwater flow within the BVG. This evaluation has been in the course of the  
COR/518 RCF3 Pump Test, of which the final peer-reviewed results are not available, even though  
6D.53 Nirex has been relying heavily on some preliminary results. The Assessor regards this Test  
6D.40 as the first & an imperfect validation exercise for models of the PRZ, in comparison with  
6D.50 Nirex's belief that the initial validation cycle was the Borehole 2/4 cross-hole testing.

COR/507 6D.73 It also seems that Nirex has been conducting random sampling from the output of  
6D.49 alternative models according to allegedly defensible degrees of belief in the models, but I

share the Assessor's scepticism at such a practice, since in my view that criterion must run a serious risk of being merely circuitous.

6D.74 In fact, difficulties are apparent along the length of the groundwater pathway. In modelling the near field there are simplifying assumptions about the release of individual radionuclides into the groundwater which would need to be refined well before preparation of the DSA, according to the Assessor. A basic point about the geosphere is that the steps being taken by Nirex formally to quantify basic geological uncertainties, such as the precise identification of faults & major stratigraphical units, are not clear-cut. Then again, Nirex's ignorance of the actual conductive properties of the major faults, on which I have already commented, is reflected in its modelling, as noted by the Assessor, who emphasises the great effect on flow path-lines & transit times of the assumptions made about the fault zones.

6D.75 A phenomenon not otherwise emphasised much is the potential for sideways dispersion in the plume of radioactive groundwater. This becomes of importance in Nirex's rebuttal of the worst implications of the agricultural wells scenario discussed in the next Chapter, and the Assessor remarks that there appears to be considerable uncertainty over the effects of transverse dispersion even though it can have a marked effect on safety assessments. Yet other needs, in his view, are for more exploration & modelling to investigate both divergent flow away from the PRZ across the SFZ to the south, and the influence of the Carboniferous limestone to the north.

6D.76 Much of such work would not be directly related to the RCF. However this review of model development indicates that there are many uncertainties yet to be adequately treated both in the modelling techniques and in the features to be modelled. The overwhelming impressions are of a large volume of work to be done and of a powerful drive to speed through it, sometimes without due regard for the chronological or statistical niceties. In turn this haste raises questions about the degree of confidence in the decisiveness of the preliminary modelling work. This rather negative effect is perhaps typified by the final points that the only study submitted to the inquiry on the perturbation & safety assessment effects of the RCF looks distinctly out of date, whereas the various groundwater flow models now under consideration do not appear to be sufficiently well developed yet to credibly predict such effects.

## 6E. RADIOLOGICAL PROTECTION & SAFETY ASSESSMENT

6E.1 The principal risk posed by a DWR is from the escape of radionuclides from the emplaced waste and subsequent exposure of people [6A.2]. HMIP regards the duration of the risk as being mainly dependant on the rate of decay of the radionuclides in the waste. Potential pathways, namely gas, human intrusion, natural disruptive events and groundwater have been modelled to varying degrees by Nirex [Chapter 6D]. A preliminary analysis of the most important pathway for a DWR, namely groundwater, has been carried out (Nirex 95 - COR/522) as part of the evolving progression of the post-closure performance assessment for the PRZ. Nirex 95 does not purport to be a comprehensive assessment [6D.5] but brings together Nirex's understanding of the processes as at early 1995 and factors which, for the groundwater pathway, determine post-closure safety performance [COR/522, Vol.3, Preface, para.2].

6E.2 Timescale. Radionuclides in the proposed waste inventory have half lives extending to 4,468 million years [6A.4]. In the light of national and international guidelines [6A.7-6A.25], Nirex uses a timescale of  $10^6$  years for risk calculation in Nirex 95 but, together with the regulators, RWMAC [GOV/409, paras.3.30-3.31] and NRPB [NRX/15/3, Doc.2, paras.84 & 93], believe that quantitative risk prediction is inappropriate for the later parts of this period and particularly beyond  $10^6$  years [COR/526, s.5.4, p.23]. The very long timescales involved would require multiple and complementary lines of reasoning to support qualitative assessment [6A.21], although the threshold for such a requirement might be as low as a few thousand years [GOV/503, s.6.1]. The Intergovernmental Panel on Climate Change has made predictions for 125,000 years [COR/527, pp.22-23] but more work is being done by Nirex to achieve dynamic modelling [6D.13]. Tectonic stability needs to be related to the duration of risk [NRX/14/2]. HMIP would probably be unable to accept a safety case based on maintaining control of the site for more than a few hundred years, and any post-closure monitoring would be primarily for public re-assurance [HMP/1/1, paras.6.4 & 7.24].

6E.3 Uncertainty. The risk target for post-closure safety is  $10^{-6}$ /y of developing either a fatal cancer or a serious hereditary defect [6A.18] with no upper bound on optimisation [6A.68]. As a matter of policy, where there is uncertainty, and potentially serious risks exist, precautionary action may be necessary [GOV/208, para.50]. However, the lifetime dose threshold entailed in the current risk target errs on the side of caution [6A.18]; and the regulators would require that the safety case takes adequate account of all relevant uncertainties [HMP/1/1, para.8.17].

6E.4 The NRPB and HMIP categorise basic uncertainties in different ways. The NRPB has grouped uncertainties under the 3 main modes of risk assessment - conceptual, modelling & parameter [NRX/15/3, para.43], and Nirex has broadly followed these in terms of model development [6D.22]. However, the Board also sub-divides parameter uncertainty into 2 types - objective uncertainty which exists as a result of the inherent unpredictability of random processes, and subjective uncertainty which arises from the fact that human knowledge of any complex system will be incomplete [idem, para.43].

6E.5 The Board has advised that the 3 main categories of uncertainty be addressed in turn by a series of calculations [NRX/15/3, para.85]. The calculative techniques suggested are



sensitivity analyses, alternative models, and comparisons with field studies & natural analogues; a series of scenarios representing qualitatively different possibilities, with "central value" risk calculations for each; and uncertainty analysis, giving a probability distribution of risks. To provide reasonable reassurance that the target would not be exceeded, the likely parameters of interest would be the central value and an upper percentile of the distribution obtained from uncertainty analysis [idem, para.86].

6E.6 The draft regulatory guidance also regards the treatment of uncertainty as central to the safety case [HMP/1/1, para.8.15]. However, the uncertainties to be assimilated into the structure of the case are categorised not by mode of assessment but by source, to include those arising from natural variability, practical sampling limitations, alternative interpretations of data, and natural events & human activities. In these terms, Nirex has categorised 3 main areas of uncertainty about the PRZ, and encompassing 10 particular key uncertainties [6C.50], on which its case on the need for the RCF is founded.

6E.7 As to treatment, some uncertainties are said by the guidance to be common to all radiological assessments, and so can normally be left implicit [idem, para.8.16]. Others may be eliminated by making simple deterministic assumptions based on reasoned arguments: and some which it is inappropriate to quantify may be treated by exploring variations of baseline deterministic assumptions. Other uncertainties may be quantified and incorporated into numerical assessments of probability or risk. Thus the safety case is expected to include probabilistic risk assessments of the disposal system [idem, para.8.21].

6E.8 The "Critical Group" is intended to typify the people whose health is likely to be most affected by radioactivity from the DWR in any scenario. In 1985, the ICRP specified that the group should display homogeneity in location, habits & metabolic characteristics affecting the doses received, and advocated the use of cautious but reasonable assumptions so that no individual doses are unacceptably high [CCC/5/12, para.46].

6E.9 The NRPB has given a similar definition in its 1992 Board Statement [NRX/15/3, para.28 & p.24]. The NRPB, together with MAFF & HMIP, have also published more recently the results of a 2-year joint study on critical group doses around nuclear sites. This concludes that current critical group methods are generally adequate, but stresses the importance of considering the combination of relevant exposure pathways in assessing doses [GOV/208, p.10, para.38].

6E.10 The NRPB's 1992 advice, however, distinguishes between routine effluent discharges and releases from a solid waste disposal facility, due to the much greater uncertainty in the case of the latter [NRX/15/3, paras.28 & 30]. Thus, for such a facility, there can only be "hypothetical critical groups" who, unlike the group for routine effluent discharges, must exist at the place where the relevant environmental concentrations are highest at any given time in the future. Also the hypothetical groups are the ones expected to experience the highest risk [idem, para.30 & p.24], whereas the critical group for routine discharges is the one that receives the highest doses [idem, para.28].

6E.11 The Board also advises that the habits of the hypothetical critical groups should broadly represent the habits of observed present-day critical groups, but should not be based on the most extreme examples [idem, para.83]. Moreover, for times beyond about 10,000

years, the critical group should be replaced by a hypothetical reference community with habits broadly typical of those of subsistence communities in the present day [idem, para.84]. Again, the reference community is to be located so as to be representative of individuals exposed to the greatest risk, at the point of highest relevant environmental concentrations; and its conservatively chosen habits should be internally consistent [idem, para.39].

6E.12 In compiling Nirex 95, Nirex has generally followed the advice of the NRPB. However, the second version of the draft regulatory guidance [HMP/1/1] introduces some proposed modifications in approach. The concept of the critical group as the one expected to experience the highest risk would be dropped, with the retention of one simple definition identical to that in Cm 2919, namely "those members of the public whose exposure is reasonably homogeneous & is typical of people receiving the highest dose from the given source" [idem, pp.5 & 6]. Nevertheless, whilst the pre-withdrawal radiological Requirement is consequently expressed in terms of the effective dose to a representative member of the critical group, the post-withdrawal Requirement relates to the assessed radiological risk to a representative member of the group [idem, pp.21-22].

6E.13 The radiological risk is in turn defined as the product of the probability that a given dose will be received and the probability that the dose will result in a serious health effect, summed over all situations that could give rise to exposure to the group [idem, para.6.10]. Nevertheless it is made clear that different groups may need to be considered at different times, and also at the same time in order to cater for different possible circumstances [idem, para.6.12]. Whilst for the very near future groups can be based on actual population subgroups expected to receive the highest doses, for the further future the second draft reverts to hypothetical critical groups to typify potentially exposed populations. But the concept of a reference community is specifically dropped [idem, bottom of p.22].

6E.14 Nirex's response to the second draft seeks the restitution of the full ICRP & NRPB distinction between critical groups receiving doses from routine effluent discharges and hypothetical groups located at the highest environmental concentrations & exposed to the highest risks [NRX/12/17, S.2.2 & Annex]. It emphasises the 1992 NRPB comment that, although (by definition) exposure within the hypothetical group is relatively homogeneous in terms of risk, any dose which actually occurred would be confined to a very small number of that group.

6E.15 Nirex proposes an expanded definition within the guidance, to refer to people at risk of receiving the highest exposures, rather than doses; and to say that for solid waste disposal assessments the exposure may be evaluated by reference to an average individual within the hypothetical group. However, its response does not criticise the suggested omission of the reference community.

6E.16 Overview of Preliminary Safety Assessments to Date. The Sellafield location has been assessed for radiological safety on a number of occasions since the MADA exercise. In the 1989 review (Nirex Report 71 or PERA - COR/501), Nirex concluded that the predicted risks would meet regulatory targets [COR/501, para.8.1.6 & s.8.14] although the MASCOT program did not address a number of effects at that time [6B.28]. The next assessment was Nirex Report 337, released in 1992, which was reviewed by independent consultants on behalf of HMIP [FOE/5/20-25, FOE/8/27 & FOE/8/51] and is mentioned in

6C.89, 123 & 154. Assessment capability at the end of 1994 was reviewed in Nirex Report S/94. The overview [S/94/001] illustrated the risk target being met [COR/507, S.6, Figs.5 & 6] and outlined continuing development of models and methodology. Nirex 95 [COR/522] represents the most up to date assessment submitted to the inquiry [6D.5]. Its modelling is summarised in 6D.5-24 and in the Assessor's Report [Appendix 1].

6E.17 Nirex 95 explores both a probabilistic base case with several variants and a base case comparison with 6 variant deterministic calculations [6D.23 & 24]. It concludes [COR/522, Vol.3, s.9] that for discharge of all radionuclides to the marine environment, risks would be at least 3 orders of magnitude below the regulatory target; and for the Temperate climate state, when some terrestrial discharge would occur, there would be a comfortable margin before the risk target was reached [idem, para.(g)]. In the Boreal climate state, with a lower sea level, the peak risks would still be of the order of  $1.1 \times 10^{-7}$  at 20,000 years after closure and  $3.3 \times 10^{-7}$  at 4 million years after closure [idem, para (h)].

6E.18 Nirex 95 calculates that changes in risk from the base case for the deterministic variants range from an increase by a factor of about 2 or 3 to a small reduction [idem, s.9.1, p.9.3]. Its conclusions on the risk control factors are summarised at idem, s.9.2.

6E.19 On the basis of further preliminary calculations, Nirex 95 concludes that, for agricultural wells in the Temperate climate state the preliminary estimate of peak risk to a critical group of about 10 children living in the relevant community resource area [COR/522, Vol.3, p.6.18] is  $1.7 \times 10^{-6}$  on the basis of an assessment for  $^{36}\text{Cl}$  and  $^{129}\text{I}$  only.  $^{129}\text{I}$  is considered by Nirex to be the major contributor, with the peak risk occurring at about 4,000 years after DWR closure from concentrations in groundwater in the region of the Fleming Hall Fault Zone, to which the travel time would be shorter than to the region where radionuclides from the DWR would be naturally discharged [idem, paras.(a) & (b), p.9.2].

6E.20 Nirex submits that Nirex 95 provides sufficient confidence in the potential of the PRZ to justify the grant of planning permission for the RCF. The results of research to date suggest that a very high level of containment should be maintained by the physical barrier for at least 1,000 years during which some 99% of the waste in the repository would decay. Undue reliance is not being placed on the engineered and chemical barriers. Indeed, it is conservatively assumed by the Nirex 95 base case that all radioactivity would be available for release immediately upon closure of the DWR [COR/522, Vol.3 Section 6.1.3 p.6.2]. The chemical barrier would operate for around 1 million years and would act to contain around 99% of the 1% of the long-lived radionuclides not contained by the physical barrier [NRX/15/43, Fig.5.1]. The groundwater flow would then be the main agent transporting the remaining radioactivity through the natural geological barrier. This radioactivity is put at 0.01% of that of the emplaced waste.

6E.21 Nirex regards its probabilistic approach to modelling as unchallenged. The plotting of risk, or expectation value, against time [eg COR/522, Vol.3, Fig.6.7] is the only proper basis upon which to compare outcomes against the risk target, a point specifically conceded by Cumbria. Complexity does not equate to unpredictability. It would be a matter for concern if there were a significant spread of risk values greater than  $10^{-5}$  despite an expectation value of risk below  $10^{-6}$ . In that event remedial measures would be taken unless

the values were an artefact of modelling in the very long term. The precautionary principle would be applied by meeting the risk target and by identifying, and dealing with, all uncertainties in a robust manner and by employing best practicable means.

6E.22 Nirex 95 demonstrates a conservative approach to modelling and safety assessment. This is achieved in a number of ways by the use of appropriate parameter distributions and values [COR/507, pp.3-4] and by conservative assumptions including unrestricted access of groundwater to wastes immediately after DWR closure [COR/522, Vol.3, s.3.3.1(a), p.3.7]; release of radionuclides from DWR vaults to Type II features which are the shortest route across the BVG [idem, s.3.2.4, p.3.5]; the absence of mineralisation as a mechanism for reducing  $^{238}\text{U}$  solubility; and reduced sorption in the near-field. In the case of the agricultural wells scenario, the assumptions are of an encased well at the maximum depth consistent with local practice in the subsistence community scenario, and ignoring the likelihood of shallower wells intercepting an adequate water supply [idem, pp.6.18-6.20]; meeting all of a farmstead's water requirements by means of the well; and the absence of recent meteoric water from the well water [idem, p.6.19].

6E.23 Additional examples of conservatism are the reduction of radionuclide sorption in the geosphere by the use of organic enhancement factors [FOE/8/9, s.5.2.2, pp.59-60]; treatment of sorption by use of distribution coefficients ( $K_d$  values); the effect of channelling within fractures; the simplifications in the calculation of risk from radioactive gases ( $^{14}\text{C}$ ); and the selection of a factor appropriate to U(IV), by which the solubility of uranium in the near-field is multiplied to take account of organic materials, which gives the highest solubility limits [COR/522, Vol.3, s.6.1.6 (end), pp.6.6-6.7].

6E.24 It refutes the suggestion by FOE that there are errors of 10,000 fold in its sorption database, putting it down to a misunderstanding of the process in question which accommodates uncertainty. FOE's proposition is somewhat equivocal, and they concede that, as understanding improved, the PDFs would become sharper. Moreover, criticisms of various aspects of its understanding of the system, such as modelling of the BVG, do not amount to criticism of the PDFs themselves in Nirex's view.

6E.25 The Nirex 95 base case results in curves of risk against time for appropriate climatic states [COR/522, Vol.3, Fig.6.6] all of which fall within the risk target of  $10^{-6}$  [idem, Table 6.18]. Variant models have been investigated to explore issues that were not identified within the base case model [6D.24]. These variants provide confidence in the preliminary base case risk assessment.

6E.26 The inability of the base case model to fully reproduce the high heads observed at depth in the vicinity of the PRZ was expected [idem, para.7.3, p.7.4] and enabled Nirex to recognise that a feature or process not included in the current model needs to be incorporated, such as a geothermal flux at depth [6D.32]. On the basis of the variants the system is robust to changes in the duration of the release of radionuclides from the DWR if the spreading time in the geosphere is constant and to changes in the spreading time if the duration of their release remains constant, the 2 being independent. Greenpeace's observation that the sensitivity of risk to flow through the DWR should be investigated is precisely the object of the RCF and for which the RCF is essential. The marginal factor for meeting the risk target

of increases above the base case is about 60 or 70 fold but imposed heads only increase flow by a factor of 2.

6E.27 Nirex contends that FOE's view that a time-variant 3-D model of the Sellafield region should exist in order to assess the impact of the RCF misunderstands the requirements at this stage. Some 3-D modelling has been undertaken and the simplification to 2-D models in Nirex 95 has been undertaken conservatively. Three dimensional modelling would be carried out in response to specific requests by the regulators.

6E.28 On geochemical processes, objectors have failed to appreciate the implications of the presence and effects of oxidising or reducing conditions in the groundwater, minerals surface chemistry and sorption. These are all matters being progressed as part of an integrated approach to developing the safety assessment. FOE for example misunderstand the relationship between activity coefficients and ionic strength [NRX/15/30].

6E.29 For colloidal transport of radionuclides to be a problem in the safety assessment, a number of unlikely factors must occur simultaneously. Preliminary investigations suggest the colloid population to be low in the PRZ groundwater and natural analogue studies suggest colloids would not cause difficulty. The issue can only be explored through a combination of continued laboratory studies, natural analogue studies and in situ observations in the RCF. The fact that Nirex 95 does not explicitly take account of the possibility of colloid transport does not therefore render the assessment in any way deficient.

6E.30 Nirex refutes the suggestion that it may have overestimated the extent to which sorption would constrain the transport of radionuclides in the far-field. It points out firstly that no account has been taken of the reduction in transport due to only a fraction of the available sorption sites in the rock being accessed by radionuclides; and secondly that the assumption that organic degradation products would attenuate sorption throughout the BVG at a level fixed by organic concentrations in the DWR is conservative.

6E.31 Criticism of the assessment of the impact of the RCF on groundwater flow and on risk from the groundwater pathway (Nirex 560) [FOE/5/19] is misplaced [6C.95]. Backfilling and sealing qualities to satisfy the safety case are planned for the RCF to satisfy the regulators. Cut-off collars, suggested by FOE, are under active consideration.

6E.32 Although the process of climate change has not been modelled so far, except for biosphere scenarios, Nirex 95 is not flawed because the peak risks from  $^{36}\text{Cl}$  and  $^{129}\text{I}$  are predicted to occur before any significant climate changes are expected by experts in the field. The effect seen in "Dry Run 3", carried out on behalf of HMIP, was attributable to an implausible treatment of human habits rather than any geological phenomenon.

6E.33 Nirex regards agricultural well calculations as simply scoping studies leading to a preliminary assessment, based upon significant conservatisms and without taking account of the effects of any optimisation opportunities. Optimisation could be achieved by storing wastes so as to minimise their effects. The inventory could be favourably disposed in relation to Type II features; DWR depth could be reviewed; and long lived radionuclides could be placed in a silo away from the main vaults or flow channel, bearing in mind that 50% of  $^{129}\text{I}$ , the main contributor to risk, is contained in only about 500m<sup>3</sup> of waste.

6E.34 Nirex contends that the justification of the choice of the critical group is a matter for the regulators in due course, and it certainly cannot be said that the regulators would be bound to reject its approach since that accords with current guidance. It refutes Cumbria's assertion that the critical group should be placed above the greatest concentrations in the plume. The assumption is that a subsistence community exists in the resource area containing the highest environmental concentrations and then appropriate critical groups are identified within this reference community. This is the smallest credible community [COR/522, Vol.3, p.6.18], and so the risks are calculated across the complete resource area even though only part of it would contain contaminated groundwater. The scenario is an example of individuals with the same habits and behaviour constituting a group which is homogeneous with respect to risk, but not necessarily with respect to dose [NRX/13/5, p.3]. Moreover the exposure to risk which is evaluated is that to an average individual within the critical group [NRX/12/17, paras. 2.2 & 6.5].

6E.35 Cumbria's assertions of increased risks in the agricultural wells scenario [CCC/5/7] are greatly exaggerated in Nirex's view and it contends that they are not supported in terms of factual information or the suggested approach. A more realistic treatment of the scenario is more likely to lead to a significant reduction in risk. For example, in the case of a well assumed to be somewhere within the plume, transverse dispersion should be taken into account, reducing the factor increase suggested by Cumbria from 5 to 2.5 [NRX/15/25, s.2]. In the case of the peak concentration in the plume, at 50 m bOD this is about  $2.3 \times 10^{-3}$  (relative to the initial concentration of 1.0 at the DWR) [idem, Fig.1], compared to the average concentration over the plume of  $7.46 \times 10^{-4}$ . This gives a ratio of peak to average concentrations of 3:1 and not an order of magnitude as suggested by Cumbria.

6E.36 As to well depth and calculated path-line radionuclide concentrations, the steady state calculations [COR/522, Vol.3, Fig.2.11] do not provide as realistic an estimate of dilution of  $^{36}\text{Cl}$  and  $^{129}\text{I}$  as in the transient case [idem, Fig.2.12], which Cumbria concedes may be so, because the steady state calculations neglect the effects of the finite duration of the source term and spreading in the geosphere which would lead to greater dilution [idem, s.2.3, p.2.12]. Also, the chosen well depth of 88 m (50 m bOD) at the location of the FHFZ is conservative because it is deeper than the most likely well depth needed for this scenario [NRX/15/25, s.4, pp.2-3]. Moreover there is no basis for Cumbria's assumption that the ratios between the base & variant cases for radionuclide concentrations tapped by the agricultural well would be the same as for the respective fluxes in their natural discharges to the biosphere.

6E.37 Indeed, some of Cumbria's mistaken assumptions about the agricultural wells scenario also affect the authority's general critique of Nirex 95. Although some of the variant groundwater flow calculations do give rise to higher risks for natural groundwater discharge, albeit by no more than a factor of 2 to 3, other variant calculations give rise to lower risks. Nirex considers that it is therefore unreasonable to assume that a revised, more realistic hydrogeological model would lead to a higher calculated risk of the order of 3 [idem, s.5, pp.3-4]. A range of models should be considered, especially as some of the variant calculations producing lower risks are more compatible with recent observations than the equivalent part of the base case model. Cumbria cannot say whether higher risks would result from further investigation and assessment; and Nirex rejects the higher risk values given by Cumbria to the preliminary estimate of peak annual individual risk.

6E.38 Nirex also regards objectors' concerns about potential pollution from the marine discharge as unwarranted [3C.16-17]. For example, contamination of coastal sediments would be extremely small [NRX/15/34, paras.9-12]. The further dilution achieved by marine discharge is not crucial to the safety case. On the other hand, a predominantly terrestrial discharge of radionuclides in the location of the exposed sea bed in the base case would be inconsistent with its knowledge of the groundwater flow system. A scoping well calculation for this scenario, as suggested by Cumbria, is not therefore called for in Nirex's view.

6E.39 Nirex refutes Greenpeace's suggestion that solubility of uranium has been underestimated in Nirex 95, resulting in the risk target being exceeded, because it is likely that, if anything, the PDFs are biased towards values which are too high; and, even if the central value for the PDFs should be a factor of 4 higher, the risk target would still not be exceeded [WR/NRX/1(15)].

6E.40 The scepticism of some objectors that long term risks can be systematically evaluated is not borne out by international opinion [WR/NRX/5(15), para.1]. Furthermore, the evidence suggests that the risk of tectonic and seismic disturbance is low and there is no evidence for significant perturbation of the site by seismic activity over the last 100,000 years [WR/NRX/4(14), para.2 & 6C.99-102 above].

6E.41 Windscale and Calder Shop Stewards Committee points out that BNFL, as the probable agent of Nirex for the emplacement of waste in the DWR, has the facilities, experience and skills in place at Sellafield to deal safely with nuclear waste; and so there is an assurance of pre-closure safety at this location.

6E.42 Cumbria points out that the comfortable margin of 3 orders of magnitude below the risk target in the Nirex base case assumes a discharge into the seabed, and yet the geological evidence suggests that this is subject to considerable uncertainty [6C.109 & 115]. It also draws attention to Nirex's reliance in their safety assessment on substantial dilution of the DWR porewater as it joins the active groundwater system in the overlying sandstones, in contrast to the BUSC environment, and on low groundwater flows through the BVG. The dilution occurs in a sandstone aquifer used as a potable water supply making well scenarios a central issue.

6E.43 The modelling of the base case demonstrates some of the characteristics of this heavily faulted general location, and that upward flow is predicted from the FHFZ. Porewater leaving the PRZ would have significant concentrations of radionuclides and flow only a very short distance below the surface. This is an inherent and unavoidable feature of the performance of the site, in its view [COR/522, Vol.3, Figs.2.7 & 2.12]. The path-lines for the high heads and transmissive feature at depth variants are even closer to the surface than the base case [idem, Figs.7.14 & 7.16] and the variants generally demonstrate great sensitivity to quite small changes in hydrogeological assumptions, so affecting DWR performance.

6E.44 Although the imposed high heads variant is artificial, and the transmissive feature at depth is based upon only one possible explanation of the uncertainty which the variants seek to explore, it is the case that the model does require some adjustment to conform with

reality, and Nirex 95 itself states that the variant outcomes need to be considered with the base case for an overall view of system performance [COR/522, Vol.3, p.7.4]. Nirex concedes that some force is creating a driving pressure from below the volume of rock currently modelled in the PRZ [6D.42] and modelling would have to account for it. It also accepts that a variant case with an increased density of Type 2 features, increasing flow through the DWR and having a shorter period in the geosphere, is relevant. Furthermore, it is conscious that more work is needed to develop a more realistic 3-D model of the geosphere. A recent contractor's report confirms the geological importance of F1, F2, F3 and F202.

6E.45 It is a matter of serious concern to Cumbria and other objectors that there is such a small margin between the final results of the deterministic assessments and the risk target [COR/522, Vol.3, Table 7.7]. This is not to require a cushion on the ultimate prediction of risk below the  $10^{-6}$  target, but to provide one in the interim so that the risk target is likely to be met, or is unlikely to be significantly exceeded, as the safety case is taken forward and new discoveries have to be accommodated. In comparison the BUSC sites would probably provide such a prudent margin, with a deterministic central value of risk of about  $10^{-9}$  or  $10^{-10}$  at this preliminary stage, and so show good promise.

6E.46 Although the modelling of climate change in HMIP's exercise "Dry Run 3", in which the results were unpredictable [CCC/5/1], had limitations, Cumbria does not accept that Nirex can preclude the possibility of unacceptable results when the process of climate change is modelled. The small margin on the deterministic assessments provides a tiny cushion if, for example, climate change substantially reduced the volume of water in the sandstone aquifer available for dilution.

6E.47 The fragility of the safety assessment in Nirex 95 is further demonstrated by the values Nirex has chosen for the fraction of radionuclide discharge going to deep soils in the biosphere calculations (value of "S") [COR/522, Vol.3, page 6.9]. Nirex concedes that the pessimistic assumption in the base case of 0.1 is questionable in the light of further research on the aquatic-terrestrial partition for deep groundwater discharge [NRX/15/4]. Cumbria takes issue with Nirex's revised view that PDF sampling of merely up to 0.2 would now suffice since that the research shows an actual ratio of 83% to 17%. But even if the pessimistic parameter value for "S" were merely 0.2, this would double all the risk results, and the highest variants would fail to meet the risk target.

6E.48 Further doubt on the efficacy of the PRZ as host for the DWR is cast by the peak preliminary estimate of risk from  $^{129}\text{I}$  and  $^{36}\text{Cl}$  versus time for agricultural wells being  $1.7 \times 10^{-6}$  [COR/522, Vol.3, Fig.6.19], breaching the regulatory target. It is standard international practice to deal with well scenarios at an early stage because they can be the worst case for groundwater transport. However, in this case they show signs of becoming the controlling scenario for authorisation. The crucial concession by Nirex in describing its subsistence community is that in using local wells for water, the community is presumed to be capable of digging and lining a well down to 88 m (50 m bOD) [NRX/15/25, s.4].

6E.49 Cumbria points out that the peak risk in the agricultural wells scenario, when radionuclides are predicted to be present in the aquifer, would arise after 4,000 years on the assumptions in Nirex 95 [idem, p.6.19]. This is strikingly short when compared with Nirex's



declared requisite attributes which include effectively static groundwater taking hundreds of thousands of years to reach water courses [COR/203, para.3.1.4]. It believes that Nirex's special measures to optimise the DWR would only deal with about one half of the <sup>129</sup>I inventory, merely reducing the risk to about the target figure on Nirex's calculations.

6E.50 There is also the question of Nirex's irrational approach to the concept of the critical group upon which the assessment is based. By averaging the risk throughout the resource area, some of which is outside the contaminated plume, and so including members of the reference community who are not exposed to the contaminated pathway (as illustrated in CCC/5/14), the risk is diluted. Cumbria contends that the correct approach is to define the critical group as living above the plume, or perhaps even above the greatest concentrations in the plume. These 2 definitions produce very significant increases in risk.

6E.51 The assumption should be made that there is a well in the plume somewhere and all members of the critical group should at least be exposed to the risk. As the Royal Society observes, the probability of occurrence of a well has been commonly taken to be unity in safety assessments in the past [COR/605, p.164]. The importance of this approach is emphasised by the assessment that contamination would come almost entirely from drinking water, especially for <sup>129</sup>I [COR/522, Vol.3, Table 5.9]. The approach accords with the latest draft guidance and the approach of HMIP's consultants [CCC/5/6, s.2.5, p.16]. This produces a risk of  $4.25 \times 10^{-6}$  for the base case in the plume on Nirex's own rebuttal calculations [NRX/15/25], and this is  $1.28 \times 10^{-5}$  when factored by 3 to represent either the highest concentration in the plume or the base case variants and  $3.84 \times 10^{-5}$  for the worst case. Cumbria's figures are  $8.5 \times 10^{-6}$  and  $2.55 \times 10^{-5}$  if the well is assumed to be somewhere in the plume but  $8.5 \times 10^{-5}$  (base case) and  $2.55 \times 10^{-4}$  (variants) if the well is assumed to be at the highest concentration in the plume [CCC/5/7].

6E.52 Cumbria regards Nirex's suggestion that ameliorative factors would significantly reduce the risk as highly questionable. None of those factors is quantified, and they may not transpire at all. To convert the assessment of risk for the variant cases of  $1.28 \times 10^{-5}$  and the base case  $4.25 \times 10^{-6}$  into one which meets the risk target requires a gain of more than an order of magnitude even though every pessimism has not yet been modelled. For example, there are uncertainties over the <sup>36</sup>Cl inventory [6D.43], and the risk from radionuclides having very high concentration factors in coastal sediments and seaweed, which then becomes used for agriculture, has not been modelled. It submits that it is not good planning to concentrate a programme of investigations on a site having such performance characteristics as are demonstrated at Sellafield.

6E.53 Copeland and Gosforth consider that radiological safety should be paramount in DWR development and Gosforth is sceptical about the objectivity of any planning decision concerning the DWR. These views reflect the overwhelming concern of those writing, both locally and nationally, who fear that Sellafield does not exhibit the robust characteristics necessary for the long term [eg WR/B/57, WR/C/146, WR/A/75, WR/T/84]. Many suspect that short term expedients will be given unreasonable weight over safety [eg WR/H/179, WR/K/2, WR/A/79, WR/O/32, WR/V/5, WR/POL/2]. Similar scepticism as to the proper application of the precautionary principle to DWR development is expressed by the Irish and Isle of Man Governments [6A.52-53] and FOE. Dr J Cunningham MP feels that the DWR risks should be ALARA. FOE submit that the removal of time pressures on Nirex

through the requirement to observe all the principles of sustainable development is a significant change in policy [GOV/208, para.42], and means that BPM is essential at every step in the process and not just when making design choices for the final safety case.

6E.54 FOE regard the safety assessment as flawed because of Nirex's inability to model such a randomly complex volume of rock as is found in the PRZ and its accompanying region together with its undetermined geochemical character [eg 6D.54, 6C.120-125]. Nirex is not investigating the possibly less complex horizons at greater depth. Lack of understanding of impacts and processes, lack of data, the failure to establish baseline conditions and the shortcomings in modelling all add to the problem for Nirex.

6E.55 The chemical barrier is similarly suspect [6C.127]. Nirex is assuming the effectiveness of the NRVB when uncertainties exist and it is being made to fit a non-validated model. Insufficient experimental work has been undertaken to ensure the safety calculations are robust, and some elicited data are non-conservative. FOE disagree with Nirex that the input into Nirex 95 for ionic strengths, precipitation kinetics and speciation of fluids is conservative [6C.123]. Nirex accepts that reliable data for the sorption coefficient ( $K_d$ ) are very important in controlling the escape of radionuclides. The failure to heed the recommendations of the HMIP review programme [6C.123] could result in a serious underestimation of the radiological doses that would arise from nuclear waste disposal.

6E.56 The engineered barrier assumes a special significance because of the complexity of the PRZ but key uncertainties exist pertaining to the sealing of the damaged zone, the interface between the excavation boundary and the backfill, and critical aspects of DWR design [6C.131]. Since the RCF has not been incorporated into the design of the DWR, it would form redundant excavations and pathways that would promote radionuclide release [6C.133-134]. Nirex accepts that they should be efficiently sealed. Premature perturbation through RCF construction could compromise future safety assessment, or, more worryingly, could give misleading data. However, FOE believe that further work would still result in difficulties in achieving an acceptable safety assessment at this site. A fully sustainable approach has not been adopted in their view.

6E.57 Greenpeace contends that high groundwater flows through the DWR would lead to unacceptable risks and the site is very sensitive to groundwater flux [6D.48]. Three of the variant calculations [COR/522, Vol.3, Fig.8.8] are already close to the risk target [idem, Table 7.7] and are sensitive to changes in groundwater flux through the DWR [6D.47].

6E.58 The hydrogeological sensitivity analysis carried out by Glasgow University shows that the controlling parameter for groundwater models is the permeability of the BVG and that flow in the Calder Sandstone and BVG are de-coupled but with some connectivity [GNP/3/4/Figs.3(a) & (b), the most realistic representation being shown in Fig.3(a) (note - length scales explained on p.89)]. Nirex is prepared to accept that these representations are not incredible even if it regards them as extreme and pessimistic. The linking of DWR flux and geosphere travel times (therefore source term and geosphere spreading times), assumed by Nirex to be independent, suggests that fluxes through the DWR in any new model would need to be less than about 2 to 5 times the central base case value in order to meet the risk target. This indicates that the range of fluxes currently produced by fracture flow models must be reduced by a factor of 30 to 75 times in order to meet the risk target even if no other

source of uncertainty is taken into account and other models assumed validated. Furthermore, Nirex's safety case appears heavily dependent on a low flux through the DWR, and would not be robust to an adverse interpretation as required by the regulator [HMP/1/1, para.7.3].

6E.59 Nirex concedes that, although best practicable means would be adopted for engineered and chemical barriers, this approach would not be sufficient if high groundwater flows were to be encountered. Optimisation of the DWR location by seeking greater depth, avoidance of Type II features, or other measures could be needed. Nirex accepts that the range of fluxes through the DWR needs to be narrowed, and sensitivity tests would be carried out in 1997 to determine the factors that have a key influence on the safety case. Shortcomings in modelling, science and techniques plus uncertainties [6C.105-6C.144 & 6D.45-6D.50] all serve to undermine the credibility of the preliminary safety assessment, in Greenpeace's view. Wherever the disposal system appears to be sensitive to an adverse interpretation of a single component part it is difficult to conceive of any aspect of the engineered design which could sufficiently enhance safety over the relevant timescales.

6E.60 Greenpeace does not regard the use of upscaled parameters as being necessarily more reliable than point measurements, especially for exploring the effect of the measured range of BVG conductivities on groundwater flows. Nirex's use of BVG conductivities no higher than median values from borehole measurements in flow model simulations contrasts unfavourably with Glasgow University's use of a wide range of hydraulic conductivities. Moreover, because a single connected fracture can have a substantial effect on groundwater flows, highly permeable, well-connected fractures should be modelled deterministically, just as faults are already.

6E.61 A geothermal model better representing heads and salinities would not be robust to groundwater flux through the DWR in Greenpeace's view. It is also of concern that HMIP's preliminary 3-D regional model suggests a predominant flow to the south, with terrestrial discharge near the River Irt increasing the risk. Furthermore, emplacement of radioactive waste near an aquifer does not appear to be consistent with the precautionary principle.

6E.62 Greenpeace regards chemical containment as crucial to providing a sufficient level of safety for uranium yet uranium solubility may have been underestimated by Nirex in Nirex 95, and the natural oxidation state of the groundwater is unlikely to provide a long-term barrier to higher uranium solubilities should the NRVB chemical conditioning fail [6C.135 & 6D.57].

6E.63 Greenpeace is sceptical about Nirex's approach to uncertainty in the safety assessment. On the one hand Nirex suggests that not all sources of uncertainty identified by the developer need to be analysed in the safety assessment [NRX/12/7, para.8.8 & 6A.49], and yet on the other hand it states that it would attempt a comprehensive evaluation of uncertainties. It contrasts the position with the Green Book's statement that risk assessment would cover "exposure pathways and health effects not at present recognised" [GOV/302, para.3.8], noting that the general principles and philosophy of this publication remain valid [HMP/1/1, p.1], but that the burden of demonstration is placed on the developer.

6E.64 Greenpeace and other objectors refute Nirex's suggestion that Sellafield is tectonically stable, asserting that the faults around Sellafield continue to be active [WR/C/146] and are likely to be subject to glaciation effects adversely affecting the safety case [6C.137-143]. The selection of a better site would reduce such uncertainties.

6E.65 As a matter of approach to the safety assessment, and when weighing benefits of the proposed development against detriment, Greenpeace contends that any exposure to radiation should be regarded as a detriment [GOV/506, para.112]. The reduction of radiological risk is therefore no more than a reduction in detriment and cannot be regarded as a benefit.

6E.66 South Cumbria Citizens consider that preferential pathways could bring concentrated parts of the groundwater pollution plume to the surface as local "hot spots" with concentrations of up to 3 orders of magnitude higher than average. They also suggest that the <sup>90</sup>Sr dose limit is too high based on epidemiological evidence. They are sceptical about the predictions and assumptions supporting the safety case [6A.55]. They share the concern of the Irish Government, Patricia McKenna MEP and Mr J Fitzsimons MEP that the DWR would further contaminate the marine environment [3C.1-2].

6E.67 Dr P Elliott does not believe that risks from the proposed DWR can be predicted, at least until the research to be carried out in any pilot project is completed [WR/E/1B].

6E.68 My conclusions on the topic of radiological protection & safety assessment relate essentially to conditions after closure of, or withdrawal of control from, the disposal facility. I have already set out in Chapters 6A & B my conclusions on the extents to which existing radiation levels or short-term safety considerations should be utilised as locational criteria for the DWR. It seems to me that safety assessment for the operational & control phases would be very similar to that for other nuclear installations; and the RCF project itself is concerned mainly with the long-term safety of the DWR. As to the length of the term, I accept the advice of the Assessor and the consensus of expert groups, that conditions beyond 10<sup>6</sup> years should be regarded as unknown. Assessments for that period can have little scientific credibility, with numerical predictions for 10<sup>6</sup>-10<sup>8</sup> years informative & useful only as indicators of general, steady-state trends. In turn, 10<sup>5</sup> years is about the maximum for credible quantitative dose & risk values for the biosphere; whilst 10<sup>4</sup> years is commonly regarded as a significant threshold for comprehensive, site-specific calculations.

6E.69 This last threshold is straddled by Nirex's predicted average times for the corrosion of a metal container. But physical containment would be complicated by various factors such as gas generation, and Nirex has prudently assumed in most of its preliminary assessments that this containment would be ineffective. It has also made some conservative assumptions about the effectiveness of the chemical barrier in the near field. Nevertheless, all the calculations in Nirex 95 presume that the barrier would have a very significant retarding effect on the longer-lived radionuclides, principally by reason of the provision of high pH conditions by the cementitious NRVB, and of distributions for solubility limits & sorption distribution coefficients obtained by data elicitation.

6E.70 The Assessor advises me that these entail great simplifications and may be non-conservative. I am also reminded that this form of chemical containment is new & untried,

6C.175 with more experimentation & modelling development indubitably required. This work would  
6D.74 to my mind be particularly difficult & important because of the problems of meaningfully  
6E.55 testing some of the components of the concept. Implicitly Nirex feels unable to credit the  
6E.62 notion that this barrier would fail; but the lack of any calculation based on an adverse, as  
6C.67 distinct from a conservative, interpretation of this chemical containment seems to me to be  
6E.59 an unfortunate omission from the emerging safety case, particularly having regard to FOE's  
6C.127 impressive critique of the concept.

6E.4 6E.71 This serious deficiency exemplifies for me the conundrums posed at this stage of the  
6E.6 assessment process by the various kinds of uncertainty, particularly by that which the NRPB  
6E.21 describes as subjective uncertainty about the incompleteness of human knowledge, and that  
6E.14 which the draft regulatory guidance refers to as uncertainty arising from alternative  
2B.15-7 interpretations of data. Generally, in my view, Nirex is least impressive in addressing these  
6E.24 types of uncertainty, and they are still substantial notwithstanding the rapid evolution of base-  
case models as painstakingly analysed by the Assessor. On the other hand, it is essential to  
keep a sense of proportion about the relationship of the RCF project to such matters, for the  
project would be in effect a massive field study designed to address principally the kinds of  
objective uncertainty which arise from natural unpredictability & variability or from practical  
sampling limitations. For example, there has been some tendency to criticise Nirex 95 for  
failing to incorporate data which in reality only the RCF could provide.

6C.2-12 6E.72 Moreover, as the Assessor comments, with the multi-barrier concept there are  
opportunities to feed back lessons from the preliminary assessments into the design of the  
waste packaging & emplacement and the detailed engineering & layout of the repository, as  
well as into more basic decisions on its location. These in turn can have implications for the  
detailed design of the RCF, and the nature & choice of investigations & experiments within  
6C.181 it. In addition, the Assessor is firmly of the opinion that, whilst the timing of the detailed  
6D.76 modelling & other work on the requisite backfilling & sealing of excavations would be late,  
6E.31 it would confirm that appropriate materials & techniques are already available.

6E.25 6E.73 Furthermore, Nirex does have some cause for optimism in Nirex 95's base-case  
6E.17 probabilistic calculations for the 4 climate states of Temperate terrestrial & marine and  
COR/522 Periglacial & Boreal terrestrial. The mean risks versus time for them all are always below  
the  $10^{-6}$  risk target, even when indicated in the far future. Within the meaningful time period,  
the peak risks calculated for Temperate & Boreal terrestrial are about an order of magnitude  
below the target, with the Periglacial 1-2 orders smaller and the Temperate about 3 orders  
smaller still. The upper bound of the 95% confidence interval for the Boreal is still below  
the target, although it is important to note that this interval is for statistical error in the  
number of realisations, and not a measure of uncertainty in the input parameters.

6E.18 6E.74 Perhaps even more encouraging is that the base-case best-estimate central parameters  
6E.25 for the Boreal terrestrial are within the target too. Even the variant deterministic calculations  
which attempt to account for the basic deficiencies in the hydrogeological conceptual model,  
and thereby increase the risk by a factor of about 2 or 3, nevertheless produce results below  
the target.

6E.32 6E.75 The Temperate marine discharge is at present regarded by Nirex as the most likely  
for some thousands of years: and, pending the more sophisticated time-variant modelling,

6E.17 a partial marine discharge is predicted to reduce the full terrestrial discharge concentrations  
COR/522 proportionately. Although this predicted marine discharge has attracted objections of  
6E.66 deliberate pollution & hence international illegality, as the Assessor points out, Nirex's  
6E.38 preliminary predictions of the amounts of marine contamination are relatively very low, and  
a scoping calculation on radio-iodine indicates that there might be no re-concentration  
problem.

6E.76 However, contemplating the possibility of marine discharge does also serve as a  
COR/522 reminder of the scale & variety of uncertainty faced in this exercise. Whereas Nirex 95  
6E.38 is fairly precise about the location of the zone of predicted natural marine discharge, I have  
6E.163 already concluded, on the advice of the Assessor, that not enough is known about present  
6E.42 groundwater discharges at or near the coast. Hence we are obliged to add spurious accuracy  
about the most probable outlet of the natural discharge to the initial undue confidence in the  
6E.44 chemical containment. Moreover the variant deterministic calculations are a constant  
reminder of the inherent uncertainties about groundwater flow & geochemistry, as are  
6E.58 Greenpeace's alternative model & insistence on some inter-dependence between source-term  
and geosphere spreading and FOE's persistent criticisms of the basic hydrogeological &  
6E.54 geochemical modelling.

6E.26 6E.77 Whilst I accept the Assessor's reservations about Greenpeace's main points & some  
6E.47 of FOE's, I also share those concerns of his which follow up Cumbria's criticisms on well  
6E.48 scenarios & terrestrial biosphere modelling. These 2 topics are in my view important tests  
of the more general Cumbria thesis, which the Assessor also broadly endorses, that the  
overall margins between the deterministic calculations and the risk target are too close for  
6E.45 comfort at this stage of the emerging safety assessment. Certainly the proximity demands a  
critical review.

6E.33 6E.78 The agricultural wells scenario is a scoping study exploring a form of human  
6E.19 intrusion into the radioactive plume before any natural discharge takes place, whether marine  
6E.48 or terrestrial. The first point to be emphasised is that, on the basis of the approach in Nirex  
95 itself, the risk target would not be met. Even if to aim for a margin below the target were  
to be regarded as too onerous at this preliminary stage, it must be reasonable to expect the  
6E.21 target to be achieved, as Nirex itself accepts. This criterion is all the more important, in my  
view, because the TOR approach does not apply to post-withdrawal risk assessment for a  
6E.68 DWR, as Cumbria & Greenpeace have erroneously assumed.

6E.10-3 6E.79 Secondly, I consider that Nirex 95 under-states the risk, albeit not to the extent  
6E.34 claimed by Cumbria. Both the NRPB advice and the latest draft regulatory guidance  
6E.11 effectively recommend that in a scenario for 4,000 years after closure/withdrawal the human  
6E.13 reference unit should be a hypothetical critical group. Although Nirex 95 does calculate the  
risk to such a group, it draws the group from a hypothetical, wider reference community,  
6E.10 despite the NRPB only introducing the latter concept for times beyond 10,000 years. The  
6E.12 latest version of the draft regulatory guidance dispenses with the concept altogether. Also,  
the NRPB advises that the group be taken to exist at the place where the relevant  
environmental concentrations are highest, whilst the draft guidance calls for assessment of the  
risk to people typical of those receiving the highest dose.

6E.80 The straightforward application of such advice means to me that all the group should be taken as drawing water from wells tapping the radioactive plume, unless it is incredible that an entire group could be doing this. This does not appear incredible to me, for, as the Assessor states, even on the Nirex 95 scenario there could be scores of household wells across the community's resource area; and so there could be a considerable number underlain by the smaller, but still substantial, extent of the main concentration of the plume. Therefore, even allowing for the sideways dispersion of the plume emphasised by Nirex, the calculated risk should be multiplied by a factor of at least 2.5 to confine the hypothetical group to the place of highest environmental concentrations or exposure to the highest dose.

6E.34

6E.50

6E.35

6E.81 I regard a conclusion of this nature as partly one of principle on the factors to be incorporated into the risk rather than merely a matter of interpretation of a detailed risk assessment. However, I would not proceed to agree also with Cumbria that the group might be taken to exist at the very point of maximum concentration, since that would in my view be an extreme position which discounted the emphases in the guidance on homogeneity and typifying & representing people at risk. On the other hand, neither do I follow Nirex's argument that another multiplier should not be used to represent the pessimistic variants due to lack of knowledge of the proportionate differences in underground concentrations, since I agree with the Assessor that the pessimistic variants are likely to provide somewhat higher concentrations for interception.

3B.39

6E.36

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6E.82 Moreover, I am not reassured by that part of Nirex's reaction to this debate which suggests a review of the conservatisms in its scoping calculation on matters such as well depth or dilution by recent meteoric recharge. The original assumptions seem to me to be of the cautious but reasonable nature called for by the guidance. The more constructive response, as the Assessor indicates, would be to consider changes in design. But since Nirex's own list of possible changes includes, for example, changes in the depth of the DWR, such possibilities suggest to me a considerable pause for reflection & revised planning rather than pressing ahead with the RCF. That kind of review might also include devising at least a profile of the actual sandstone aquifer over the timescale in question; and might question too whether an agricultural scenario is the most pessimistic well scenario in the circumstances, having regard to other well scenarios mentioned in the PCPA Report on Human Intrusion & Natural Disruptive Events.

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6E.52

6E.33

6E.42

NRX/15/2.

Box G

6E.83 This exercise is also a reminder that Sellafield is not an optimum environment in which the sedimentary layers combine to present a barrier to upward flow, but that instead Nirex is relying on the layers to dilute & disperse the radioactive plume. The theoretical vulnerability of this concept to relatively rapid movement towards the biosphere tends to be confirmed by both the wells scenario and the debate on subsurface routing to the biosphere. Subsurface routing is the pathway by which the radionuclide flux enters a biosphere catchment from below and goes directly to stream channels without interacting with surface soils. Any fraction of the flux which does not do this but is translocated to surface soils instead (denoted in Nirex 95 by the symbol "S") is important because it seems to substantially increase the risk.

6A.66

6E.47

6E.84 This importance is acknowledged in Nirex 95 by detailed calculations of theoretical values of S, plus a pessimistic bounding calculation in which it is assumed that subsurface routing does not occur in the Boreal terrestrial biosphere. The conclusions of these are that

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the S value of 0.1 used in the base case for Temperate & Boreal climates is conservative; and that the increase in risk is directly proportional to the value of S. Nirex has introduced the 1995 paper on 1991-3 Canadian research to confirm its contentions that the probability of no subsurface routing at all (ie S=1) is zero, and that an S value of 0.1 is conservative. But the paper does not confirm the latter. Instead it summarises a finding on its research site of a partition which could be as high as 83% aquatic: 17% terrestrial, and suggests that biosphere models could use in effect an S value of up to 0.2 unless site-specific data are available. I infer that value to be a conservatism and not an extreme of a probabilistic distribution range.

6E.47

6E.26

6E.4

6E.85 As the Assessor points out, substituting 0.2 for 0.1 as the value of S would seemingly take the pessimistic deterministic variants over the target. He describes these variants as the "better match" because they attempt broadly to mimic a transmissive feature at depth and the observed heads & salinities. Clearly more work needs to be done on the value of S. But the Assessor comments further that it is an illustration of the large differences in the estimates which can be brought about by variations in a single parameter: and I would add that it is rather a striking example of subjective uncertainty on the part of Nirex.

6E.86 Thus indications of the tentative state of the emerging safety assessment of the groundwater pathway are reinforced. I do accept that the encouraging base case calculations mean that this emerging assessment cannot reasonably be claimed completely to rule out on its own any promise in the Sellafield site. However, the exercise is still directly over-arching great uncertainties, such as on chemical containment and natural groundwater discharge, which would not by any means be resolved by the RCF. It is also highlighting the vulnerability of relatively rapid transport of radionuclides to the water-bearing sedimentary layers and the biosphere, compared with the slow downward flow of the ideal hydrogeological environment.

6E.46

6E.2

6E.54

6E.1

6E.87 When further uncertainties are added, such as those over the time-variant & other pathway modelling, or the degree of tectonic stability, or the nature of features & processes at greater depth, the overriding conclusion must be to agree with the Assessor that this RCF proposal is premature. This is without taking into account either the central uncertainty of the BVG's hydraulic conductivity or the need to await the results of the major revisions in modelling development discussed in the previous Chapter. At least another cycle of preliminary safety assessment, ending with more comprehensive & definitive conclusions, would be required before this type of RCF project could be effectively carried out so as to confirm, clarify or contradict such findings at this site.



## 6F. ROLE OF RCF AND PROMISE OF PRZ

6F.1 Further work proposals to provide sufficient understanding to support a robust safety case are outlined above [Ca 6C-E]. Some work, such as aspects of NSARP [6C.22-27] and establishing boundary conditions of the hydrogeological region [6C.147], does not need the RCF. However, Nirex, some of the main parties and of those writing [eg WR/C/147, D/7, H/195, SPC/1, & WMC/1] and external bodies, such as HMIP, RWMAC and the Royal Society [COR/120, s.4; GOV/407 para.4.11 & GOV/414, para.45; COR/605, s.6.6, pp.107-8], regard an RCF as a necessary precursor to a DWR at the appropriate stage. This is in order to investigate the potential host rock in a way, and to an extent, that would not be possible from surface boreholes. Although some of the bodies have reservations about various aspects of the proposals, the primary issue is whether the appropriate stage has yet been reached at this PRZ. A second issue is the degree of benefit that would accrue from an RCF on this site.

6F.2 **HMIP** considers that the development of an RCF would be broadly consistent with programmes in other countries for examination of the deep geological structure and hydrogeological conditions at potential repository sites [COR/120, paras.4.1-2]. Studies underground could improve understanding of the geological and hydrogeological conditions at depth and facilitate DWR design so as to enable the presentation of a scientifically and technically robust safety case [COR/120, paras.4.1-4 & 4.11]. An RCF would allow a range of tests to be conducted to secure information which is not readily available from other routes, and would gain access to a larger volume of rock than is accessible from boreholes [COR/120, para.4.12].

6F.3 It would also assist studies of the chemical and physical processes which may influence the migration of radionuclides through the geosphere [COR/120, para.4.13-4] and build confidence in modelling [COR/120, para.4.15]. These views were shared by **the Royal Society Study Group** [COR/605, s.6.6, pp.107-8]. Because such data may be used to support a future safety case for a DWR, HMIP regards it as important for all the activities during construction and operation of the RCF to meet nationally or internationally recognised quality assurance standards [COR/120, para.4.7].

6F.4 HMIP does not regard the RCF as an aid to understanding the parts of the regional hydrogeological system [idem, para.4.9] which are distant from the PRZ, but a scientifically and technically robust interpretation of the geological and hydrogeological conditions at the site would be expected, taking account of uncertainties arising from an incomplete knowledge of the full system and its future evolution [COR/120, para.4.10]. Because the construction of the RCF would alter the hydrogeological, hydrochemical and geochemical regime at the site, a demonstration that any potential perturbation to the site arising from RCF construction would not destroy valuable information or have any consequent effect on the long term performance of any possible future DWR on the site is essential [idem, para.5.5]. This view is shared by **RWMAC** [GOV/414, para.32].

6F.5 Although the RCF's main purpose is to enable the submission of a post-closure safety case for the DWR ahead of construction, RWMAC sees the RCF as potentially having

alternative functions of generic research; as research dedicated to the DWR at this site; as a means of access to the DWR in due course; and as a component part of the DWR during its operation [GOV/414, para.6]. In particular, it sees the RCF shafts becoming part of the DWR to minimise delay and costs [idem, para.41]. It is also concerned at the optimism of Nirex's programme [idem, para.35 & GOV/407, para.4.22], a view shared by the Royal Society Study Group [COR/605, s.1.6, p.6].

6F.6 The Nirex Review Panel considers that the site has shown sufficient promise to justify proceeding with RCF development [COR/516/Appendix D, para.3.2]. However, it also recognises that the approach for upscaling local predictions into the wider area needs to be addressed [idem, para.3.8].

6F.7 Nirex points out that the RCF programme is planned on a flexible and provisional basis [2B.15-17], to help it address key uncertainties in the 3 main areas of flow & transport, changes to the geological barrier, and DWR design & construction [6C.50]. At the first decision point, about halfway through Phase 1, Nirex must initially judge whether the prospective post-closure safety performance of a DWR in the PRZ would be acceptable, and DWR construction be safe at an acceptable cost. Confidence that the regulator would foresee no impediment to the eventual grant of RSA authorisation would be a prerequisite to Nirex making a DWR proposal.

6F.8 The observations, testing and interpretation achieved from surface observation to date are amongst the most advanced and comprehensive undertaken at any geological site in the world. From a scientific standpoint Nirex believes the results are spectacular and reflect the high calibre of expertise employed. They show that the PRZ has hydrogeological attributes which demonstrate that it has potential to host a DWR. Nirex considers the site to be stable and the degree of complexity to be sufficiently well understood to have predictability which underpins the site's good promise. The necessary scientific tools are available and further work to be carried out in parallel with the RCF is unlikely to change its view of site performance substantially. Investigations from boreholes undertaken and planned take the work as far as it can go without the RCF.

6F.9 Nirex emphasises that its object is to gain sufficient understanding of the geology and hydrogeology of the site to provide input to the conceptual and mathematical models leading to a reliable probabilistic safety assessment. The object is not to collect information for its own sake, as implied by the thrust of objectors' arguments. Their proposals for more investigation are regarded by Nirex as inconsistent with the RCF's basic purpose. There is no contingency to explore different parts of the PRZ.

### RCF Programme

6F.10 The RCF Programme timing, revised to the close of the inquiry, extends to the year 2009, assuming a start to construction in July 1997, including site restoration [COR/102D, Drg.008010 amending NRX/16/10, Fig.5.1]. Phase 1 would run from 1997 to 2002, Phase 2 from 2001 to 2003, and Phase 3 from 2003 to 2007. The time taken to bring a DWR into operation is an important influence on total costs. The RCF and other related Sellafield costs are forecast at £348M at 1995 prices excluding interest and inflation [3A.2]. The RCF would

help to assess DWR construction costs. Nirex does not regard the costs of reverting to another site, should Sellafield prove unsuitable, as an obstacle to such reversion - a view shared by the Rt Hon Dr J Cunningham MP. Much of the work completed so far would still be useful to apply elsewhere and, taken in its national context, the cost penalty of failure at Sellafield would not be great.

6F.11 Phase 1 would involve the calculation of the groundwater flow into the DWR and geosphere spreading effects from continuous mapping and hydraulic measurement during construction of shafts and galleries. It would be established whether the Basal Deep St. Bees Sandstone is a barrier to flow rather than being intersected by large scale sub-vertical fracture systems, and whether Type II features extend as preferential flow paths from DWR depth to the overlying sedimentary formations.

6F.12 Targeted sector tests would be carried out [NRX/16/10, Table 7.1 & Figs.7.1-2] together with dyed grout injection [idem, Figs.4.1-2], geochemical sampling [COR/101, para.1.62] such as Eh/pH values (for which the RCF is essential), observation of mineral formation and probe-hole hydraulic testing. These data would provide information on the extent of drawdown, and confirmation of surface drilled borehole core analysis, establishing the geological history of flow patterns over extended timescales, including seismic events.

6F.13 The effect of excavation disturbance on containment performance of the natural geological barrier, in the wake of the ZEDEX project [NRX/16/1], would be measured towards the end of Phase 1. Information on the spatial variability of the rock would be more effectively obtained from the RCF than from drilling Boreholes PRZ 6 to 10 [NRX/13/2, pp.1-2 & Fig.7]. Furthermore, 5 m diameter shafts would provide direct observations at 50 times the lengthscale of the 100 mm cores obtained from boreholes and permit a high degree of observation of fracture networks. DWR design parameters, in particular, depth, location, layout and orientation, would be confirmed by continuing shaft sinking to the optimum point where the decision on DWR depth (equating to RCF gallery depth) would be made.

6F.14 Models would be progressively validated by comparing forward predictions of the expected geological and hydrogeological characteristics of the BVG with observational data subsequently obtained. During shaft sinking simultaneous validation of coupled flow and transport models should be feasible. By the time Phase 1 is completed, 2 more main validation cycles for groundwater flow models would have been carried out, centred around firstly the Borehole RCF3 Pump Test and then the Shaft Drawdown Experiment [6D.20-21, 34-35].

6F.15 Dynamic biosphere modelling would be introduced [6D.13] particularly incorporating the effects of climate and landform change over some 100,000 years, plus more complex 3-D representation of the Quaternary sedimentary cover over the catchment areas [COR/526, pp.20-21] to produce resultant groundwater flows. The RCF programme allows ample scope to build confidence by responding flexibly to the outcome of each cycle of model testing. Nirex refutes suggestions by Greenpeace that the RCF would do little to assist the validation of regional groundwater flow models. Apart from obtaining invaluable drawdown data, upscaling assumptions would be tested and evaluated; regional flow features could be investigated at 2-D or even 3-D scale, linking NAPSAC and NAMMU [6D.29, 35-36]; and high quality hydrochemical sampling could be undertaken. Near-field models would be

improved by the inclusion of time-dependent effects such as corrosion, solubility, sorption and gas migration [COR/528, pp.22-23].

6F.16 During Phases 2 and 3 the Site Characterisation and Demonstration Experiment would characterise the flow of groundwater through connected fractures in a 1,000,000 m<sup>3</sup> region of BVG unaffected by excavation disturbance [NRX/16/10, Fig.5.2]. It is broadly comparable to experiments carried out at Stripa [NRX/16/2] and planned at the Canadian URL [NRX/16/3]. The Ventilation Tunnel experiment, similar to that carried out at Grimsel for NAGRA [NRX/16/4], would measure the hydraulic conductivity of the BVG, including that of the excavation damaged zone, over a lengthscale of about 100 m [NRX/16/10, Fig.5.3]. Laboratory measurements of rock matrix diffusion would be validated by comparison with in situ observations, as would essential geochemical sampling. Colloid transport would be observed within single fractures and fracture zones for the development of simple models. In Phase 3, gas migration would be studied by measuring gas entry pressure into fractures and gas/water flow characteristics within fractures.

6F.17 Natural and induced changes to the geological barrier would be calculated from experiments to measure the effects of the chemical disturbance to networks of connected fractures which arises from highly alkaline fluids, thereby building confidence in laboratory work. Measuring mechanical and hydraulic changes in the excavation disturbed zone would be continued during Phases 2 and 3. These trials include a "Mine Through" experiment near the end of Phase 3 to investigate the extent to which excavating the DWR vaults and access tunnels would induce significant hydraulic and mechanical changes in the rock mass [similar to Canadian URL "Mine By" experiment - NRX/16/3], albeit the feature through which it would pass has not yet been identified. Further cycles of model validation would continue.

6F.18 Experiments relating to the design and construction of the DWR would also validate models from data provided by mapping the galleries and underground drilling from insets within them; from measurements of inflows to the excavations; and from measurements of drawdown effects in the groundwater pressure monitoring system. The final location of the DWR vaults in the rock mass would be confirmed on the basis of underground drilling from the Phase 3 galleries, possibly along the line of the vaults. The required properties of seal materials would be established for the shafts [NRX/16/10, Figs.5.4-5 & 5.7]; for seals in galleries parallel and perpendicular to the maximum horizontal stress direction; for seals in boreholes [idem, Fig.5.7]; and for seals of fractures and the excavation disturbance zone. The RCF would confirm laboratory studies and provide data for the PCSR.

### RCF Design & Construction

6F.19 Hydrogeological baseline monitoring would continue during site establishment until shaft sinking begins. Shaft, rather than drift, access has been selected to reach rocks at depth for reasons of economy. A second shaft would provide a separate access for safe working [COR/101D]. It would be required for the Peripheral Drilling and EDZ experiments during Phase 1. The shafts and galleries would allow regular and routine access to the rock mass for scientific measurements and observations for which a cautious "drill and blast method" is a prerequisite [COR/101, paras.2.76-90 & NRX/16/11, Fig.A2.5]. Much has been learned from international experience [eg Canadian smooth blasting experiment NRX/16/5] which has shown that it is essential to retain a degree of flexibility to adapt the layout of the laboratory

and the experiments during the course of development [NRX/16/6, para.3.2.1]. The proposed layouts for the underground excavations are therefore indicative and not prescriptive. One fundamental flexibility is to the gallery horizon which could be between the preferred level of 650 m bOD and 900 m bOD [2B.12].

6F.20 In Nirex's judgement, FOE are wrong to claim that the impact of excavation damage is insufficiently understood to warrant development of the RCF. In any event, it makes a conservative assumption that the hydraulic conductivity within the EDZ may increase by a factor of up to a hundred over a distance equivalent to twice the diameter of the excavation [6C.95]. Measurement methods would be based on international research and delay is unnecessary.

6F.21 It denies the suggestion that drill and blast construction is a questionable method of excavation pointing out that, given care, the extent of blast induced fracturing would be small using the proposed cautious or smooth blasting technique and certainly not inferior to the Tunnel Boring Machine method [NRX/16/11, Fig.3.1]. Shaft boring would suffer from problems of verticality, essential for the RCF shafts, and using an adit for spoil clearance so compromising working safety. Drill and blast is a well proven method used in UK and world wide and Nirex have call on a blast consultant with international experience of cautious blasting. Blast damage could penetrate the rock from the shaft wall some 38 cm for sandstones, 36 cm for the Brockram and 50 cm for the BVG. This is broadly consistent with experience in the Canadian URL [NRX/16/8, p.8] and the ZEDEX project at Äspö. Furthermore, the strength of the cover rocks through which the RCF shafts would be sunk is great, and not relatively weak as suggested by FOE. There would be support trials during Phase 1. The construction would meet civil and mining engineering standards and principles and could be upgraded if necessary to satisfy the requirements for the DWR. Ground freezing may be required for safety reasons during shaft sinking [2B.12].

6F.22 Mr Spendlove's alternatives for shaft location [NRX/16/11, Figs.5.1-2], use of a single shaft, and headgear design [5A.54-58], overlook important factors. The RCF has a man-riding safety requirement for the RCF shafts, and needs both an underslinging allowance for equipment and simplicity in operation. The use of below-ground decking, as in the Alternative DWR option [SPD/1/1], would introduce complications, and so it has been set aside in favour of ground-level decking together with safe overwind protection. The RCF's man-riding and materials conveying capability demands taller permanent headgear (29.2 m) than would be necessary for the DWR Preferred Option (15 m) although construction headgear would be the same for both (25 - 30 m).

6F.23 His alternative location for the South Shaft would place the shafts outside the volume of rock which Nirex seeks to characterise in detail, making continuity of mapping much more difficult. The shafts would also be outside the centre of the groundwater pressure monitoring system, thereby impairing the effectiveness of the shaft drawdown experiment during shaft sinking without further monitoring boreholes. The collar-and-foreshaft construction would be more difficult and expensive in unconsolidated water-bearing ground and either a new centreline borehole would be needed for the south shaft or the shaft sunk without the benefit of one. The proposed twin kibble spoil removal method is more efficient than that using the single kibble. For all these reasons Mr Spendlove's proposals are substantially disadvantageous. Furthermore, the suggestion by Dr Cobbing that the Bleawath Formation

is a suitable alternative host rock sequence to that proposed [WR/C/146] is unsound because it is too deep [WR/NRX/4(14)].

6F.24 Use of the single shaft for Phase 1 would impede progress to Phases 2 and 3 by some 3 years and deny the scientific benefits which the second shaft would provide to Phase 1. Furthermore, Mr Spendlove's presumption that the decision point on whether to abandon or continue the project would be arrived at part-way through Phase 2 would introduce rigidity into an essentially flexible operation.

6F.25 The scope for re-use of the shafts in a DWR would be limited by their design having been confined to the requirements of the RCF's scientific purposes. However, sealing and grouting would be carried out with the DWR safety case in mind. The RCF's location in the PRZ is designed to guard against the possibility of the shafts providing a preferential pathway for groundwater flow which could compromise the containment performance of the geosphere. One element of this is for the shafts to be upstream in terms of flow, and another is to facilitate provision of an inclined drift access to a DWR without going outside the PRZ. If Phase 1 were to be successful, the DWR would probably be located near the RCF. At some distance, extrapolation between them could be less reliable. As a matter of principle, Nirex considers there should be as much physical commonality as possible between the RCF and DWR without significant penetration into the potential DWR location.

6F.26 All the points raised by the RWMAC in its report on the RCF [GOV/414] have been addressed. A hydrogeological baseline has been established and monitoring continues. Nirex intends to publish its predictions of significant findings expected to arise during shaft sinking and the results of Phase 1 sector by sector. Shaft lining would be installed through the sandstones and the Brockram, but not the BVG, and the shafts monitored so that any disequilibrium could be remediated promptly with support should it prove necessary. Microseismic activity, natural gases and geothermal effects are planned to be monitored. Trials are planned for NRVB in a surface-based facility or in the RCF during Phase 1, and then once a DWR vault has been constructed. Drawdown would be monitored during shaft excavation as described above and would continue through all phases as part of other studies.

6F.27 Nirex points out the penalties involved in further delay to the DWR programme. Sinking further boreholes and monitoring for 5 years followed by peer review, as put by FOE, would take to about 2006 and add to costs. The RCF planning permission would then be delayed to 2009/10 with consequent further costs. While the Government lays down no fixed timetable for a DWR, it emphasises the need to avoid unnecessary delay [GOV/208, para.101]. Nirex well knows the consequences of failing to satisfy the regulator of the establishment of baseline conditions and it is in its interests to ensure that it succeeds. This is not a matter for the RCF inquiry. Nirex is negotiating an agreement with the Environment Agency to define submissions by Nirex and responses from the regulators, and there is also its assurance that it would submit a peer-reviewed baseline report to the regulator, in time to receive the regulator's views, before shaft sinking [6C.158].

6F.28 Copeland's view that the Olkiluoto VLJ repository carried out safety studies in situ is mistaken [NRX/13/6]. They were conducted in a laboratory, as is proposed by Nirex in this exercise, so Copeland's reservations about the work programme are groundless. Nirex's programme compares favourably with international experience [NRX/13/7].

6F.29 **Cumbria** has very substantial doubts that a safety case can be successfully developed at Sellafield because it is such an unpromising site [6E.42-52]. Although the RCF would yield more information than the boreholes, and Nirex concedes that there is much work to do, the present unfavourable level of risk is likely to persist. The host rock sequence exhibits serious deficiencies [6C.120] and was not selected for its promising radiological performance but for other questionable reasons [6B.58]. Nirex concedes that a potential DWR could be so geologically complex that the degree of intrusive investigation could compromise the safety case and it does not claim to be able to engineer a solution to all situations of geological complexity or identify all features in the PRZ with certainty.

6F.30 Allowing further long, costly and complex investigation, and the harm that would result, is not justified in this PRZ. By the end of Phase 1 total expenditure would be £793M (£425M Sellafield specific); by the end of Phase 2 £857M (£463M); by the end of Phase 3 £1018M (£543M); and total cost to waste emplacement £1820M [NRX/12/18, Table 4.2]. Although some work is generic in nature, repeating the exercise once commenced would be very expensive, the pre-commitment being of concern to many organisations and individuals writing [eg WR/SLC/1, ACC/1, ANG/3&4, T/55].

6F.31 **Copeland** regards the RCF as premature because, leaving aside paramountcy of safety in site selection, the work programme does not go far enough. In situ testing of the multi-barrier system, testing the feasibility of pre-closure retrievability of waste from its emplacement, and preparing for long term pre- and post-closure monitoring of the waste, need to be made systematic in order that the public may be reassured. It cites the Olkiluoto VLJ repository in Finland as an example of best practice [CBC/3/1, p.13 - "safety studies"].

6F.32 **Gosforth** is sceptical about the promise of the PRZ and sees the chemical and engineered barriers as providing inadequate assurance to compensate for the complexity of the host rock. The wet environment at Sellafield is flawed in its view [WR/GPC/2, p.3], a point supported by **Mrs M S K Higham** who draws attention to the additional costs involved in overcoming difficulties. Gosforth regards the RCF programme as being rushed with insufficient time for baseline conditions to be properly established and models validated; for results to be subjected to peer review; and for older waste storage plants and associated waste storage facilities to be upgraded [WR/GPC/3, para.7], a view shared by **GAG**.

6F.33 **FOE** assert that baseline conditions are far from being established, a point of concern to several parties and many of those writing, and that Nirex does not understand the complex hydrogeology of the host rock or the impact of excavation damage on fluid flow. Information from the RCF would be of little or no value until these problems have been overcome. They cite HMIP's point that failure to properly establish baseline conditions could frustrate the objectives of the RCF. Moreover, because RCF construction is premature, it could also prejudice the achievement of a PCPA and successful development of the DWR [6C.133] - a view shared by **South Cumbria Citizens**, **Patricia McKenna MEP** and **Mr J Fitzsimons MEP** amongst others. A very comprehensive programme of further work is needed, especially for more boreholes, [6C.144] and peer review would extend this

preparatory period. FOE estimate that Nirex's RCF programme is about evenly divided between generic or engineering functions and site specific characterisation.

6F.34 It is essential, as a prerequisite for the RCF, for a robust interpretation of the geology and geochemistry in and around the PRZ to be achieved as a framework for reliable models and to identify the correct location for the RCF. Equilibrium conditions of the hydrogeological regime must be established which, because of complex fluctuations, could take 2 years or more to achieve [6C.109-110]. International experience, particularly in Canada, suggests that a site programme should involve about 5 years testing of about 6 to 12 boreholes over a 10 km<sup>2</sup> area, targeted at conditions known from seismic and geophysical data. Fracture flow must be understood and models validated. The RCF should be planned as part of the staged programme of DWR development so that its location is optimised [6C.134]. RCF experiments should form the culmination of generic and other surface-based research and Nirex should publish a forward programme for the integration of laboratory and field/RCF work which they claim they are going to follow. However, Nirex concedes that the acquisition of more information from surface based investigations would add to its understanding.

6F.35 Nevertheless, FOE doubt that the PRZ is capable of characterisation or of being suitable for a DWR [eg 6C.112 & 120]. The PRZ is lacking a low hydraulic gradient throughout the site, and simple geology and hydrogeology [6C.114-115]. Modelling is still at an early stage [6D.51-7] and unjustifiable inferences have been drawn from experience gained in the relatively massive, uniform and fracture free crystalline rocks in Canada and Sweden [6C.106]. Experience in Sweden and Canada indicates that in situ data would be of little value to flow characterisation and the PCPA [eg FOE/7/20, p.199, lines 39-43 & FOE/6/28, p.7, penultimate para.], and further fundamental research and development in this area is necessary before excavation is commenced [6C.106]. Without the extra boreholes at Sellafield [6C.144], there is a real danger that even a 3-D time variant model would give an inaccurate representation of the flow regime.

6F.36 Similarly, construction impacts are not yet sufficiently well understood, so that data could be potentially misleading and compromise a satisfactory PCPA [6C.133]. Standards of construction, science and engineering appear to be inadequate [6C.131]. In particular, non-conservative assumptions of the impact of the RCF on the PCPA have led to unacceptably low performance objectives for the engineered barriers. Reliance on drill and blast, and failure to examine alternative methods, would not minimise damage to the rock mass, a point also made by Mr J N Walker. Although more costly, a cut-off collar may resolve sealing problems and there is a strong case for machine mining the second shaft because it should reduce the EDZ. Nirex concedes that the Ventilation Tunnel Experiments would only produce broad results because of practical problems. In addition, the concept of backfilling and sealing of emplaced waste is presently flawed and needs more generic research before testing in situ [6C.127-8 & 131-4]. FOE also doubts that there is room in the PRZ for the RCF and a DWR.

6F.37 Dewatering as a result of RCF (and DWR) development could be concentrated along the FHFZ and transmitted to permeable superficial deposits to the West in the Newmill Beck valley, and to the exposed outcrop of St Bees Sandstone in the East near Gosforth. More data are needed on this before perturbation by the RCF. Although there are difficulties in



establishing baseline Eh/pH values from the surface, FOE insists that as much progress as practicable should be made before the RCF is excavated. Nirex has not yet published a programme for the integration of laboratory and field/RCF geochemical work and is over-optimistic about the rate of progress which can reasonably be achieved. Progress towards understanding geochemical processes, for which laboratory work is appropriate, is not sufficiently advanced to justify perturbation by the RCF and potentially compromise future geochemical modelling [6C.123, 6D.57], a view supported by South Cumbria Citizens.

6F.38 Potentially serious risks could result from failure to produce a reliable DWR PCPA of which the RCF development is a part. The high degree of uncertainty in this project, and the likelihood of further difficulties ahead, demands a precautionary approach in accordance with the principles of sustainable development [GOV/208, para.50], a point emphasised by The Irish Government [6A.52]. Nirex's proposals would cause grave and demonstrable harm to interests of acknowledged national importance in FOE's view.

6F.39 Greenpeace does not believe that Nirex would ever be able to sufficiently characterise the PRZ to achieve a satisfactory PCPA for the DWR, and so there is no benefit in the RCF. Furthermore, failure to optimise the location of the RCF would have an adverse impact on the DWR safety case and so risks would not be as low as reasonably achievable (ALARA). This is a material consideration and subject to the Euratom Directive's principles of justification & optimisation [2A.2 & 6A.49] and to SP Policy 54(ii).

6F.40 In addition, all Nirex's activities should employ best practicable means (BPM). BPM could not be implemented without a validated hydrogeological model of the region [6D.45-6]. Without such a model the proposed positioning of the RCF shafts is open to question and yet is critical to optimising the DWR because of the likely role of the shafts for ventilation and emergency access and because of the perturbation caused by excavation. Nirex concedes that the radiological performance of the site could be affected by the RCF yet is equivocal about the physical relationship between the RCF and the DWR. On one hand it cites the difficulties in extending the shafts deeper if an unexpected problem is encountered in the galleries, while on the other it emphasises the need for flexibility of location of the DWR.

6F.41 If the RCF is to confirm current understanding, this must be sufficient to determine the optimal DWR location prior to shaft excavation. Nirex concedes that harmonising the locations of the RCF and DWR would minimise perturbation and costs and the regulator seeks to avoid undue disturbance [HMP/1/1, para.7.12]. Perturbation by the RCF could also compromise Nirex's ability to collect suitable data on glacial flushing, and the RCF is unlikely to facilitate such data collection in any event. The OECD advocates the use of long-term monitoring programmes early in site characterisation in order to establish baseline conditions prior to major perturbations and capture them when they occur [GNP/4/7], but that is not occurring satisfactorily here.

6F.42 The lack of understanding of regional hydrogeology also inhibits Nirex's ability to address key uncertainties through RCF data in Greenpeace's view. Narrowing the range of groundwater fluxes through the DWR [6E.59] would be more effectively conducted through further Cross-Hole and Pump Tests than a single, non-repeatable, poorly constrained RCF Shaft Drawdown Experiment, which itself would make a very large perturbation in the natural flow system thus making further regional borehole experiments much more difficult.

world yet shows unfavourable features for a DWR. He also regards the programme as deficient in its failure to carry out in situ trials using radioactive materials. He points out the great evolution of scientific knowledge which is likely to occur, particularly over protracted timescales. The application of new robotic techniques to the disposal of nuclear waste suggested by Mr J Michael could be a case in point [WR/M/194].

6F.49 Many of those writing also question the need for the RCF at this stage [eg WR/W/66]. On the other hand Dr E J Cobbing challenges the location under investigation suggesting that the deeper Bleawath Formation is much simpler, more determinable and less active than the host rock in the Fleming Hall Formation, and recommends that it be investigated as likely to provide a more reliable safety case than current proposals [WR/C/146].

6F.8  
6F.1  
6F.50 My conclusions on the role of the RCF within Nirex's future work programme start by acknowledging once more the general quality & innovation of Nirex's scientific & technical work to date. Moreover, I note the consensus that a facility of the nature that is proposed must form a central part of the subsequent stages of the DWR project. There is no doubt that the detailed excavations, investigations & experiments planned for the RCF would contribute significantly, and in many cases crucially, to the sum of knowledge required to implement the DWR concept at Sellafield.

6F.7  
6F.15  
6F.48  
6F.22-4  
6F.51 Also I accept entirely the principle that the programme for work within the RCF must be flexible, in order to cope with actual conditions as they are revealed, albeit subject to the critical requirement that the relevant baseline conditions must be fittingly established for each piece of work before it is started, whether it is a deviation from the programme or not. Whilst admiring Mr Spendlove's boldness in taking on Nirex's design team single-handedly and thanking him for the intellectual stimulus of his alternatives, I have firmly concluded with the benefit of the Assessor's advice that Nirex's twin shafts would be an integral part of the essential flexibility.

6C.159  
6C.163  
6C.169  
6C.161  
6F.37  
6F.44  
6F.52 I have drawn together these generally favourable conclusions at the outset because I do not wish to appear to detract from them, and yet I do consider that as I near the end of this report I must nevertheless concentrate on the drawbacks which the Assessor & I perceive in Nirex's approach. In the first place, Nirex is too optimistic about the situation it has reached. It does not understand the regional hydrogeological system well enough, and it is not planning to give the remainder of its investigatory programme sufficient scope to remedy that deficiency. Secondly, it does not fully comprehend the extreme complexity of the PRZ, and over-estimates its own knowledge & understanding in crucial respects. Thirdly, it is much too hopeful about the speed & confidence with which it could reliably process information and make firm decisions in constructing & operating the RCF.

6F.53 There are 2 general points to be deduced from these propositions, in my view. The first is that Nirex should not be allowed to proceed with the RCF in its current state of inadequate knowledge, for that would cause needless damage to the PRZ; make it very difficult for anyone to predict the consequences of Nirex's actions; and result in a confusing outcome. The second is that it is difficult to credit that Nirex has optimised the location of the RCF, because it has not equipped itself with the knowledge to do this. It does seem

6F.25 expedient to prefer a location in the upstream part of the PRZ; the environmental appraisal  
5A.2-3 does suggest that a drift access should be accepted as a design constraint; and there could  
6B.101 well be room for a DWR at the preferred location. But, with respect to RWMAC, the advice  
to me is that it would be physically impossible to characterise the remainder of the PRZ from  
the RCF, and so those pragmatic parameters would have precluded all other options within  
6F.40-1 the PRZ. Except by coincidence, this RCF could not be the confirmation of the suitability  
of the most stable, understandable & impermeable volume of rock for a DWR. This paradox  
is redolent of the defects of the site selection exercise.

6F.42 6F.54 Moving on to give some more detailed underpinning of these general conclusions, the  
6F.6 Assessor advises me that the RCF would be unable to provide information on about half of  
6F.19 the principal hydrogeological units which make up the current regional transport model.  
6F.21 Also, whilst Nirex's choice of excavation method is agreed as the obvious & conventional  
one, and the shaft drawdown & excavation disturbance experiments should be very useful,  
there are 2 very problematic points about the early stages of the RCF. The first is that,  
although flexibility is being retained over the repository horizon, merely digging down to the  
preferred horizon of about 650 m aOD would not enable a decision to be made about the  
actual horizon at which the DWR would be constructed. Even to confirm that the preferred  
horizon would be definitely unsuitable would have to await the results of tests after arriving  
there. A preliminary decision to stop at that horizon made on surface-based information  
would by definition be unreliable.

6F.7 6F.55 The second point is that the Assessor and I cannot conceive that a decision could be  
made halfway through Phase 1 to proceed with a DWR application. Nirex would not be far  
enough into the rock nor have enough additional information for such a decision point to be  
realistic. Further examination of the items in the RCF programme corroborates this  
6F.16 judgement. Some of the main experiments in the preferred option for Phase 2 would not  
actually be to help design the DWR as Nirex's overall scheme suggests, but would really be  
6F.14-5 still testing the suitability of the preferred location. In conjunction with this, Nirex seems  
6F.17 to remain unduly optimistic about its model development & validation programme. Put  
broadly, it would in practice be at least one cycle behind what should be the case, so that  
Nirex would be at serious risk of basing successive predictions on inadequately refined  
models, in turn producing output of insufficient reliability.

6D.70 6F.56 This sequence of retardation would start with unsatisfactory knowledge of baseline  
6F.4 conditions before the RCF begins. This is a matter of particular concern to HMIP, and,  
according to Nirex's timetable, there might be no subsequent opportunity for hydrogeological  
6F.16-8 conditions to recover between the end of RCF work and the start of DWR construction. The  
baseline should be established across the entire primary network of boreholes for the region:  
6C.159 but it would not be established, because Nirex has no plans to sink some of the requisite  
6C.163 boreholes, and does not intend with its existing & planned ones to monitor them for long  
enough for any responses in the deep BVG to annual rainfall trends to become  
characterisable. Some current fluctuations suggest that there are hydraulic connections which  
have not yet been identified.

6F.57 Although a backfilled & sealed RCF should recover to its natural state in ordinary  
restoration terms, I am advised that there would be subtle changes which could affect  
radiological safety. In my view, no opportunity to detect such changes should be lost, but

on Nirex's favoured timetable, the normally important phase of observing the recovery following cessation of pumping would be omitted, and there would follow instead the even greater drawdown caused by DWR construction itself. This would certainly alter the baseline conditions, including the geochemical ones, so I am advised. Following the sequence of events through in this way emphasises the importance of establishing the baseline conditions as thoroughly and robustly as practicable before commencement of the RCF.

6D.71  
6C.158  
6F.5  
3B.39  
6F.58 Although the welcome assurance has been given to submit a peer-reviewed baseline report to the regulator for comments before the development begins, it is now apparent that there are a number of drawbacks to this procedure. The report would not cover all of the conditions which it should, either by way of regional detail or over time. Then I agree with the Assessor that, even on the incomplete basis which Nirex intends to provide, there would not be the time to have the report properly peer-reviewed for Nirex's programmed start to excavations. The regulator would in any event have no statutory standing in the matter - a reminder that under current UK law & policy the planning system is in effect the state's controller of the present stages of the DWR project.

6F.59 I appreciate that Nirex feels strongly that the details of these scientific & technical matters are for the regulators to consider when eventually they do have formal standing in relation to the project. But the fundamental point on this planning appeal is that, to put it at its lowest, the evidence shows to me that to go ahead with the RCF now would be seriously premature. Thus there can be no benefit to be taken into account under SP Policy 54 for going ahead now, and there could well be some harm to the radiological safety potential of the PRZ.

## 7A. MITIGATION OF ENVIRONMENTAL EFFECTS

7A.1 In the ES [COR/101] Nirex explains various measures intended to minimise adverse effects. However, during the course of the Inquiry, Nirex and Cumbria have agreed a list of conditions [COR/113] to augment, or give precise expression to, the measures in the ES. Many of these have also been accepted by Copeland and Gosforth. This Section of the report is based on COR/113, but also takes account of the variations suggested by other parties [CCC/1/25, CBC/2/6, GPC/4 & 4A, GRY/1/1 & WR/LOW/1]. I have taken account of these mitigation proposals in the course of earlier chapters and my comments below are without prejudice to the views already expressed.

7A.2 The development would be for a limited period of 13 years [idem, Condition 1] and subject to comprehensive landscaping, restoration, replacement and aftercare schemes [idem, Conditions 28-29, 31-35, 38-39]. There is a contingency for early cessation of the development [idem, Condition 30]. The stripping, storage and use of soils and overburden and control of weeds, would be regulated with reference to submitted schemes with some details being left for later determination by Cumbria. All works would be required to conform to approved schemes [idem, Conditions 2, 40-41]. Of particular note is the schedule of approved drawings appended to the list of conditions [idem, s.1], being the subject of Condition 2. These conditions are not in contention, subject to comments below and save for FOE's scepticism that the 13 year period would suffice: and I regard them as crucial.

7A.3 Design and external appearance of the buildings are proposed to be controlled by an amended scheme [idem, Condition 3a with Scheme A]. However, the scope for discretion is limited by the terms of the application [4B.26] and the scheme is not agreed by Copeland or Gosforth, which differ from Cumbria in seeking a treatment much more sympathetic to the vernacular in materials as well as design [5A.43 & 46]. To my mind the colour scheme now proposed for the profiled cladding of the headgear and buildings would help reduce visual impact to a degree. But, bearing in mind that the heapsteads would not be completely screened, I consider it a retrograde step for the earlier proposed brick finish to their walls to have been replaced in the latest plans by profiled cladding [compare Drgs.008019 and 008021 in COR/102A and COR/102B].

7A.4 Supply of electricity, access arrangements (including special measures for construction traffic - idem, s.10, Drg.008916) and dust suppression measures would also be achieved through agreed schemes [idem, Conditions 4, 6 & 15], while the details of freeze drilling arrangements, should they be necessary [2B.12], and external lighting would be subject to the submission of further details and approval [idem, Conditions 3b & 5]. These conditions are generally agreed but Gosforth and Cllr Gray object to night lighting and anti-intruder fencing [GPC/4, s.16, GPC/4A, s.1 & GRY/1/1]. Because of the nature and vulnerability of the RCF and its activities, and the likely value of on-site plant and equipment, I accept the need for lighting for safety and security purposes but consider that the proposed Condition 5 is capable of ensuring that lighting is limited to the minimum necessary. Nirex has significantly reduced the extent of proposed fencing and lighting [NRX/1/5, Fig.2] and it has incorporated this alteration in the amended application plans [COR/102B, eg Drgs.008007B, 008009B, 008014B]. To my mind the amended application approaches the practicable minimum of security fencing for this operation and is commended accordingly.

7A.5 Blasting and noise levels are designed to be controlled within reasonable limits taking account of nearby vulnerable locations during day, night, weekend and holiday conditions through monitoring [idem, Conditions 7 to 13]. The noise conditions are agreed by Cumbria subject to a further condition on hours. Cumbria and Copeland agree with the blasting criteria. Gosforth's contention that blast levels should, in effect, be undetectable by human senses in any part of the National Park and should not, in any event, be carried out between 2200 hours and 0700 hours [GPC/4 & 4A, s.5], seems extreme, in my view, given the low levels of blast stipulated and the effects caused by HGVs on the A595(T) [5D.11].

7A.6 Gosforth's request for investigatory machinery for complaints of nuisance from blast or noise, or breach of planning conditions, is met already under present legislation, and its concern regarding remedies for blast-induced damage is not a planning matter. Its requests for log-keeping and positive control of operations by the Regulating Authority without any breach necessarily having taken place [GPC/4, ss.7 & 8], while understandable, would be unduly onerous upon Nirex and the relevant Authority. However, I entirely support Copeland and Gosforth's point that the regulatory regime must be effective.

7A.7 On noise, I have already concluded that there should be a general night-time limit of 39 Db  $L_{Aeq}$  [5D.29], and I consider that suggested Conditions 9 & 10 should be amended accordingly, since I am satisfied from the evidence that Nirex could comply with such a limit. I have also concluded that the site establishment & fore-shaft excavation activities should be prohibited at night [5D.30]. Nirex has accepted without prejudice the description of the activities to be specially controlled as in Cumbria's suggested Condition 14 [CCC/1/25]. However, there is a problem in that Nirex has expressly declined to acquiesce to a prohibition of any particular working on Saturday afternoons, Sundays & holidays, on the grounds that there is no evidence to support such a distinction. This by-passing of national policy [5D.30] applies to suggested Conditions 9 & 10 as well as 14. My view is that the same limitations as at night should be imposed for the normal rest days on a development of this timescale as a matter of policy, although it might be thought necessary to refer the matter back to the parties with an indication that permission would be granted subject to such an imposition.

7A.8 Groundwater resources should be adequately safeguarded by condition after consultations with the Environment Agency [COR/113, Addendum & WR/NRA/1], in Cumbria's view. However, Nirex believes such a condition would be unnecessary because it would duplicate the Environment Agency's power to serve a Conservation Notice [GOV/803, s.30]. Nirex points out that the authorities, including English Nature, are satisfied that pollution would be obviated by conditions attached to any Discharge Consent [CCC/1/27]. The powers available to the EA Regulator under a S.30 Notice do appear to be generally limited [COR/113C, Addendum, NRA letter of 30 January 1996], and indeed I am unsure whether they are applicable at all to the particular circumstances of the RCF. Although I am also doubtful whether the abstraction could cause serious harm, on balance I conclude that the condition proposed through Cumbria [idem, NRA letter of 19 January 1996], substituting the Environment Agency for the NRA, would be reasonable. On the other hand there is no need in this specific case for planning conditions to control pollution of the watercourse [5E.29].

7A.9 Archaeological remains would be safeguarded by submission of a scheme of investigation to be submitted to, and approved by, Cumbria [idem, Condition 18]. Also uncontentionous between the parties is the action to protect badgers and conserve part of their habitat by the maintenance of a grass sward, provision of tunnels and a monitoring scheme [idem, Conditions 19-21].

7A.10 The woodlands management scheme in the planning agreement is generally agreed as helping to mitigate the visual impact of the RCF from the many potential viewpoints in the landscape, and I support this view [Ca.5A] as a complement to the landscaping conditions mentioned above. Although the woodlands are largely outside the appeal site [compare NRX/11/18 with COR/101, Fig.3.5.1 & COR/113, Restoration Scheme H, Drg.008046], there is some duplication with Schemes G and H in conditions 28a and 29. In particular there is overlap of the important tree belts which give some protection to the dwellings on Newton Manor Estate Road. Thus there is technically a degree of conflict with Circular 16/91, Annex B, para.B6, that the terms of conditions imposed on a planning permission should not be restated in a planning obligation, because this would involve nugatory duplication and frustrate a developer's right of appeal. However, I consider that this is not important on this occasion.

7A.11 Gosforth's proposals for road improvements by widening the A595(T) between Gosforth and Calder Bridge; by provision of a footpath and cycleway between Gosforth and New Mill; and by construction of a new access onto the Sellafield/Blackbeck road [GPC/4, s.10-12], have been considered in Chapter 5C. I have concluded that the general improvement of the trunk road is unnecessary and may be environmentally damaging. My conclusion on the footway/cycleway is that there is not the physical highway capacity for both that and the RCF project's vehicular traffic, and so it would be unrealistic to require its provision if the RCF is to be permitted. So far as the service road towards Sellafield is concerned, the publication of a detailed feasibility appraisal is the first requirement.

7A.12 I have considered the remaining conditions put forward, including Mrs Lowery's suggestions for speed restrictions and better signposting [WR/LOW/1; also GRY/1/1], but, in my view, they are either unnecessary, do not relate to matters of proper planning control, or are dealt with by those which I am recommending.

## **7B. ENSURING SCIENTIFIC AND TECHNICAL BENEFITS**

**7B.1** In addressing the matters about which you particularly wished to be informed during the course of the inquiry [1.5 Matter 6], and bearing in mind the guidance in Circular 11/95 paragraph 2, I have formed the view that the securing of scientific and technical benefits through the imposition of conditions is an option worthy of exploration with the parties [COR/113C, para.1a]. Suggested conditions are set out at COR/113C, Annex A, as a focus for discussion. The aims would be to control the establishment of baseline conditions; and to ensure satisfactory scope & standards of modelling, monitoring, and experimental work.

**7B.2** A requirement on the lines of Condition A would lay down the principle of agreeing a programme of work dedicated to the DWR safety case, whilst one on the lines of Condition B would set out the framework of the programme. An assurance on the lines of Condition C would be needed to preclude premature perturbation of the PRZ before the baseline conditions had been properly settled. Further requirements on the lines of Conditions D & E would be necessary for operational control and monitoring purposes.

**7B.3** **Nirex** submits that the suggested conditions seem to be directed at matters appropriate to an eventual determination by the regulator. It would be wrong to place Cumbria in the position of the regulator, particularly as Cumbria is unwilling to adopt that role, and as it is uncertain that the Environment Agency would be prepared to advise Cumbria. In the meantime, there is no formal role for the regulator during the investigatory process.

**7B.4** Furthermore, Nirex submits that such requirements would be unnecessary in view of the formal assurance which it hereby gives to the Secretary of State, that:-

- (1) work to extend and refine information about baseline conditions continues;
- (2) a further independent peer review of the available data, considering both groundwater pressures and hydrogeochemistry, is planned to be carried out by the end of 1996;
- (3) the Environment Agency would be provided with a peer-reviewed baseline report for discussion prior to shaft sinking, in order that it may give a view before underground characterisation commences;
- (4) Nirex would take account of the Agency's views before shaft sinking begins; and
- (5) the baseline report put to the Agency would be published.

**7B.5** **Cumbria** shares Nirex's view that the suggested conditions appear to be unenforceable in practice because the Council does not have the expertise or financial resources to implement & police them. The relevant matters are appropriate for the Environment Agency rather than the County Council. Although Cumbria considers that the conditions are



potentially lawful, it would not wish to see them imposed. It questions the precision of the procedure of peer review and the measurements necessary to satisfy the conditions, both of which could become fertile areas for dispute. In its view, the need for Conditions A, B and C demonstrates that the development is premature because a lengthy period of other site characterisation is required first. Conditions D and E seek to control matters once the RCF is in being, and so their planning purpose is more tenuous than the avoidance of over-hasty excavation of the potential repository site. In any event, because these conditions could take such a long time to satisfy, refusal of permission is the right course.

7B.6 **FOE** also have misgivings about the absence of regulatory control by the Environment Agency during the investigative stage of the DWR project. This undermines their confidence in the effectiveness of conditions to secure satisfactory RCF development. The only basis on which the RCF could proceed is to meet in full the requirements articulated by HMIP. This would require a further 10 years of work prior to RCF shaft sinking [6C.144], with an uncertain outcome. Such requirements would derogate from the grant of planning permission and be regarded as unreasonable.

7B.7 Without prejudice to this view, FOE regard it as essential to require the provision of a work programme and its results to Cumbria for approval before RCF development commences. The work programme should relate to the establishment of baseline conditions and research [6C.144], including assimilation of international research and a comprehensive programme of work for the RCF. The results of investigation and research should be available to the scientific community for a 6 month consultation period and, like the RCF work programme, be submitted to an independent peer review panel. These results should also be submitted to Cumbria for approval before RCF development was commenced.

7B.8 The need for public reassurance that scientific and technical benefits would be achieved if the RCF were to proceed is generally felt by objectors and specifically articulated by **GAG** and **Mr S Balogh**.

7B.9 **My conclusions** on securing the scientific and technical benefits of the RCF again rely heavily on the Assessor's evaluation. He and I are clear that it is necessary to ensure that these benefits are secured. Otherwise, the DWR project could fail through premature, or ill advised, development of the RCF; and environmental damage would occur without justification. As to the means of achieving adequate control of the scientific & technical aspects of the development, I consider that a binding agreement between Nirex and the Environment Agency could be the most appropriate form in the current legal context [2A.14-7]. The assurance given by Nirex could be deemed to cover the first steps to be taken under such an agreement.

7B.10 However, should planning permission be granted for the development in the absence of such an agreement, Cumbria must perforce regulate all aspects of the RCF as local planning authority; and I believe that most of FOE's concerns could be met in the drafting of precise provisions. But I take Cumbria's point about the shortage of resources necessary for it to carry out this special national task. The inquiry has shown that considerable specialist expertise is essential to fully consider the relevant matters and make competent

determinations. Yet the DWR project has now reached a critical stage where self-regulation by the developer plus summary Ministerial endorsements following reports from advisory bodies might well not suffice in lieu of decisive and authoritative external control. In the absence of direct jurisdiction by the Environment Agency under statute or by agreement, the most expedient action might well be to ask the Agency to advise Cumbria in regulating the development, in parallel with a constructive process of peer review [6C.158].

7B.11 The reservations expressed about the possibly lengthy time delay in meeting requirements on the lines of the suggested Conditions A, C and D have to be weighed against the complexity and national importance of the DWR project, in my view. Although I have not sought to define independent peer review, nor state the requisite measurements and data requirements, the concept of peer review is, I am sure, well understood by the scientific community [6C.156-7], and the measurements and data required would be for Nirex to suggest and for Cumbria, on advice, to specify. Although Cumbria has balked particularly at operational control of the RCF, I consider it as important to supervise work inside the inherently flexible RCF as it is to settle baseline conditions in advance.

7B.12 In short, my view is that controls along the lines which I have canvassed would be necessary, both to ensure that the benefits which weigh in favour of granting permission are actually obtained and to avoid uncalled for harm to the potential DWR location. If it is decided that it would be altogether inexpedient to secure such controls, then I fear that this would reinforce the reasons for refusal.

## 8. FINAL CONCLUSIONS

*These conclusions summarise and draw together the preliminary conclusions from each chapter of my report. The references for the individual conclusions are given in those chapters. This synopsis generally follows the structure of the report, but in some places material on a particular point has been collated from a number of chapters. My final conclusions are given on the matters which I regard as the main considerations in determining the appeal.*

### Main Considerations

8.1 I regard the main considerations in determining the appeal as:-

- (1) the legal and political framework within which the appeal should be decided;
- (2) the relevant provisions of the adopted and emerging development plans for the area;
- (3) the degrees of adverse visual, socio-economic, traffic and other environmental effects likely to result from the proposed development and any associated development, and the extent to which such effects would involve conflict with the development plan or national planning policy;
- (4) the suitability of the appeal site for the development;
- (5) the degree of scientific and technical benefits likely to be obtained from the development, to be weighed against the likely adverse effects, as required by the development plan and national planning policy; and
- (6) the nature and form of the conditions which should be attached to the planning permission for the development, if granted.

### Legal and Political Framework

8.2 The Rock Characterisation Facility (RCF) would be in the form of a deep mine, and there would be no radioactive waste in it. Therefore no authorisation for the disposal of such waste would be required, and the site would not need to be licensed as a nuclear installation. If the RCF were to be followed by a deep waste repository on the site, the law would need to be changed by a statutory instrument for the repository to be required to obtain a nuclear installation licence. It has been submitted that the present law would not require the repository's operator to obtain a waste disposal authorisation either, because the producers of the waste would already have appropriate authorisations. My opinion is that it cannot be

assumed that this would be so, and it is clear that this is not the situation which the Government envisages.

8.3 A more important aspect of this point for me is that no potential regulator of the repository has a formal standing for the time being in relation to the overall repository project. Although the predecessor body responsible for authorisation has been shadowing some of Nirex's work, that has been as informal preparation for the anticipated application for authorisation. A suggestion for a formal working agreement between Nirex and the regulator was under discussion at the time of the appeal inquiry, but the arrangement had not been made by the close of the inquiry. This situation, of the repository project being well under way without any formal involvement of the regulator, is not one which is contemplated by the various international guidelines as I understand them.

8.4 It is against this background that there is a need to resolve the first set of legal issues between Nirex on the one hand and the Irish Government, a joint committee of local authorities and several other parties on the other hand. In my opinion, the work on the repository project is much too advanced for Nirex to be able to claim that the potential repository is merely hypothetical, and that it should be ignored for the purposes of the present appeal apart from reviewing the choice of location. Nirex has been working on the Sellafield repository project for several years: the function of the RCF would be to appraise the suitability of a particular volume of rock as the place for the repository: and parts of the RCF could well be used for repository construction. The connection between the RCF and the repository is direct and obvious, and so cannot simply be set aside in the rest of the appeal determination process. Nirex itself has referred to the connection in some of its other evidence.

8.5 This close association means to me that the potential impact of the repository can be relevant to the determination of this appeal, so long as a judgement on such impact can be informed and measured, and not merely speculative. The most appropriate words to describe this relevance in terms of environmental assessment law, in my opinion, are that some of the repository's impact would comprise indirect effects of the RCF development, either as an obvious consequence of a successful RCF or in combination with some of the impact of the RCF itself. Any doubts about this are resolved by referring to the European concept of the project. The RCF development would not be a project on its own because it would be crucially dependent on the development of a cluster of boreholes on the same site which has already been permitted. Thus the immediate project is the appeal development plus the boreholes. But, equally obviously, this project is just one of a series of Sellafield projects, the next in line of which could well be the repository construction project - and all under the umbrella of the overall repository project. The fact that the whole enterprise could abort does not negate the inter-connections, in my opinion.

8.6 Since the function of the RCF would be to appraise the potential location of a repository, it follows that any alternative sites which have been considered for the repository are alternative sites for the RCF too. There is also a clear public advantage in characterising the rock of the potential location for the national repository. On the other hand, there are plainly some substantial environmental objections to this RCF development. The skills and

other resources required to carry out investigations of this nature must mean that there will only ever be a few RCFs at the most in the UK. Crucially, it is obvious that the appeal site is not uniquely suitable for a repository, and that a variety of potential locations could be chosen depending on the importance attached to different factors. Cumulatively, these propositions make an overwhelming case for examining the merits of alternative sites, in this instance.

8.7 The law, in my opinion, requires these alternatives to be examined by the state sooner rather than later, so that they must be looked at now if that is practicable, instead of waiting for the inquiry into the construction of the repository. Nor is it a matter to be deferred until it can be considered by the regulators, because national policy as I understand it is for the locations of potentially polluting developments to be reviewed by the planning authorities, and not the pollution control authorities.

8.8 It is practicable to compare alternative sites in this case, since Nirex has already done this some years ago, albeit that with the passage of time a review of the comparison is gradually becoming more difficult. The planning authority has already exercised its right to require more information from Nirex about this site selection exercise. It has been dissatisfied with the amount of information supplied in response, but has eventually formed the view that planning permission should be refused in any event. Now that the application is subject to appeal, my opinion is that it is necessary to enforce the authority's reasonable requirement, and not grant permission before outline environmental profiles of the short-listed alternative sites have undergone a public consultation process. Although this procedure would raise some alarm around the alternative sites, this is overridden by the advantage of locating the repository, with its exceptionally long-term potential impact, in a well chosen place.

8.9 It also appears that a locational criterion required to comply with the UK's international obligations has not been applied in the site selection exercise. A repository near the sea would put the marine environment at greater risk of radioactive pollution than an inland site, for instance by means of a groundwater flux from the repository as is predicted by Nirex in this case. In my opinion, the special legal protection of the sea and the modern precautionary principle combine to require both an exceptional justification for locating a repository near the sea and an assessment of potential effects on the marine environment.

8.10 An incidental point on the legal adequacy of the environmental information supplied so far is that it does not cover the environmental effects of abnormal incidents at the RCF.

#### **Relevant Provisions of Development Plan**

8.11 The adopted Cumbria and Lake District Joint Structure Plan 1991-2006 applies to the appeal site and is up to date. Its strategic framework policies relate to, amongst other things, the protection of Cumbria's scenic beauty and natural resources from inappropriate development; the protection and enhancement of the essential qualities of the Lake District National Park; the regeneration of the economy of West Cumbria; the improvement of inter-urban communications; and steering the growth of tourism.

8.12 The bulk of the Structure Plan's policies are concerned with either managing the environment or guiding development. The key one for the purposes of the RCF development is Policy 54, applying to major developments which are more national than local in character and have significant environmental effects. This Policy prescribes 4 criteria: the sum of benefits to clearly outweigh any harm or risks; to cause the least practicable harm; to minimise adverse impacts; and not to harm interests of national or greater conservation importance unless the value of the benefits outweighs the value of the interests.

8.13 In my judgement, the first criterion plainly requires a wide-ranging balancing exercise, which cannot be confined to the local environmental impact of the development nor to particular tests or formulae for evaluating benefits, so as to purport to exclude the planning authority's discretion under PPG 23 or consideration of alternative sites. The second and third criteria are of particular interest when examining mitigation measures and proposed conditions. The fourth criterion is agreed to cover any effects of the RCF development on the Lake District National Park, despite the site's location just outside the National Park.

8.14 Policy 57 is another major projects policy which would apply if the development were concerned with the reprocessing, storage or final disposal of radioactive waste. From reviewing the gestation of this policy, I am sure that it is not intended to apply to the RCF: and I consider that it would be unnecessary and confusing to take it into account now even though it would apply to the repository construction project.

8.15 Other relevant Structure Plan policies of substantial importance are Policy 11, which seeks to protect the characteristics and landscape qualities of the National Park, particularly its undeveloped open countryside and the character of land identified on its Conservation Map; Policy 13, which seeks to protect the ordinary, undeveloped open countryside from development not required to meet local infrastructure needs; and Policy 25, which aims for all new development to enhance the visual quality of the existing environment. Although the RCF development as specifically described would last for a maximum of 13 years, these policies do not expressly exempt temporary developments from their constraints. Also, in my view, the appeal site is plainly in undeveloped open countryside, as is the nearest land in the National Park.

8.16 There are other relevant policies in the Structure Plan. Policy 16 relates to woodland tree planting, and Policy 17 to nature conservation. Policy 21 applies to emissions, noise, vibration and risks of accident; Policy 22 to sewage or other effluent discharges; and Policy 24 to flooding. Important archaeological sites, features and settings are normally protected by Policy 26. By virtue of Policy 36, development will not normally be permitted where there is insufficient capacity in the service or transport infrastructure. Policy 60 concerns the effects of waste disposal sites, and is relevant because most of the spoil from this mine would be disposed of on-site; whilst Policy 62 is for the imposition of strict restoration conditions. Finally, Policy 63 includes the A595(T), which runs alongside the site, in a key route for long distance inter-urban road transport, albeit there is no specific improvement scheme for the local length of the trunk road; whereas Policy 70 is for large bulk flows and dangerous materials to be transported by rail wherever possible.

8.17 The adopted Mid Copeland Local Plan also applies to the appeal site, but it is becoming out of date, with some land use policies not in conformity with the new Structure Plan. Policy 6I, for development in rural areas to have regard to traditional design and local materials, is still extant but is, in my view, intended to apply to residential development. Other relevant policies remaining in force are Policy 6J, which seeks to protect the character of listed buildings; Policy 6Q, which relates to the substantial retention of existing trees and woodland; and Policy 6R, for the protection of important archaeological remains.

8.18 There are 7 relevant policies retained for development control purposes from the 1988 Structure Plan, pending the adoption of new local plans. But they do not seem to differ significantly from the policies in the emerging local plans in their approach to any interest of acknowledged importance.

8.19 The Inspector's report into objections to the deposited Copeland Local Plan, which applies to the site, had been received by the close of the appeal inquiry. Further progress will have been made by now towards adopting the Plan, and some policies will have been re-numbered. However, these conclusions can, of course, only refer to the deposited policies as recommended for modification by the Inspector.

8.20 The appeal site is outside any town or village development limits defined by the Copeland Local Plan. The closest village with defined limits is in fact Gosforth to the south-east, but that settlement is just inside the National Park, and so its limits are defined by the deposited Lake District National Park Local Plan. Policy DEV 1 of the Copeland Local Plan is for development outside defined limits not normally to be permitted unless the proposals accord with other policies. The appropriate other policy for the appeal proposals is ENV 33, which is to support the RCF so long as 6 criteria are satisfied.

8.21 The first criterion is for the need to be justified by reference to the national radioactive waste management strategy, bearing in mind the Borough Council's fundamental requirement that safety is paramount. The second criterion requires specific justification of further investigations of the suitability of the site for a repository; whilst the third stipulates that the RCF fits into the overall research programme and contributes to the safety case to be put in due course to the regulators. The fourth criterion requires an acceptable non-nuclear environmental impact. The next criterion is a cross-reference to Policy IMP 1, which in turn sets out in some detail the Borough Council's expectations of agreements under Section 106 of the Principal Act, in circumstances where such agreements would be appropriate. The final criterion is for eventual restoration to agriculture subject to any repository safety requirements.

8.22 Policy DEV 3 sets out 8 design principles, normally expecting a high quality of building design and layout, in order to respect the character of the surroundings and help contribute to a strong sense of place. In pursuance of the Council's commitment to sustainable development, Policy DEV 4 is to have regard to the long-term effects of development proposals on the Borough's environmental, social and economic resources.

8.23 Amongst the Local Plan's transportation policies, TSP 5 requires satisfactory standards of access; TSP 6 normally requires significant traffic generators to have direct access to an appropriate standard of road; TSP 7 is for the needs of pedestrians, disabled people, cyclists and emergency vehicles to be taken into account in design and layout; TSP 8 requires compliance with parking standards; and TSP 13 is to support the transfer of freight traffic to the railway. Policies SVC 1, 5 and 6 deal respectively with effluent water quality and quantity, land drainage, and underground services.

8.24 Policies ENV 1 to 5 relate to nature conservation interests. Policy ENV 1 protects sites of international importance, and Policy ENV 2 those of national importance. Policy ENV 4 is for sound reasons to be shown if locally important sites, or the continuity and integrity of some defined landscape features, would be adversely affected by development; whilst Policy ENV 5 will not permit development which would have an adverse effect upon the conservation interest of any site supporting species protected by law.

8.25 A number of the Copeland Local Plan's other environmental policies are also relevant. Policy ENV 11 gives conditional support to new tree planting, and Policy ENV 13 normally requires landscaping schemes. Policy ENV 14 protects existing rights of way, whilst Policy ENV 15 seeks to protect watercourses and avoid flooding. Policy ENV 23 is to support proposals for the disposal of inert waste, effectively so long as their environmental impact is acceptable. Policies ENV 26, 29, 49 and 50 relate respectively to aerial discharges, noise and the settings of listed buildings and Scheduled Ancient Monuments. Policies ENV 51 and 52 effectively elaborate on the archaeological aspects of Structure Plan Policy 26, in line with PPG 16.

8.26 Although not part of the development plan, the Conservation Map in the National Park Plan delineates some mountain, moor and heath in the foothills to the north-east and south-east, and some coast to the south, of the appeal site. A larger area of the Park to the east of the site is defined by the deposited National Park Local Plan as part of the Park's Quieter Areas, the character and appearance of which are normally to be protected by Policy NE5 from disturbance by development.

8.27 A consultation draft of the Cumbria Minerals and Waste Local Plan has been published. Policy 43 of the draft supports minerals exploration provided that there are no significant adverse effects on local communities or the environment: and Policy 51 permits inert waste landfills next to major projects provided that there are net benefits compared with disposal at existing landfill sites.

### **Degrees of Adverse Environmental Effects and Extent of Conflict with Policies**

8.28 Although the landscape of the appeal site does not have a special quality, its importance is increased to some extent by its sheer proximity to the National Park. Also the site does contain some woodland and a small valley which are attractive in themselves. In the much broader perspective of the sweep down from the Lake District's fells across the coastal strip to the Irish Sea, the opencast coal zone to the north and the Sellafield Works to the north-west are much larger than the RCF would be: but that does not mean that the RCF



and associated development would be trivial by comparison. The mine-head up to 30 m high, on a platform of 4 ha within an operational area of 38 ha, would inevitably have a substantial visual impact, even on this well-wooded and undulating countryside.

8.29 The industrial air of the access to the appeal site has already harmed the countryside on either side of the trunk road there, and the screen planting beside the road is obscuring a public view seawards from this edge of the National Park. Little attempt has been made to design the RCF structures to be in keeping with the local vernacular tradition, with the result that they would look palpably out of place; and their impact would be accentuated somewhat by artificial lighting and security fencing. The interesting little valley would be spoilt by the platform works. Whilst I accept that both shafts which Nirex wishes to sink would be required for the effective implementation of its project, the extensive offices and car parking proposed on site are open to criticism. Although the spoil disposal area would be tucked away from the trunk road, it would be in an otherwise pleasant spot visible from a drive in public use. The design would not minimise environmental impacts despite the good quality of its landscaping, nor would it meet high standards of design, both contrary to Structure Plan Policies 13 and 25.

8.30 The overall development would not remain subordinate to the landscape, but would look incongruous, in my judgement. Also, it would cause visual harm to its setting. Although areas identified on the Conservation Map would be marginally affected at most, the RCF would visually intrude into parts of the National Park which are being identified for special protection of their quiet enjoyment. There would be a similar intrusion into a stretch of undeveloped open countryside in the Park, to the protection and enhancement of which particular regard is to be paid. Moreover, the development would be seen as a distinct, modern protrusion in views of the rising ground of the Park from towards the coast to the south-west. Both the Park's appearance and its local character, as spelt out in Structure Plan Policies 2, 5 and 11, and other Plans, would thereby be harmed, notwithstanding that the site is outside the Park and that Sellafield Works is not far away.

8.31 Although the settings of the nearest listed building and Scheduled Ancient Monument would not be affected, nor the Hadrian's Wall Military Zone, nevertheless the breaches of the various Structure Plan policies bring the proposals into conflict in turn with the last 3 criteria of the key Policy 54. It would have been practicable to cause less visual harm and impact, in my judgement, by making the ancillary development smaller in the first place and by preparing a better external design of the structures. Whilst I would rate the visual harm to the National Park as moderate, that plus the harm to the ordinary countryside do now have to be outweighed by more significant benefits under the first criterion of the Policy.

8.32 There are corresponding breaches of the Copeland Local Plan. The visual impact would be unacceptable, in conflict with the fourth criterion of Policy ENV 33; and the utilitarian and rootless type of external design is at odds with the principles of Policy DEV 3. Moreover, although Nirex has compared the RCF's visual impact favourably with that of the local boreholes, the latter are really part of the same project and so actually exacerbate the adverse visual effects. Looking further ahead, the permanent platform site of the preferred repository design concept on the appeal site would seemingly be less obtrusive and

more sympathetically designed; but there are outstanding points about the visual impacts of any service road from Sellafield and of use of the RCF shafts for repository construction purposes.

8.33 Turning to socio-economic effects, there would be some modest employment and economic benefits from the RCF development, and significantly higher ones from the repository's construction and operation. However, it is now very evident that West Cumbria is too dependent on the nuclear industry, and so it would be an economic detriment, in my view, to significantly consolidate the nuclear industry by establishing the repository near Sellafield. Also, despite relative familiarity with the industry, there is a substantial degree of local apprehension, mainly about health and safety in relation to radioactive waste, which affects residential amenity. Similarly, there could be noteworthy effects on tourism, fisheries and inward investment in business.

8.34 Although these perceptions are connected to the proposed repository, Nirex concurs that they are relevant at this stage. Indeed, some research evidence suggests that the impact is greater during such an anticipatory phase. The point that the effects are largely indirect ones of the RCF does mean, however, that a planning obligation to mitigate them might not be appropriate. Nirex has not offered any such obligation, albeit that it could, in my judgement, have taken formal steps towards a joint venture and trust fund, which would considerably mitigate the social and economic effects of the RCF. As it is, there are socio-economic benefits and detriments to be weighed up under the first criterion of Policy 54, and in the meantime there is some conflict with Local Plan Policy DEV 4.

8.35 The present access to the site is a temporary one, and it is time to settle the principle of its permanent retention, especially because the RCF project would be far too fragmented to be viably served by rail. On the other hand, the feasibility of a service road from the Sellafield Works to the appeal site has not been ruled out to my satisfaction, and so there is a national policy objection to retaining the access onto the A595(T), since that is part of a key long distance route identified by the development plan, and also a primary route onto which direct access should be avoided so far as practicable.

8.36 Looking at the particular circumstances to see whether an exception can be made from national policy, the trunk road's carriageway would have the physical capacity to carry the RCF project's vehicular traffic. That traffic should not in itself increase hazards for pedestrians and cyclists on the main road. However, this is the only public road from Gosforth towards the north-west, and is at present unsuitable for pedestrians and cyclists. I consider that utilising any spare capacity for the project's traffic would preclude making conditions better for them. Also every additional access increases the risks of accidents and obstruction, and this length of road is a vital vehicular link. Moreover, its safety record leaves no room for complacency.

8.37 Therefore my view is that no exception should be made to policy, and that the appeal proposals' infrastructure does not include a satisfactory access, contrary to Structure Plan Policy 36 and Local Plan Policy TSP 6. This would entail in turn another breach of the fourth criterion of Policy ENV 33. I have also noted that the layout of the RCF development

would fail to provide for pedestrians and cyclists, whilst making apparently excessive provision for car parking, contrary to PPG 13 and Local Plan Policies TSP 7 and DEV 3. There would thus be further conflict too with the second and third criteria of the key Structure Plan Policy 54. On the other hand, I cannot agree with the powerful local feeling that the whole length of trunk road carriageway from Gosforth to the next village needs immediate improvement, as distinct from a segregated footway/cycleway and specific safety measures.

8.38 As to other environmental effects, the site's quiet rural setting does mean that lower than normal noise limits should be imposed, despite Nirex's resistance, because in my judgement the RCF's essential work could be continuous whilst complying with such limits. The vibration effects from rock blasting should not cause disturbance, subject to the usual precautions and controls.

8.39 Although the proposed landscaping and restoration should enhance the general nature conservation value of the area in due course, I consider that Nirex and the authorities have made a serious error of judgement over disturbing the local badger clan, which is particularly important because it seems to be the last surviving clan in the locality. The spoil disposal operations would take place on most of the clan's principal feeding ground. The mitigation measures which have been considered and proposed do not go far enough and are untried. This would amount to a serious interference by a waste disposal operation with the core habitat of a protected species, contrary to Structure Plan Policy 60 and Local Plan Policies ENV 5 and 23, in my view. Thus there is yet more environmental detriment to take into account under the key Policies 54 and ENV 33.

8.40 Whilst there is a nationally important habitat of European-protected natterjack toads at risk down the course of the local beck from the appeal site, I accept that the unusual arrangements that have eventually been made between Nirex, English Nature and the Environment Agency to protect the core habitat of the toads from effluent from the development should suffice. But I note that there is an unresolved dispute between Nirex and the Environment Agency over the control of the ingress of underground water into the RCF. A very careful evaluation by Nirex has satisfied me that the part of a recorded Monument which has already been affected by landscape planting very probably does not constitute archaeological remains at all, and that the requisite degree of evaluation of the rest of the Monument has been carried out.

8.41 Other points raised in relation to agriculture, groundwater derogation, air quality, rights of way, recreation and the proposed explosives store I regard as either relatively minor or having been met. However, cumulatively they do confirm the general sense that the appeal development would be out of place.

### **Suitability of Site**

8.42 Although the general international and national criteria for the location of a deep waste repository are merely indicative guidance, 2 overriding principles can be derived from them. One is that the location should be in a region of low hydraulic gradients, so that there should

be slow-moving and long groundwater pathways: and the other is that the geology and hydrogeology of the site and its district should be readily characterisable and predictable. Whilst there has been a shift of focus in the guidance from the properties of the host rock to the wider hydrogeological setting, the requisite features of potentially suitable environments which were identified for Nirex in 1986 complied with both the general principles and the shift in focus. But there now appears to be a fundamental difficulty with some of the choices, in that there was then a preference for maritime locations due to the huge dilution offered by the sea, and yet the reverse preference is suggested by international law, to avoid marine pollution.

8.43 A type of geological environment which eventually scored consistently well in Nirex's site selection exercise, and is favoured by Cumbria, is termed "basement rock under sedimentary cover" (BUSC). This seemingly could offer a range of inland locations. Nirex appears to misunderstand the concept, by claiming that the appeal site is within such an environment, whereas the area has never been so designated by its geological consultants. It seems that Nirex takes the concept too literally, rather than looking for the particular features which led to the environment being identified, such as a minimum scale of hydrogeological system, and a mix of layers in the sedimentary cover to act as a barrier to upward groundwater flow from the basement rock.

8.44 Nevertheless Nirex is right to point out that the ultimate test is whether the preferred host rock has the potential to pass the regulator's safety requirements, regardless of its guideline classification. Also Cumbria and Greenpeace seem to have misunderstood national policy on the safety standards for repositories. There is no risk limit or constraint specified as an upper bound for determining the post-closure safety acceptability of a disposal facility, but there is a risk target as a lower bound beyond which it is not necessary to go. On the other hand, Nirex has failed to appreciate that Cumbria as the planning authority is entitled to its own view about the acceptability of the risk, so long as it does not seek to substitute its own detailed risk assessment for that of the regulators. Cumbria in turn has given no indication of supporting site selection criteria based on existing radiation levels, as suggested in some of the representations.

8.45 However, Cumbria's basic point is that the staged site selection process undertaken by Nirex in 1988-9 was detailed but flawed, and in essence I agree with Cumbria. Although I concur with the exclusion from the initial area of search of designations of national conservation importance, it was in my view premature and excessive to exclude also whole local authority districts on the ground of population density, and tracts of land which might have to be compulsorily acquired. In the later stages of the process, the crucial point is that safety was not treated as the most important discriminative factor. This role was given instead to the costs to be borne by the generations which would utilise the repository, and yet that is contrary to the principle of sustainability, in my judgement. Another fundamental difficulty is that the expert team and the Nirex Board, who should have interacted smoothly in the late stages of site selection, actually used different critical criteria in their final choices - geology for the one and local support for the other.

8.46 I consider that there were 3 crucial discontinuities in what should have been a methodical process. The first was the late introduction of an alternative Sellafield site which was not particularly promising according to the original criteria, and so probably would have been eliminated earlier if it had been included at the start. The second was the inconsistency between the team and the Board, which resulted in this lately introduced site and the doubtful Dounreay being kept in play whilst others with better safety potential were discarded. The third was the subsequent dropping of the alternative Sellafield site when it was realised after all that it is not suitable, and its substitution by the appeal site which, although nearby, had not been through the process at all.

8.47 This cannot justly be described as following a rational procedure, in my judgement. It seems that the process was affected by a strong desire to locate the repository close to Sellafield. Thus my view is that Nirex has failed to make its case on site selection even on its own terms of showing that it followed a rational procedure. Looking at the topic in the wider context which I consider appropriate for a planning authority, it is difficult to see the general public benefit in continuing to concentrate entirely on this site rather than any other. It has not been chosen in an objective and methodical manner, and there are strong indications that there may be a choice of sites in a different part of the earth's crust in the UK with greater potential to meet legal and regulatory requirements.

8.48 Nirex's scientific and technical work since the appeal site was chosen has generally been very impressive. But it does indicate amongst other things that the practical difficulties of the deep disposal option were originally under-estimated by the international consensus, which makes it all the more important to my mind to concentrate on an apparently favourable site. Also I consider that Nirex's emphasis on the relatively novel chemical containment concept in the mixed artificial and natural barrier suggests a lack of confidence in the geosphere. Although international cooperation has provided Nirex with considerable amounts of data on rock properties and responses, none of the experimental sites in other countries is very similar in geological setting to the appeal site.

8.49 All the work and cooperation have not led Nirex to a sufficient understanding yet of the groundwater conditions in and around the appeal site. Another fundamental point is that the area is extensively faulted but there is a considerable amount of speculation as to the influence which any local fault has on groundwater flow. Nirex does not know whether the faults in general or particular increase or reduce or deflect flow, nor does it know where all the faults are. There is a promising feature of the work in that there are indications that the groundwater in the basement rock has been there a very long time, but much more research is required to confirm this, and it would not be a determinatively favourable feature even when confirmed. For the basement rock is volcanic, which makes it inherently variable; and moreover it is very probably within a collapsed caldera, which makes the variability random.

8.50 Nirex does not seem to have fully appreciated these limitations on its understanding of the appeal site, nor the significance of the limitations. Partly in consequence of its undue optimism, it is not planning to take all the steps necessary to put these deficiencies right. This leads to problems in turn with the adequacy of its modelling, in my view. Whilst conceptual and mathematical models have a vital role to play in Nirex's investigations and

preparations for a safety case, the models must be based on a sufficient understanding of the geology and hydrogeology.

8.51 There is no indication that Nirex would have a model of landfill gas migration through the geosphere ready for testing in the RCF. A more fundamental point is that Nirex's regional conceptual model and its derivatives cannot match observed groundwater heads and salinities. This is a failure to account for some basic processes and parameters of the hydrogeological system, and the new model promised to cope with this problem is of completely unknown quality. There are also probably even deeper conditions and processes which have yet to be addressed. Within the basement rock itself, Nirex is still evaluating no fewer than 6 alternative conceptual models of groundwater flow, and typically expressing too much optimism about the results of the evaluation.

8.52 The preliminary safety assessments of the appeal site reflect these difficulties. The last assessment published in 1995 assumes that the artificial chemical barrier would have a very significant retarding effect on release of the longer-lived radionuclides from the repository, and yet the barrier is new and untried and the assumptions in the assessment entail great simplifications and may be non-conservative. Also the assessment predicts zones of discharge to the biosphere even though knowledge about the present groundwater discharges in those locations is inadequate. The results of the main calculations in the assessments which comply with the regulatory target have to be read subject to an appreciation of the uncertainties encompassed in these and similar points. Furthermore the scoping study for agricultural wells reveals and yet understates a potential problem of premature human access to the radionuclide flux. This is a reminder that the appeal site is not in any of the preferred environments: and that far from the sedimentary rocks acting as a barrier to upward flow, Nirex is actually relying on them to dilute and disperse the radioactive plume.

8.53 Whilst this assessment cannot be claimed to completely rule out on its own any promise in the appeal site, it thus directly over-arches great uncertainties which would not be resolved by the RCF, and highlights the vulnerability of the concept of relatively rapid upward transport of the radionuclides, compared with the slow, downward flow of the favoured hydrogeological environments. The indications are, in my judgement, still overwhelmingly that this site is not suitable for the proposed repository, and that investigations should now be moved to one of the more promising sites elsewhere. On this basis, there is really no national or regional benefit to be gained from continuing investigations at this particular site, to be taken into account under the first and fourth criteria of Structure Plan Policy 54. Also, the first two criteria of Local Plan Policy ENV 33 are not satisfied, in that the paramountcy of safety does not justify further establishment of the geology and groundwater flows in the vicinity of the appeal site, nor has it been shown that any further investigations at all of the suitability of the site are justified.

### **Balance of Benefits and Adverse Effects**

8.54 It is necessary finally to consider any generic research benefits from the RCF, and also whether it would actually cause harm to the geosphere. To obtain such benefits, it would be necessary to subject all the work both to independent peer review and to guidance

from the regulator, in my view. The RCF would certainly be essential if the site were promising, to obtain more information for example about geochemistry, conductivity, sorptive capacity, gas migration, colloids and excavation disturbance. But for the RCF to be beneficial, the baselines from which it would start must be clear and comprehensive, and the investigations and experiments must be well focused and designed.

8.55 In order to be sure about the impact of the RCF on its geological setting, and implement it in the least harmful and most effective manner, there is a need to first improve the present detail and interpretation of that setting. There should be more boreholes in or close to the appeal site, and there should be some more years of monitoring trends in the basement rock. Also considerably more laboratory work and modelling development and refinement are required on matters specifically related to the local rock and groundwater before perturbation of the appeal site by the RCF can be justified. Nirex's modelling protocol also need to be generally improved, in my judgement, to recognise the absolute limitations entailed in the quality of input data and the span of human uncertainty and error.

8.56 I consider that Nirex should not be allowed to proceed with the RCF in its current state of inadequate knowledge, for that would make it very difficult for anyone to predict the consequences of Nirex's actions, and result in a confusing outcome. Furthermore, in the eventuality that my conclusion about the suitability of the site is incorrect, to proceed now would cause needless damage and yet very probably could not optimise the repository location. Examination of the details of the RCF programme merely reinforces these apprehensions. The timetable of events is far too optimistic, from starting before baseline conditions are satisfactorily established, through experiments which would still be basic research after crucial decisions had been taken, to restoring the mine without observing the recovery period.

8.57 Therefore I consider that there is no benefit to be obtained on any basis from proceeding with the RCF at present, and indeed it might well harm the potential repository location if it transpires that, contrary to my belief, it is suitable for a repository. The fact that construction of the repository here is precluded on either of the above scenarios has the consequence that its employment and economic benefits cannot be taken into account in the final balancing exercise under the first criterion of Structure Plan Policy 54. My ultimate conclusions are that the modest employment and economic benefits of the RCF itself would by no means outweigh the harm to the appearance and character of the National Park; the encroachment on the open countryside; the detriment to residential amenity and the adverse effects on tourism, fisheries and business investment; the lack of a satisfactory access and of proper provision for pedestrians and cyclists; and the serious interference with the surviving local badger clan. There would thus also be a failure to satisfy the first four criteria of the emerging Local Plan Policy ENV 33.

### **Nature and Form of Conditions**

8.58 My comments on conditions are subject to any further environmental information obtained on the profiles of alternative sites, on the effects of the repository, or on abnormal incidents at the appeal site.

8.59 In relation to the mitigation of environmental effects, I commend the conditions set out in COR/113 subject to the conclusions in my Chapter 7A. Particular consideration needs to be given to the noise controls to be imposed on the permission, having regard to Nirex's reluctance to accept some of them but my finding that it could implement them. Nirex has also expressed reservations about the condition to control ingress of groundwater, but I am clear that on balance this should be imposed.

8.60 As to ensuring scientific and technical benefits, the most practicable solution would be a binding agreement between Nirex and the Environment Agency. The conditions suggested by me in COR/113C, Annex A were as a focus for discussions on alternative control by planning if no agreement is forthcoming. However, I do consider that experience to date shows it would be necessary for some authority to regulate the RCF as it is developed; and so if planning conditions are regarded as inexpedient, this becomes another ground for dismissing the appeal, in my judgement.

8.61 In any event, notwithstanding my comments on deficiencies in the environmental information and on conditions, like the planning authority I consider that the RCF development should not go ahead, for the reasons I have summarised above.

## 9.0 RECOMMENDATION

9.1 I recommend that the appeal be **DISMISSED**.

I have the honour to be  
Sir  
Your obedient servant

*C.S. McDonald*

C.S McDonald