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Used Fuel Disposition Campaign

Lessons Learned Activity and Perspectives on Nuclear Waste Management Activity

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Five Lab Participants in Lessons Learned and Perspectives Activity

- **Leads at 5 Labs**
  - ANL – Mark Nutt
  - LANL – Frank Perry
  - LLNL – Jim Blink
  - SNL – Rob Rechard
  - SRNL – Joe Carter
- **DOE-NE NV Oversight**
  - Lam Xuan

Multi-Year Lessons Learned Activity

- **Review past experience on efforts to implement technical aspects of nuclear waste management and provide insights for implementing a future nuclear waste management program**
  - Much has been attempted. What should be learned?
  - Focus in FY10 was on reviewing past experiences at the interface between technical implementation and HLW regulatory framework

Multi-Year Perspectives on Nuclear Waste Management Activity

- **Waste generated under future fuel cycles could be managed under current framework. Yet, what changes could be made to optimize waste management?**
  - *Sitting of storage, disposal, and reprocessing facilities big issue. Would characterizing 2 or 3 sites help? What is role of volunteer sites? Would stepwise decision making help?*
- **In FY10, explored different perspectives on the past experience through a workshop and survey, which was input for the Lessons Learned activity**

1st Part to Lessons Learned Activity

- **Lessons Learned activity will again focus on HLW/SNF in FY11**
- **Part 1 (1st half of FY11): Basis for Selection of Disposal Options**
  - Alternatives to Geologic Disposal
  - Alternatives to Mined Geologic Disposal
  - Alternative Media for Mined Geologic Disposal

1st Part to Lessons Learned Activity

- **Level 2 report on Disposal Options due End of March**
  - Briefing document
    - *1-4 pages of text per topic*
    - *Text supported by many references*
- **Status:**
  - Developed Statement and Outline for Discussion
  - LLNL Working on Alternatives to Geologic and Mined Geologic
  - LANL Working on Alternative Media—started in Jan

Basis for Disposal Options – LLNL

- **As part of the March deliverable, we are reviewing the following:**
  - **Alternatives to Geologic Disposal**
    - *Space, Ice-Sheets, Engineered Mountain/Mausoleum*
  - **Alternative Locations for Geologic Disposal**
    - *Islands, coastline, mid-continent, and saturated vs. unsaturated zone*
  - **Alternatives to Mined Geologic Disposal**
    - *Well injection, rock melt (other labs are reviewing subseabed and deep boreholes)*
  - LANL and SNL are reviewing alternative media for Mined Geologic Disposal

UFD Lessons Learned Activities - LLNL

- **Four step process**
  - Identify candidate references
  - Subject reference list to “gray-hair” review
  - Develop a text summary for each reference (the parts pertaining to the above areas)
  - Reorganize the set of summaries to be by subect, citing the various references

Examination of Alternative Media—LANL and SNL

- Salt
- Granite and other Igneous/Metamorphic Rock
- Shale/Clay
- Basalt
- Tuff
- Alluvium
- Carbonates and Chalk
- Sandstone

2nd Part to Lessons Learned Activity

- **Part 2 (2nd half of FY11): Expand on 3 Topics from FY10 Work**
  - Screening Criteria, Steps for Site Characterization—Frank Perry, LANL
  - Integration of the Waste Management System—Jim Blink, LLNL, Joe Carter, SRS, Mark Nutt, ANL
  - Enhancing Acceptability and Management of Repository Development--SNL
- **Level 3 Report on 3 Topics due Mid September**
- **Status:**
  - 5 Papers for HLW Conference will review FY10 work and provide foundation for FY11

Screening Criteria and Site Characterization Step

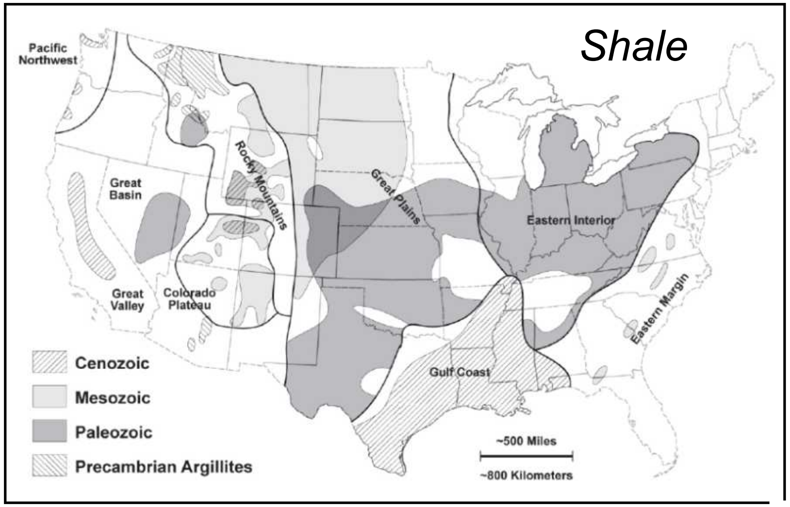
- **Evaluating multiple sites in alternative host media**
  - What data are needed to evaluate one site against another?
    - *What data could be reasonably gathered (time, cost, regulations)?*
    - *Fairness: Avoid biasing siting because of different levels of existing data*
  - Gather standard, primarily non-intrusive data sets akin to the Czech Republic model? (e.g., geophysics, water chemistry, rock properties)

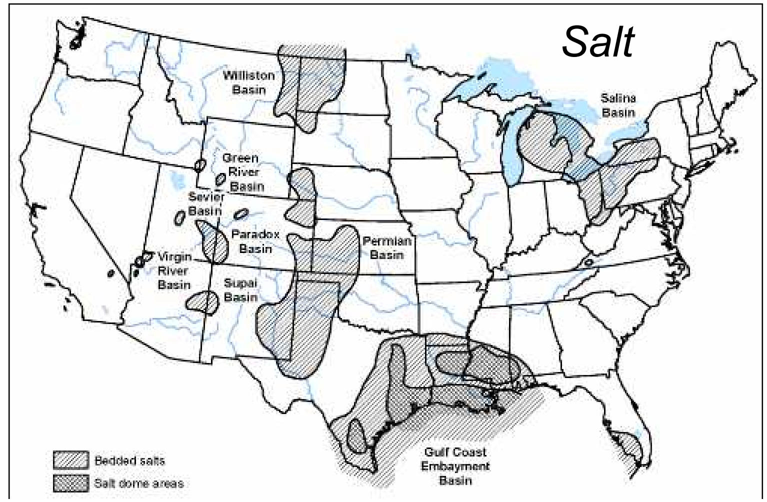
Integrate with Regional Geology and Tectonics GIS Database Work Package

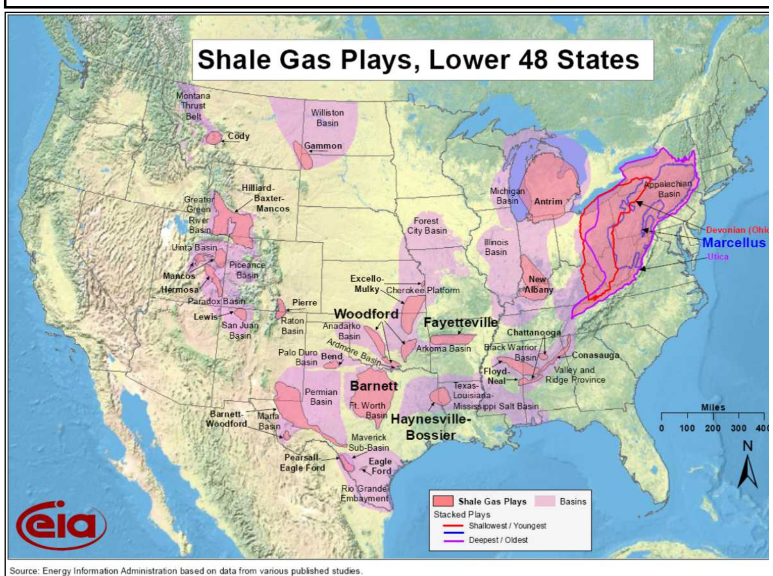
- **Build spatial (GIS) database to create a common information tool for analyzing alternative host rocks to inform future experimental and modeling work**
- **Include in spatial database features that have the potential to influence siting**
  - e.g., economic resources, tectonic hazards, topography, hydrologic environment, land use, population

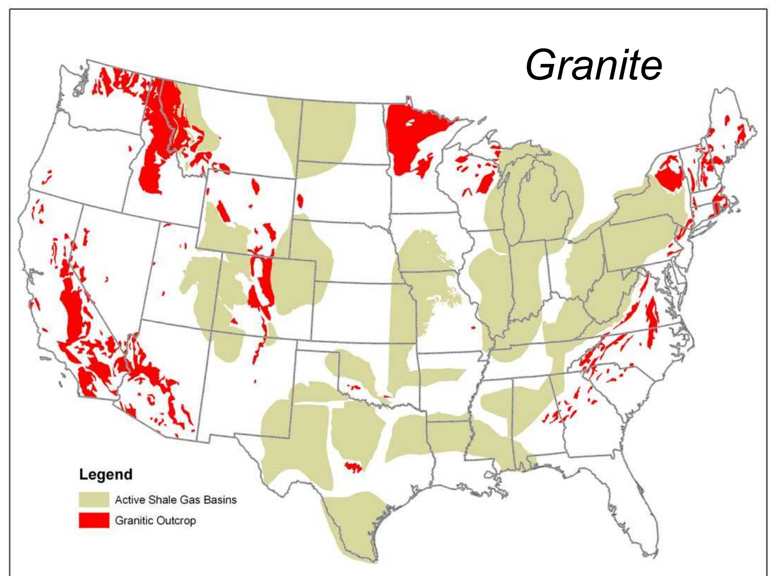
Used Fuel Disposition

Example: Potential Host Rocks and Natural Gas Resources









Used
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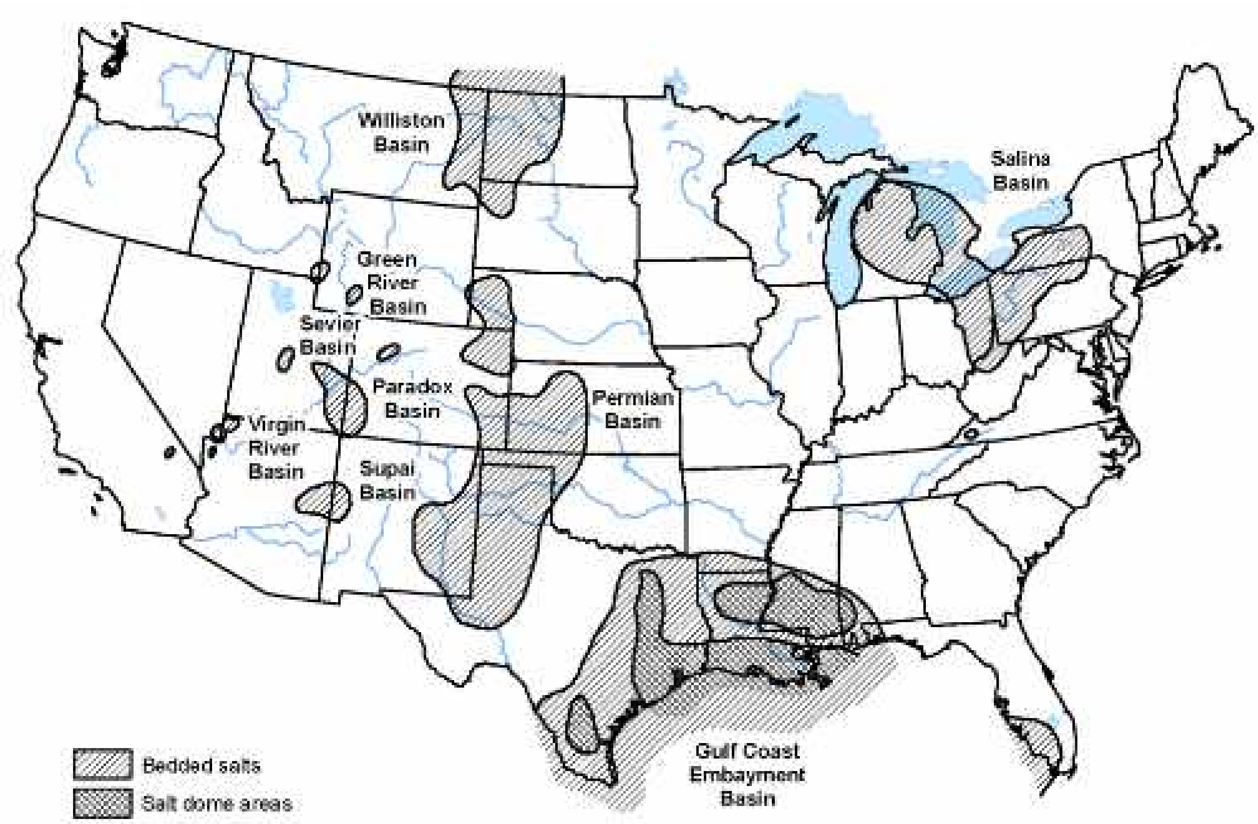
Disposition

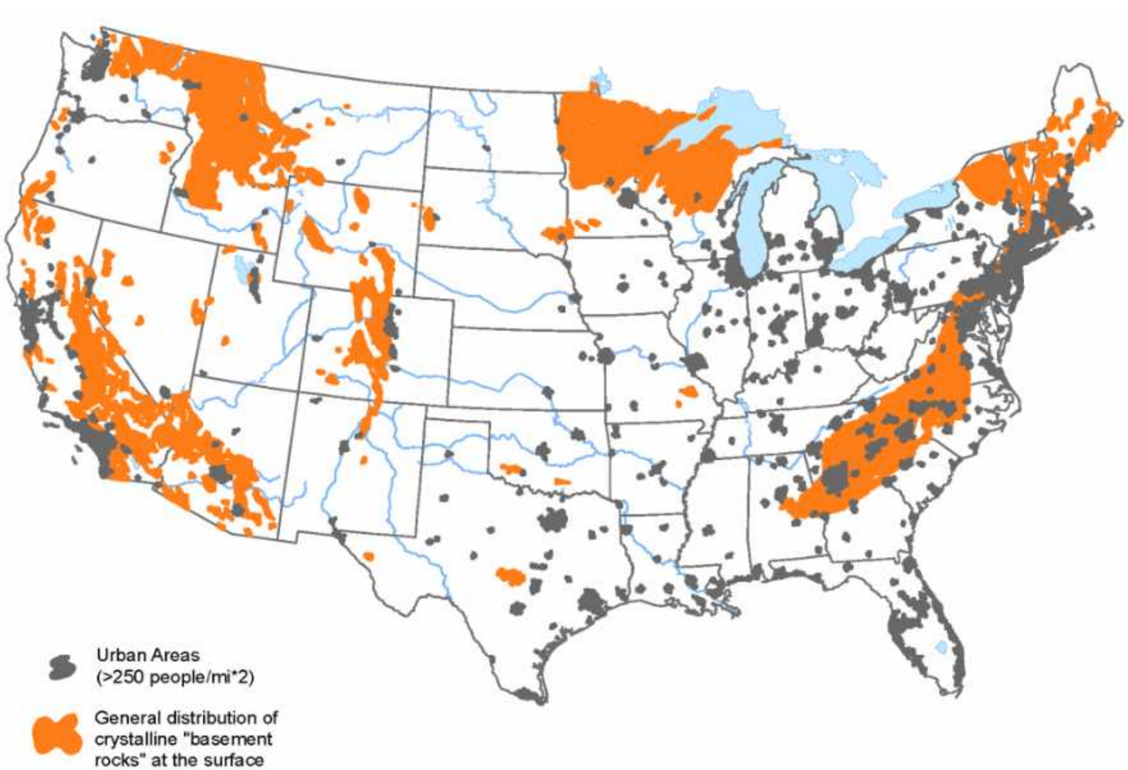
Salt



- **Ductile, self healing**
- **Low permeability**
- **High thermal conductivity**
- **Stable geology**
- **Continue study of thermomechanical response to thermal load**

History: Recommended by NAS (1957), WIPP, International Experience

Granitic Rocks



- Large areas of U.S. within 1-2 km of surface
- Generally less sorptive than shale/clay
- Transport dominated by fracture flow
- Greater reliance on engineered barrier syste
- Granite provides stable environment for EBS
- site in tectonically stable, reducing environments

***History**: DOE Crystalline Rock Program, Climax Spent Fuel Test (operational and R&D goals), International Experience*

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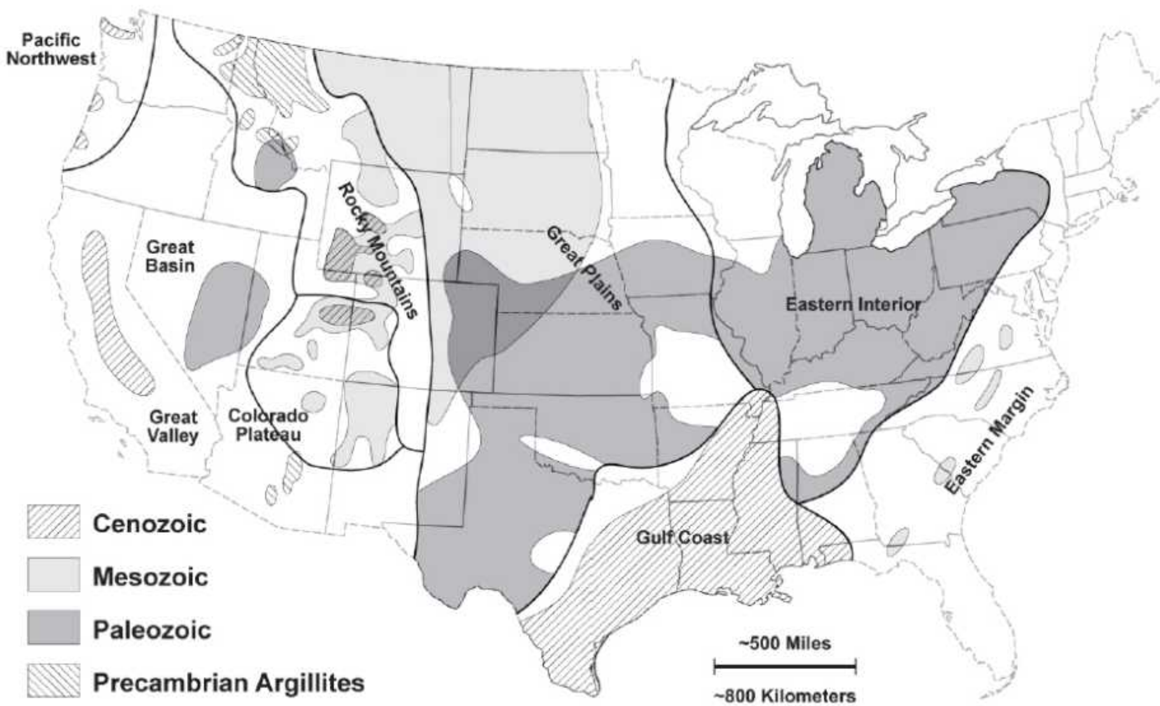
Shale/Clay



- Low permeability, high sorption, reducing environment
- Competition with natural gas resources?
- Diffusion-dominated transport and self-sealing in ductile (soft) shales
- Thermal response/drying?
- Colloid transport?

History: *DOE Sedimentary Rock Program (shale ranked higher than sandstone, carbonate, anhydrite and chalk using multiple critieria ranking [ORNL, 2003]), International Experience*

Lessons Learned - Siting Issues

- **FY11 Focus**
  - Review and document international implementation of siting criteria as applied to early stages of site screening
  - How site screening has been implemented within a volunteer framework (use of exclusion criteria in earliest stages to define unsuitable regions for no further site consideration)

Lessons Learned - Siting Issues

- Integration with Regional Geology and Tectonics work package
  - Using information gathered from Lessons Learned, assess how potential exclusion criteria used internationally could constrain the availability of alternative host rocks in the U.S.
  - Flip side: what factors contribute to a desirable geologic environment?
  - At the continental/regional scale, how do both “desirable” and potentially excluded geologic environments and potential geologic host media spatially intersect? (use GIS analysis)

Example: New siting approach in UK

- The UK's "A Framework for Implementing Geological Disposal" (2008) defined a new process for siting a repository that included a voluntarism/partnership approach and criteria for evaluating candidate sites

"With publication of this White Paper, Government invites communities to express an interest in opening up without commitment discussions on the possibility of hosting a geological disposal facility at some point in the future."

Example: New siting approach in UK

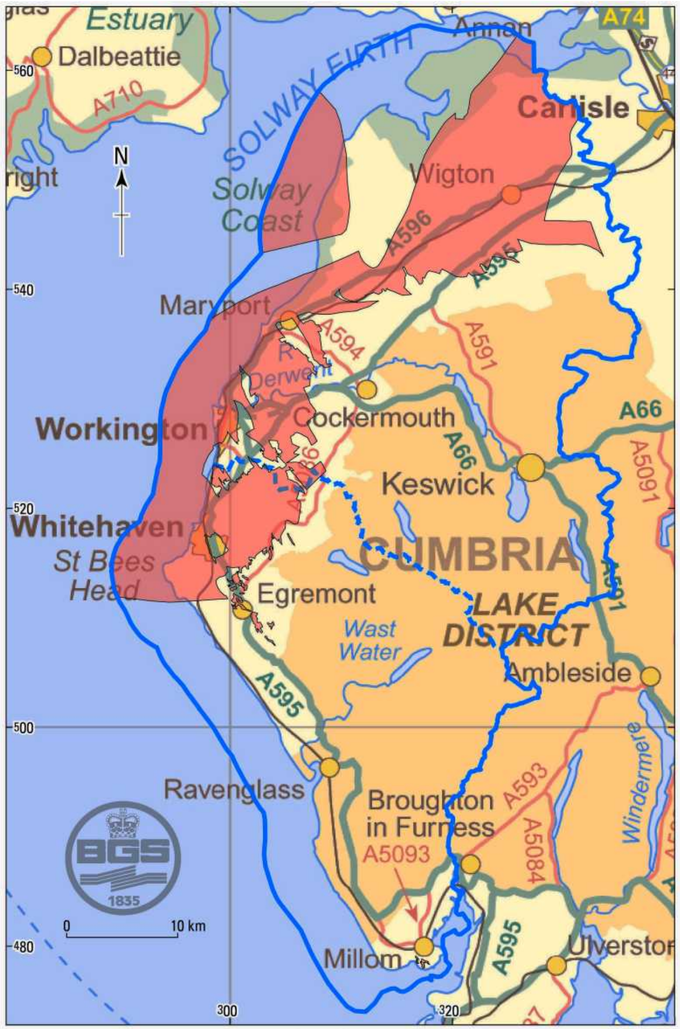
- County councils of Cumbria (county in NW England that hosts the Sellafeld site) and two district councils within the county formally expressed interest to the government in 2008
- The British Geological Survey published "Initial Geological Unsuitability Screening of West Cumbria" in 2010
- No other communities have expressed interest ("Plan B is to make Plan A work")

Discussion of exclusion criteria from British Geological Survey Report 2010

- “the exclusion criteria were derived to provide an initial ‘first cut’, solely to remove any obviously unsuitable geology from further consideration”
- “The criteria could not be area specific and had to be suitable for application to any area of the country that ‘expressed an interest’”
- “The criteria need to recognize the early stage of the site selection process in which they are applied and, as such, have to be applicable across potentially large geographical areas using existing information only”

Used Fuel Disposition

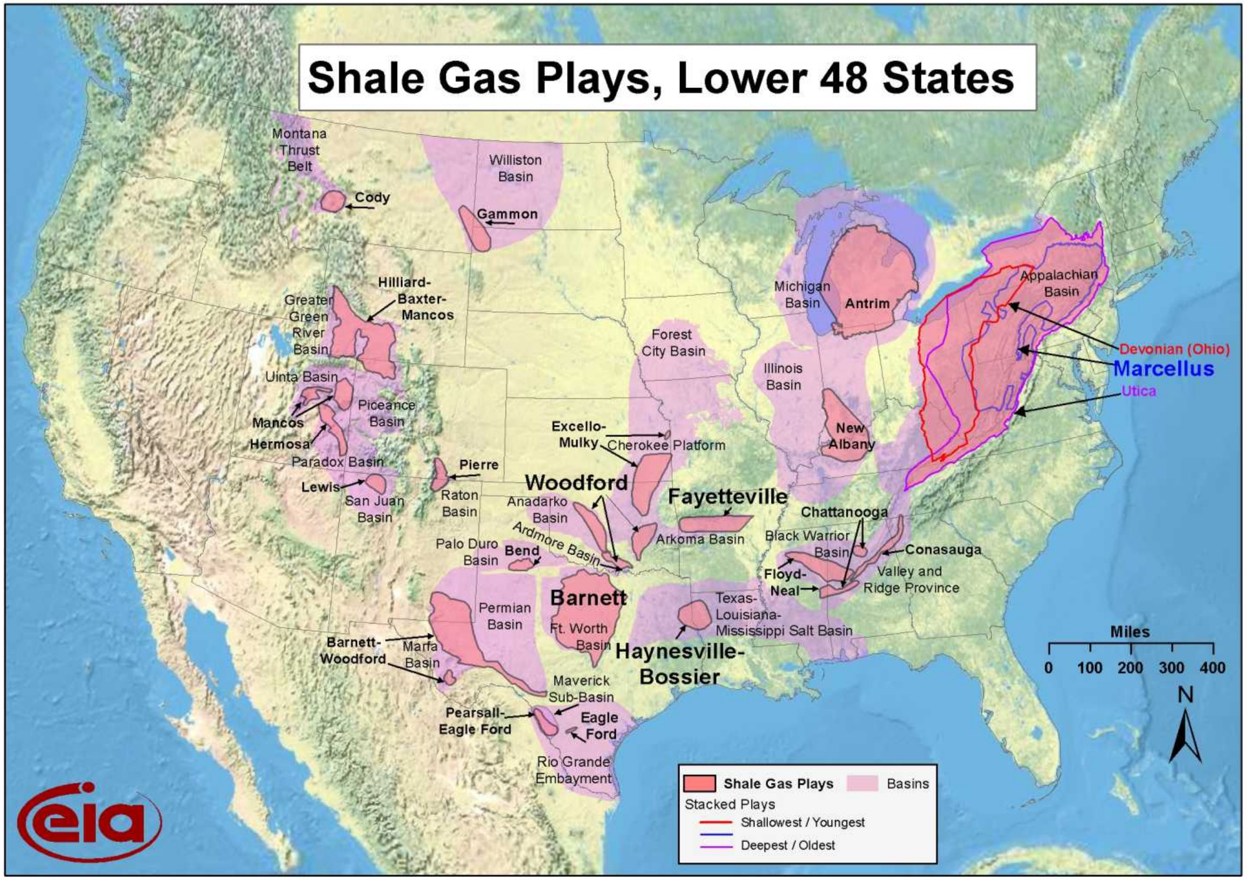
Implementation of Exclusion Criteria in Cumbria, UK



GBS, 2010, Fig.2

- Initial exclusion criteria limited to presence of natural resources (risk of human intrusion) and groundwater resources:
  - Coal and iron ore
  - Freshwater aquifers
- Criteria applied to rock volume between depth of 200-1000 meters
- Intent is to define areas that obviously could not host a site, and does not suggest that other areas could definitely host a site

How could exclusion criteria impact siting in the U.S.?



Example: natural gas resources and shale

Increased use of shale gas resources (e.g., through extraction of tight gas by hydraulic fracturing) could impact shale as a potential host rock in certain areas of the U.S.

Integrated Waste Management System Design

- **The following subsystems comprise the Waste Management System (WMS)**
  - Storage (at operating reactor sites, at orphaned reactor sites, and at dedicated regional storage sites)
  - Transportation
  - Repository above-ground operations, including lag storage and cooling storage
  - Repository below-ground operations

WMS Integration

- Requirements for the WMS subsystems are prescribed by different federal regulations
- Designers of WMS subsystems consider the applicable regulation and also the interfaces with supplying and removing subsystems
- However, a full system approach has not been implemented, and in some cases, a subsystem designer may avoid system integration options because of the financialsituations
- If DOE-NE does not encourage integration between storage and disposal, US will end up with a variety of canister sizes and likely as big as individual utility sites can accommodate

WMS Integration

- **Yucca Mountain moved to the Transportation, Aging, and Disposal (TAD) canister concept for Systems Engineering reasons**
  - The TAD canister would move from storage (aging), to transportation (cask), to disposal (waste package) overpacks during its lifecycle, but would only be opened for unusual circumstances
  - Yucca Mountain was designed for large waste packages, which was consistent with commercial cask and dry storage container sizes

WMS Integration

- **Many of repository concepts being investigated in UFD have restricted WP diameter or thermal capacity, which will result in shipping casks and aging canisters being too large for direct overpacking and disposal at a repository of TAD sized canister**
- **One Systems Engineering approach would be to develop aging sub-canisters, which could be overpacked as a group for storage and transportation, but disposed of individually at a repository**
  - This would retain the advantages of not having to reopen sealed canisters, and of minimizing and distributing bare fuel lifts

Perspectives on Nuclear Waste Management Activity

- **Task 1: Summarize nuclear energy and waste findings from 4 survey groups**
  - Advocacy (e.g., utilities) and Opponent groups
  - Commercial (e.g., Gallup)
  - Academic
  - International quantitative and qualitative work (European Barometer)

Perspectives on Nuclear Waste Management Activity

- **Task 2: Examine attributes of both successful and unsuccessful siting activities of controversial facilities**
  - e.g., Evaluate stakeholder interaction methods
- **Task 3: Small scale workshops to support Lessons Learned activities:**
  - Site Selection
  - Waste Management Integration

Perspectives on Nuclear Waste Management Activity

- **Level 3 report due mid September**
- **Status:**
  - Planning for 2nd half of FY11

Backup Slides

Waste Classification

- Waste classification system should not provide a disincentive to pursue advanced fuel cycles and reprocessing regardless of current economic situation
- Because LLW classification system based on deterministic evaluation of waste streams 30 yr ago, potentially new LLW waste streams might not be appropriately classified.
- NRC starting major study and DOE-EM working on orders; hence DOE-NE might begin background work on performance based classifications systems for HLW, UNF and TRU

Waste Classification

- **Current Definitions are Source Based**
  - HLW = highly radioactive materials from reprocessing…
  - LLW = radioactive materials not defined as HLW…
- **Resulting in some low hazard materials being classified as HLW**
  - Typical examples include waste from captured and treated off-gas such as grouted H-3, grouted C-14, Kr-85…
- **“Ideal” classification system should be based upon the hazard which integrates the radioactive and chemical risk**
- **Proposed Scope Investigates potential alternatives and discusses potential application in alternative fuel cycles**
  - IAEA method
  - NCRP Report 139 , Risk-Based Classification of Radioactive and Hazardous Chemical Wastes

Stepwise System Development

- The schedule in NWPA, utility contracts, and the essential blockage of the MRS as buffer storage space in NWPAA encouraged a rapid siting, construction, and full scale construction for disposing UNF and HLW
- Annual funding limits do not jive with rapid full-scale construction
- To be more consistent with annual funding, a slower learn-as-you-go approach should be considered

Stepwise System Development

- The regulations could accommodate stepwise waste management development that combines storage, stepwise repository development and eventual disposal with continued research.
- To facilitate thinking, might propose conceptual designs for stepwise repository development