Summary evidence for the Cumbrian MPs *ad hoc* committee
(Chair: Sir Tony Cunningham MP)

Why the current MRWS process should not proceed to Stage 4

by
David K. Smythe
(Emeritus Professor of Geophysics, University of Glasgow)

Where I stand. I am grateful for this opportunity to present written evidence to the *ad hoc* committee. Due to personal circumstances I was unable to accept the invitation to appear in person.

I am a retired academic, whose career spanned firstly, the British Geological Survey (BGS), followed by the University of Glasgow. I believe in the (now outmoded) concept of public service; I have no axe to grind, either over the nuclear industry or West Cumbria; I have no financial or personal interests to declare; I no longer even live in the UK, and am in the process of applying for French nationality; I believe in honest impartial science in the aid of civilised society; I follow current affairs closely, especially from a European perspective.

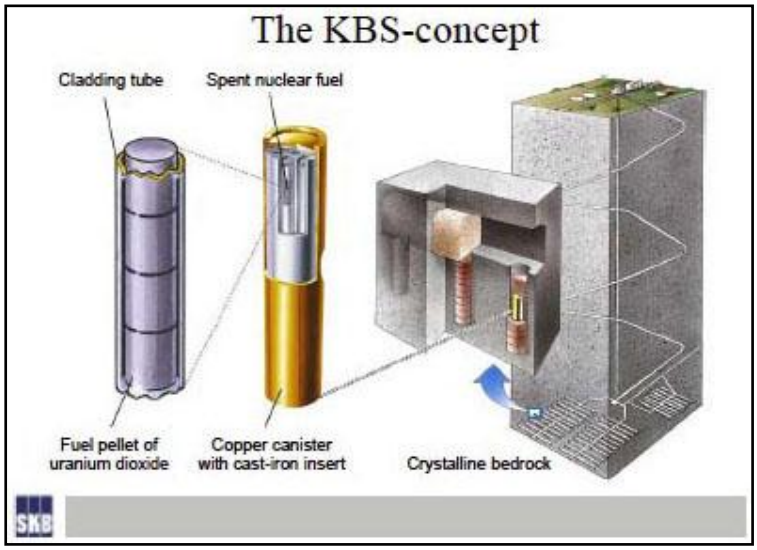
I served on the BNFL Geological Revew Panel, 1990-91. I proposed and carried out the trial 3D seismic reflection survey at Longlands Farm for Nirex in 1994 (a double world first – the first time that an academic research group had used this then novel method, and the first time that a potential radwaste site had been surveyed in this way). But I was so concerned about Nirex's lack of understanding of the highly complex geology there that I felt obliged to appear against Nirex, as an expert witness for FoE, at the Nirex Planning Inquiry in early 1996.

My concerns about radwaste disposal in West Cumbria were revived with the publication of the Defra MRWS White Paper in 2008, to the consultation of which I had submitted a response, pointing out that the 'voluntarist' approach left open a return to consideration of West Cumbria. My fears then have proved to be correct.

This submission summarises my views at Stage 3 of the MRWS process. I have tried to complement rather than duplicate the submission of my former Glasgow colleague Professor Stuart Haszeldine, whose views I largely share, and who is appearing before the committee in my place. It is based on many months of (*pro bono*) full-time study and research. My project folder hosts some 9000 files, of which some 1600 are pdfs of research papers and the like, and some 1700 of which concern BGS publications, and so on. I have spent over £1K purchasing BGS maps, data, and reports where necessary. Fuller details of my results can be found in my MRWS consultation submission (some 168 pages) and on my website.

Why the geology is crucial. The final and most important barrier to limit radioactive escape from a repository into the environment is the geology. Engineers may (over-)confidently predict that their 'engineered barrier systems' will succeed, so that the geology of the repository hardly matters, but this is not true. Let us look at the example of the Swedish copper radwaste canisters, the KBS-3 concept. It comprises:

- Fuel placed in isolating copper canisters,
- With a high-strength cast iron insert.
- Canisters are surrounded by bentonite clay,
- In individual holes at 500 m depth,
- In granitic bedrock.



The NDA has adopted this model for the UK. The Swedes developed this concept in the 1970s, and as late as 1999 were still predicting that the canister would be corrosion-resistant (in the right groundwater conditions) for a million years. But the Swedes also fund an independent NGO office to undertake independent critical research (something lacking in the UK); this office funded and published a comprehensive study in 2011 showing that there is a previously unknown leaching mechanism which can eat away all the copper within a 1000-year timescale. The several lessons to be learned here are:

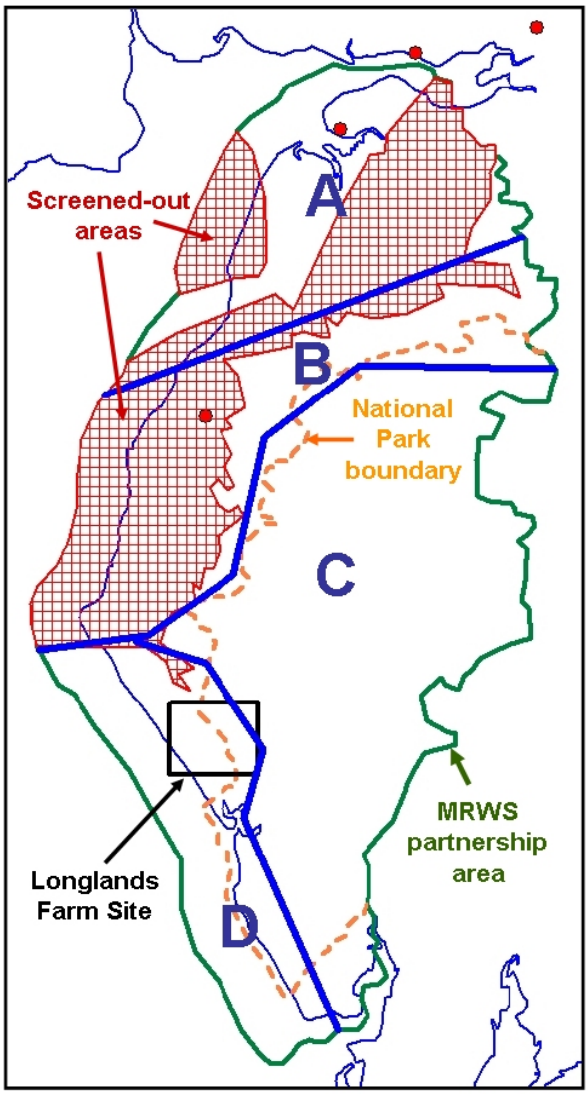
- The UK must fund truly independent critical research.
- The research timescales are decades-long (the

Swedish experience above being 35 years).

- Engineers' predictions simply cannot be trusted when it comes to geological timescales.
- We have to go with Nature, finding the best natural barrier, neither fighting it nor choosing sub-optimum geology.

What is suitable geology? Internationally agreed fundamental criteria for how to search for a potential radwaste site all converge on the same broad principles. These include low hydraulic gradients (so that groundwater flows very slowly), and simple, predictable geology. Most of the Partnership area fails both of these tests immediately.

The whole area is very well known geologically, because the Lake District has been a classic area of geological study for two centuries. Contrary to certain views, the £400M of Nirex studies were not all



concentrated within the 50 sq km Site area (see map), but extended well away, from Workington to Barrow, inland for 15-20 km, and west offshore for 50-70 km. Northern Allerdale, not studied by Nirex is, on the other hand, well understood from 40 years of oil exploration.

Area A comprises the Solway plain north of the blue line, but most of it has been screened out by the 2010 BGS exercise for DECC (red hatching), on the basis of coal and coal-bed methane resource potential.

A site at Anthorn Airfield had been considered during the BGS/Nirex national site search in 1988 (the red dots on the map show sites considered at that time), but was then rejected on geological grounds. The rock at the surface in the coastal plain is the Mercia Mudstone Group (MMG), which had been considered and rejected by the BGS in 1986. But Dr Jeremy Dearlove, the MRWS consultant geologist, stated in 2011 "*I understand from brief discussions with the BGS that the Mercia Mudstones within this area would also form part of the BGS's "potentially suitable sedimentary formations*".".

So the area appears to be back in play on a no more sound basis than a coffee-time chat with anonymous BGS personnel. This is not a rational way to find a repository host rock. My review of the ample available data, published by the BGS, shows that, although the non-excluded area near Silloth has simple geology, and is far enough away from the Cumbrian fells for the hydraulic gradient to be relatively low, the MMG has a hydraulic conductivity from 10,000 to one million times too high for it to be considered as a repository host rock. This is because it is a siltstone, and a brittle fractured shale, not a plastic clay host rock, such as has been found by the Swiss, French and Belgians. Furthermore, the rock volume where the repository would have to be excavated, between the two screened out areas, (a) is very shallow, at around 400 m depth, and (b) is cut through by at least two large faults. The geochemical groundwater environment is oxidising, which is the opposite of what we need. The rock is classed as a 'Secondary B' aquifer, and there are currently active water wells drilled to more than 100 m depth. It should properly have been screened out, leaving nowhere in northern Allerdale for further consideration.

One also has to ask, if waste must be shipped 40 km north from Sellafield to Silloth for burial, why cannot it simply continue on a longer journey to a suitable geological repository somewhere in eastern England?

Area B is a belt of complex limestone and coal geology fringing the northern and western flanks of the National Park. Much of it has been excluded already (iron and coal resource intrusion risk). The part remaining is highly faulted and comprises mainly limestone. Lastly, hydraulic gradients will be high. There is no possibility of finding a suitable host rock environment here, and

none has ever been suggested.

Area C comprises the hard crystalline rocks of the National Park. The extreme relief of 800 m is sufficient *a priori* to rule it out of consideration; contrast that with the Swedish and Finnish repository sites, which both comprise coastal hard rock, and where the local ground relief is of the order of 20 m. No other country has considered placing a repository in such steep terrain – except the now-defunct Yucca Mountain site in Nevada, which was selected to be hundreds of metres *above* the water table, in a desert environment. Nevertheless, the Eskdale and Ennerdale granites have both been proposed (informally) as repository host rocks. Both bodies have a *millefeuille* pastry, or lasagne-type structure, in that layers of granite are interleaved with the slates into which they have intruded. This is complex and unpredictable. The granites have also been severely faulted after solidification.

The one area of the granites which appears to be clear of surface faults is the central part of the Ennerdale body, comprising Ennerdale Fell. There has also been mention of direct tunnelling obliquely from Sellafield – or, more probably, from Longlands Farm, which the NDA has inexplicably held on to, 15 years after Nirex lost its planning appeal to site a test repository there.

Firstly, it is unlikely that this portion of the granite is different in structure from the other parts, so the likely complex structure would have to be investigated in detail. There is no question that this would involve extensive heavy engineering investigations. By analogy with Longlands Farm (and hard-rock sites abroad), 20-30 boreholes would be needed for detailed hydrogeological study over a decade or so (the 2010 Entec environmental report for NDA quotes 20 deep boreholes and 50 shallow boreholes). A lightweight drilling rig weighs 30 tonnes or more. This would have to be assembled *in situ* on the top of the Fell by a mobile crane. All this requires HGV-capable roadways to be cut first. The only way to image the subsurface is by a 3D seismic survey, and in this kind of terrain the only possible source would be dynamite. I estimate that around 60,000 holes, each 1 m deep, and charged with 200 g of gelignite and a detonator, would be required to image the 25 sq km of the granite in sufficient detail, together with millions of pounds-worth of sophisticated ground recording gear laid out in grids. Secondly, NDA schematic plans and volumetric calculations show that three permanent vertical shafts are required from the surface (i.e. the summit of Ennerdale Fell) to the repository.

All the above demonstrates that Ennerdale Fell and its surrounds would become an industrial mining zone, closed to the public for security reasons, for many decades; this is clearly incompatible with its status as part of the National Park. The NDA's own planning documents, together with current international practice, show that it would be quite impossible to construct a repository purely by tunnelling obliquely from a surface location like Longlands Farm.

Area D comprises the coastal strip of sediments at the surface, west of the hard rocks of the Lake District. The hard rocks underlie the sediments at a few hundred metres depth. Note that the Partnership area, for the purpose of geological screening by the BGS, extends 5 km offshore.

The 1988 BGS/Nirex national site search did not include Longlands Farm, nor any geologically similar location. The 537 sites selected and sieved (or screened out) at successive stages included only a 'Sellafield', where the target was a potential anhydrite (salt) layer dipping offshore. But early drilling proved that the layer was too deep. 'Sellafield' then shifted location (twice) and category of rock (once), and was only introduced at a late stage in the national site search. Politics, and not geology, forced this 'cuckoo' site onto the shortlist, and it was finally chosen over Dounreay. Longlands Farm was supposed to be in the 'basement under sedimentary cover' (BUSC) category, but the Inquiry Inspector perceived that it was not a proper BUSC example. It failed because the geology is far too complex and unpredictable.

In 2005 Nirex tried to claim that a post-Inquiry revision of its modelling (a group of documents known as Nirex 97 and issued in 1997-98) now showed that the Longlands Farm site exceeds the safety threshold. This is wrong. My analysis of the modelling used to predict the water flow shows that the effect of the faults cutting the rocks has been ignored. In fact, the faults will cause contaminated water from a leaking repository situated at 650 m depth in the hard rocks to migrate obliquely upwards along the fault planes, to reach the surface in a short time. My view is supported both by theoretical modelling of fault zones, and by the empirical results of United Utilities, who stated in 2011 that they were drilling the fault zones for drinking water south of Egremont because they gave the best flow. The theoreticians conclude that fault zones on the small scale are inherently unpredictable. The improvement in computing performance since 1997 is irrelevant – the same fundamental errors will simply be recreated, but faster and in more detail. So the only safe way to find a good repository site is to <u>avoid faulted rocks</u>. This is

what the French and Swiss are successfully doing – they have selected simple clay geology.

The coastal areas north and south of Longlands Farm are even worse prospects; the site around which £400M was spent could be said to have the 'least bad' geology in the area. Offshore west of Sellafield is also unsuitable; it comprises the same MMG as in northern Allerdale, with the same problems. In addition there would be severe political problems with the Irish and Norwegian governments, if any attempt were made to study a potential offshore location.

Summary of areas A-D. No stone has been left unturned, so to speak. There is no possibility that a rock volume exists that conforms even approximately, or in part, to the international guidelines for suitability. The 'three wise monkeys' approach adopted by the MRWS process, - that we do not yet know enough to rule out all the geology, because we have not yet done Stage 4 - is false. The evidence is all there in the public domain, mostly the work of the BGS and Nirex. All I have done is review and synthesise it. No-one has seriously challenged, in detail, any of my conclusions, but instead some resort to claiming that 'only the BGS' can decide.

The hubris of the engineers, that their engineering can overcome natural obstacles like adverse groundwater flow and chemistry, must not be accepted. We must, in short, go with the flow, and not try to fight Nature.

Comments on the MRWS process to date. The White Paper misleadingly implies that voluntarism has been the successful approach abroad. This is disingenuous. France, Switzerland, Finland and Sweden have all made progress in site selection by doing the geology first, and only then seeking local support or veto. DECC has tried to justify putting the voluntarism cart before the geological horse by claiming that a national screening exercise would be too expensive. This is also untrue, as the overseas examples demonstrate. The assertion wilfully conflates the detailed screening-out of rock volumes with the more general search for potentially suitable geological environments. In fact, a national search by the BGS was done in the 1970s, repeated with new criteria in the 1980s, and evidently nearly finished in revised form in early 2006, when a joint BGS/Nirex statement was issued to say that rather more than 30% of the UK landmass had potential, and that a full report would be published later that year. The report never appeared, allegedly because of a change in government policy (i.e. the birth of the voluntarism approach). The NDA has told me that the maps on which the 30% estimate must have been based do not exist. I find this hard to believe. There is a strong suspicion that the whole process has been predetermined – it is a 'quick fix' designed to enable a return to West Cumbria.

What if one or more councils proceed to Stage 4? I no longer have confidence in the impartiality of the BGS as an organisation, although I still trust the integrity of its individual scientists. **Firstly**, comparison of the draft BGS 2010 screening report (which was supplied anonymously to me) with the final published version, together with the published peer reviews, show that severe alterations were made to the draft. Contrary to popular belief, the final BGS screening report has *not* removed aquifer rock volumes from consideration; consideration of this important screening criterion has merely been postponed. Northern Allerdale was also initially screened out in its entirety on hydrocarbon grounds. **Secondly**, the BGS is angling for a lucrative contract to study the Partnership area in detail; this fact means that it is no longer impartial. **Thirdly**, the senior BGS radwaste scientist has stated on public radio that West Cumbria "*offers potential*" for finding a repository site; it will therefore be all-but impossible for the BGS to conclude at some stage in the future, that, sorry, there are in fact no suitable rock volumes worthy of more study. **Fourthly**, I have direct experience as a senior BGS scientist myself, in 1985, of being obliged by BGS management to conform to a Department of Energy instruction to write a confidential paper arguing a case I did not believe in. I believe that this paper was then forwarded as geological 'advice' to the F&CO. It was one of the reasons that persuaded me to quit BGS employment.

Conclusion and recommendations. The MRWS process should not go to Stage 4, as there is ample evidence that public money will be wasted, and time will be lost. Political pressures will mean that a geologically poor site will be chosen, but shored up by nuclear waste civil engineers who will assert that they can solve the insoluble, and that their grouting and filling will be good for 100,000 years.

The urgent problem of Sellafield's current wastes should be taken care of by an interim surface storage solution, to last 100 years. The next 25 years can then be given over to thorough research into waste encapsulation (at Sellafield), together with honest and transparent search for a satisfactory repository site elsewhere.

4 January 2013