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Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

Practical Considerations for Modeling and Monitoring of Engineered Barrier Performance

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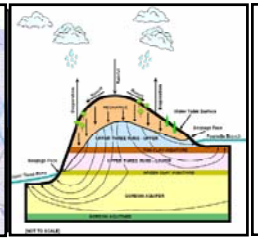
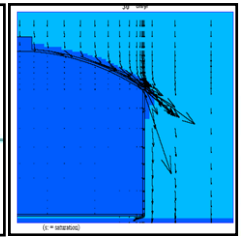



NRC Workshop on Engineered Barriers Performance

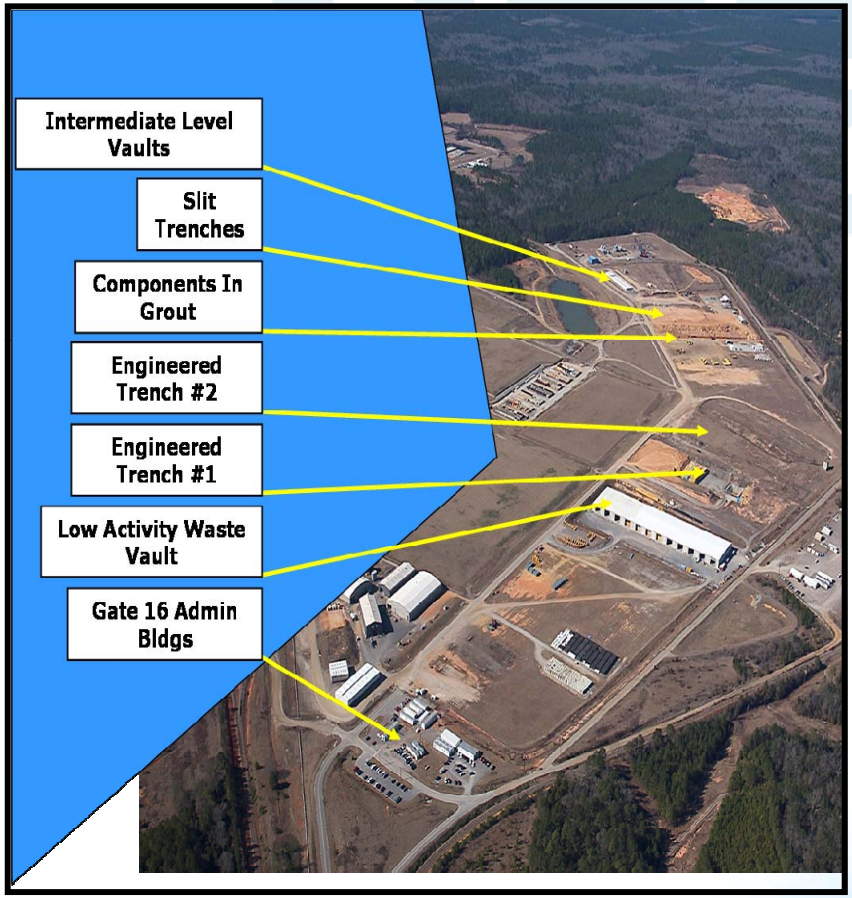
Radiological Performance Assessment Section

SRNL-MS-2010-00129-S, Rev. 1

Introduction

- **Design of disposal facilities depends on a combination of technical and non-technical considerations**
- **Relative importance of barriers and modeling approaches depend on site- and waste-specific considerations**
- **Need flexible modeling capabilities to identify and quantify processes important to performance (learning vs. predicting)**
- **Given time frames and uncertainties, modeling alone is not the answer, need integrated approaches including site-specific mix of monitoring, field/laboratory studies and other confidence building activities**

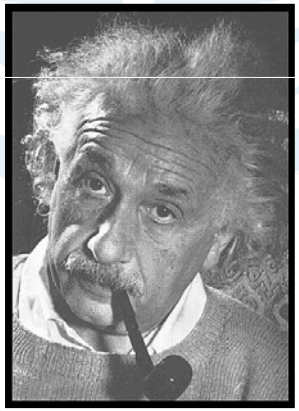
Background – Performance- & Design-Based Approaches



Different systems of "barriers": Covers, liners, waste forms, containers, vaults, natural system

Questions for Session

- **When should numerical modeling of engineered barriers be performed?**
- **What are the criteria to determine the detail of modeling needed *(and where to apply more detail)*?**
- **Over what time periods should performance simulations be considered?**
- **How should ecological and climatological changes be incorporated into performance simulations?**
- ***Recommended codes***



"Everything should be made as simple as possible, but not simpler"

Standard Performance Assessment Answer…

IT DEPENDS ! …

Waste Being Disposed

Waste Forms

Local Climate

Pathway of Interest (Gas, Liquid)

Data Availability

Regulatory Regime

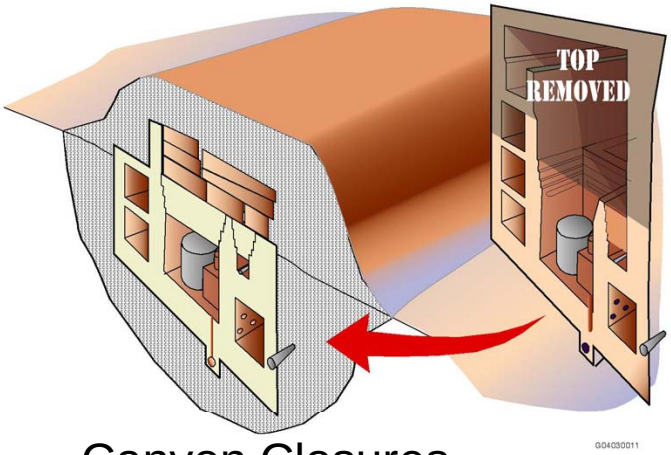
…

<u>Other Factors</u>

Availability of Materials

Stakeholder Preferences

…



Canyon Closures

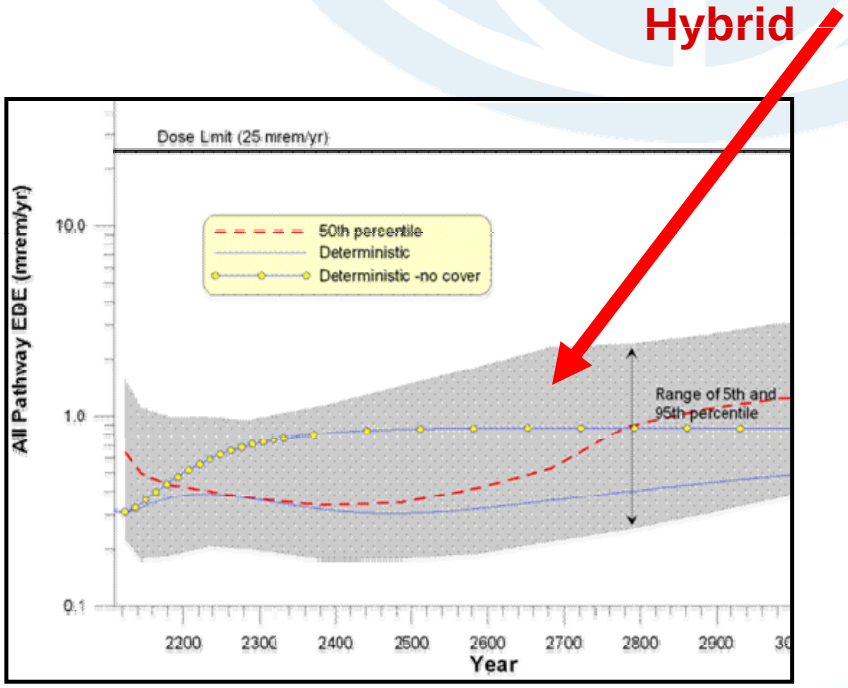
UK LLWR

Modeling Needs and Level of Detail

- **Graded and iterative approach – identify important features, available data, don't lose sight of the forest for the trees**

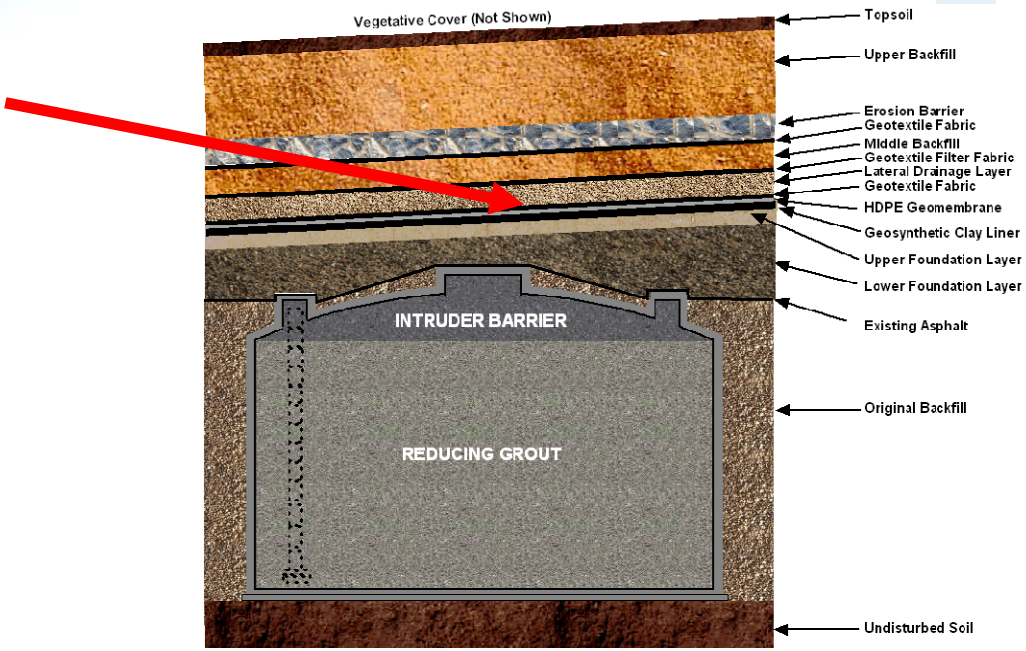
Interim Cover

Subsidence can have significant impact on local infiltration rates



Assessment approach including consideration of large range of infiltration and show minimal impacts

Modeling Needs and Level of Detail - Example



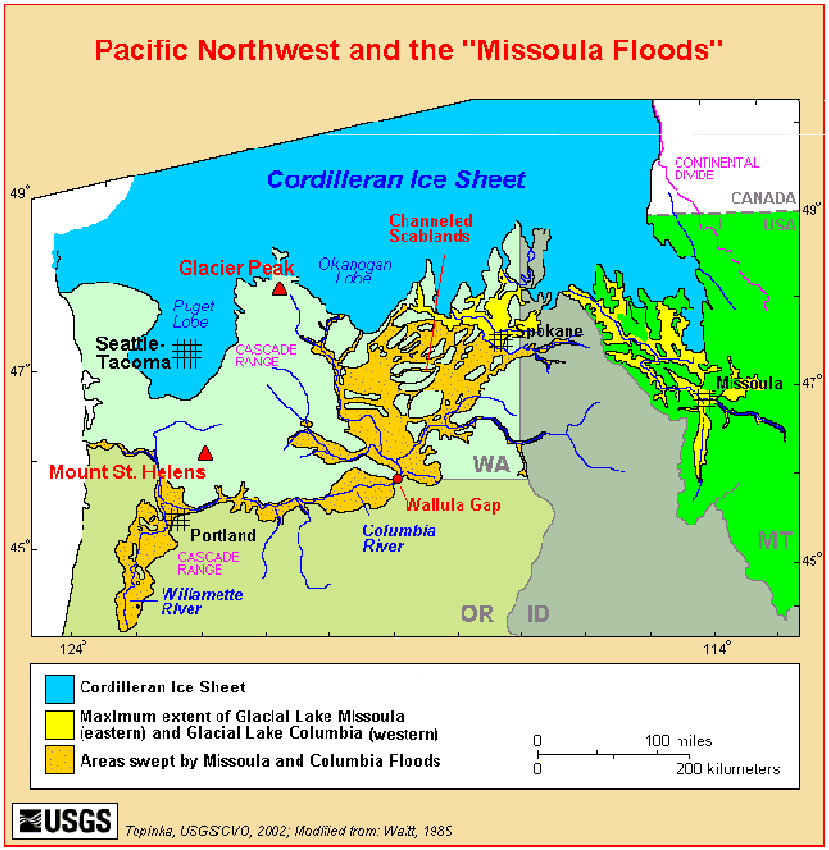
[NOT TO SCALE]

Savannah River Site Tank Closure

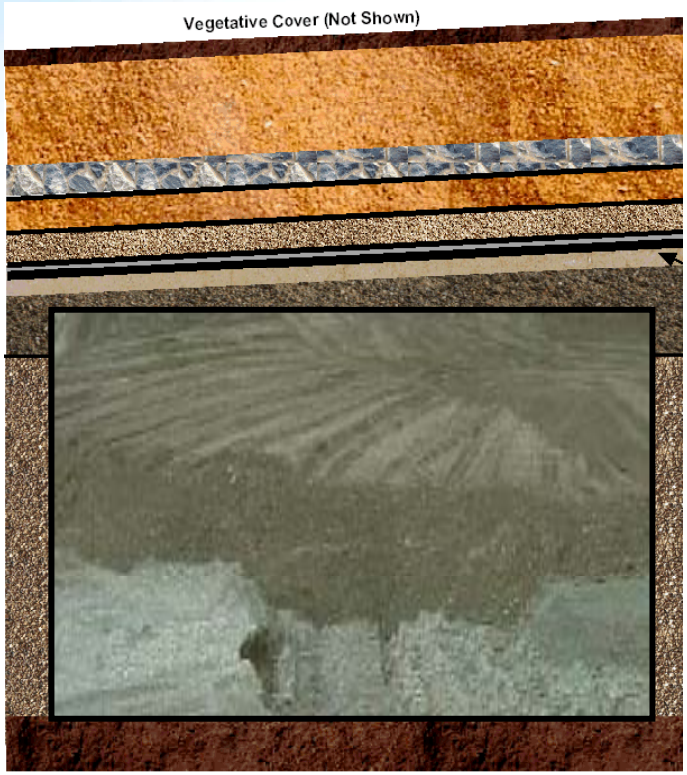
<u>Performance-Based Approach</u> – More detailed consideration of cover performance, results used to focus modeling detail and design

Time Frames and Climate/Ecological Changes

- **Maintain perspective regarding increasing external uncertainties over time that may overwhelm details in models**
- **To what extent are calculations really meaningful for time frames hundreds? thousands? or tens of thousands of years from now ?**
  - Detailed process considerations relative to external factors ?
  - ICRP recommending quantitative calculations for up to 1,000 to 10,000 year time frame, qualitative later in time

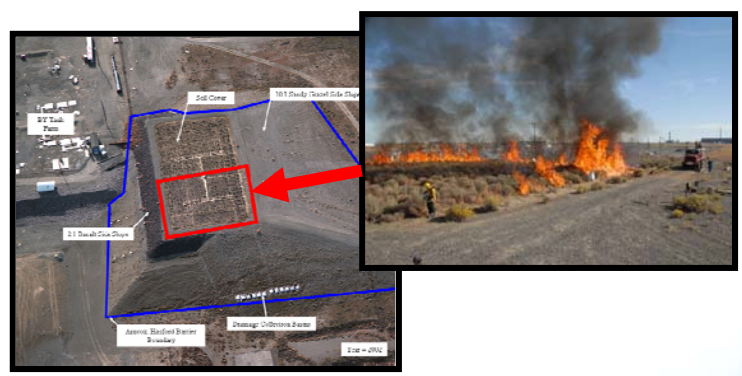


Time Frames and Climate/Ecological Changes - Examples



Time frame that is important for cover performance depends on waste

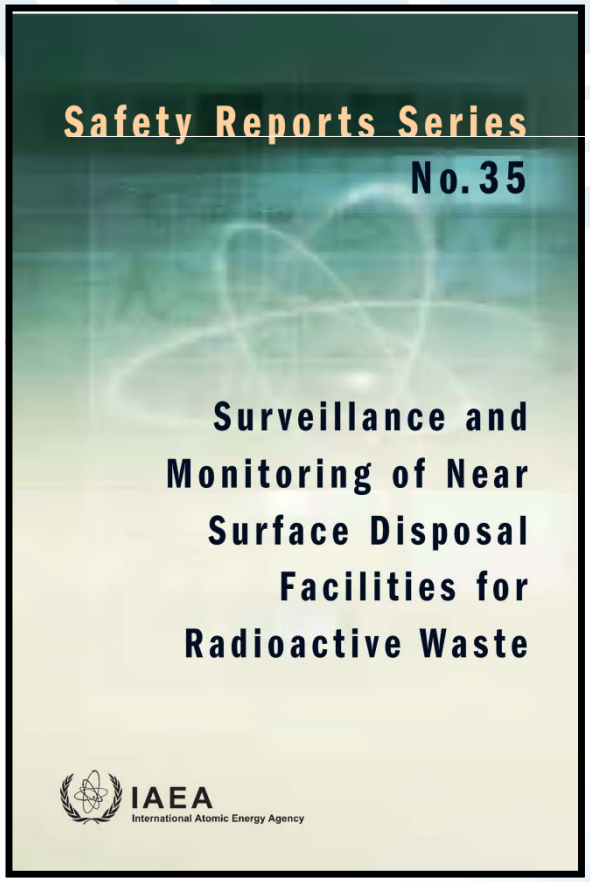
Liners are critical for soils during operations, not as important for containerized waste



Different processes can change ecological conditions, how important are they in terms of overall performance ?

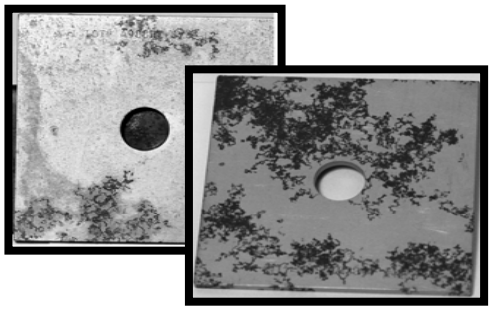
IAEA Monitoring Objectives

- **Pre-Operations**
  - Characterization/archival samples
  - Baseline radiological conditions
- **Operations**
  - Public protection and worker safety
  - Confirm as-built engineered features
  - Refine post-closure program
- **Post-Closure**
  - Public protection
  - Confirm modeling assumptions
    - e.g., Chemistry, barriers



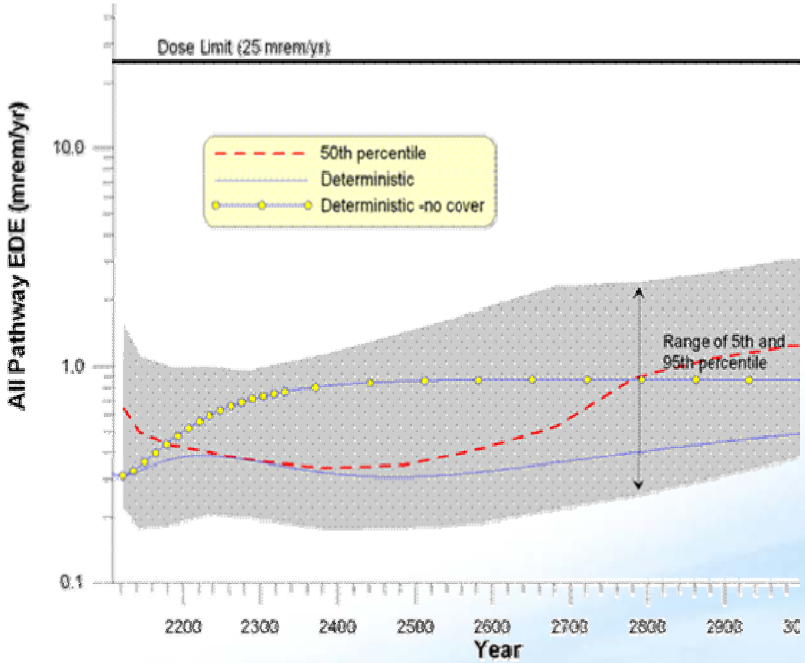
Broader View of Monitoring

- **Need to think more broadly about what constitutes "monitoring" for situations where migration is not expected for long times**
- **Link to indicators identified in PA calculations and models**
- **NRC "monitoring" for tank closure confirming as-built properties (measurable)**
- **Experiments, field studies, etc. can be used as surrogates to build confidence in assumptions**



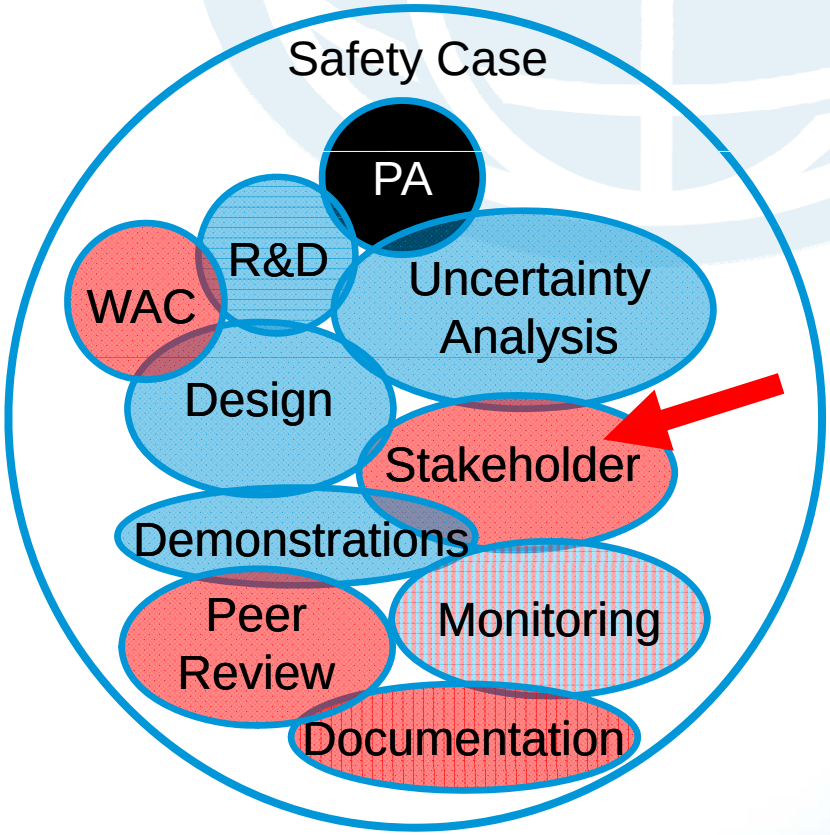
Monitoring Considerations

- **Use PA to prioritize monitoring needs (DOE Order 435.1)**
- **Before implementing new monitoring approaches, consider how results can be explained to the public?**
  - Expect the unexpected, address in PA
- **Limitations of single point values**
  - Emphasize temporal and spatial trends
  - Ranges of values
- **Performance monitoring should be used as an indicator to improve understanding – not necessarily a pass/fail**



Managing Uncertainties – International Concept of "Safety Case"

- **IAEA, Nuclear Energy Agency and others**
- **Reflects use of performance assessment as only one part of a package used to support decisions**
  - *"The purpose of computing is insight, not numbers"* – Richard Hamming
- **Similar concept to the Radioactive Waste Management Basis in the DOE System**



Summary

- PAs and risk assessments can benefit from improved capabilities to model engineered barriers, optimization is also needed
- When considering level of detail for modeling, a graded and iterative approach is recommended, recognizing data requirements and availability
- Maintain perspective regarding increasing external uncertainties when considering the relative value of calculations over increasing time frames
- Consider how results will be reported to the public when planning innovative monitoring programs
- Need integrated approaches including site-specific mix of monitoring, field/laboratory studies, demonstrations and stakeholder involvement

Thank You

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