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WIPP Performance Assessment Approach and Results

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WIPP Background

- **WIPP is a permanent disposal facility for transuranic (TRU) waste**
  - **Located in southeast New Mexico**
  - **Operated by U. S. Department of Energy (DOE)**
  - **Regulated by U. S. Environmental Protection Agency (EPA)**

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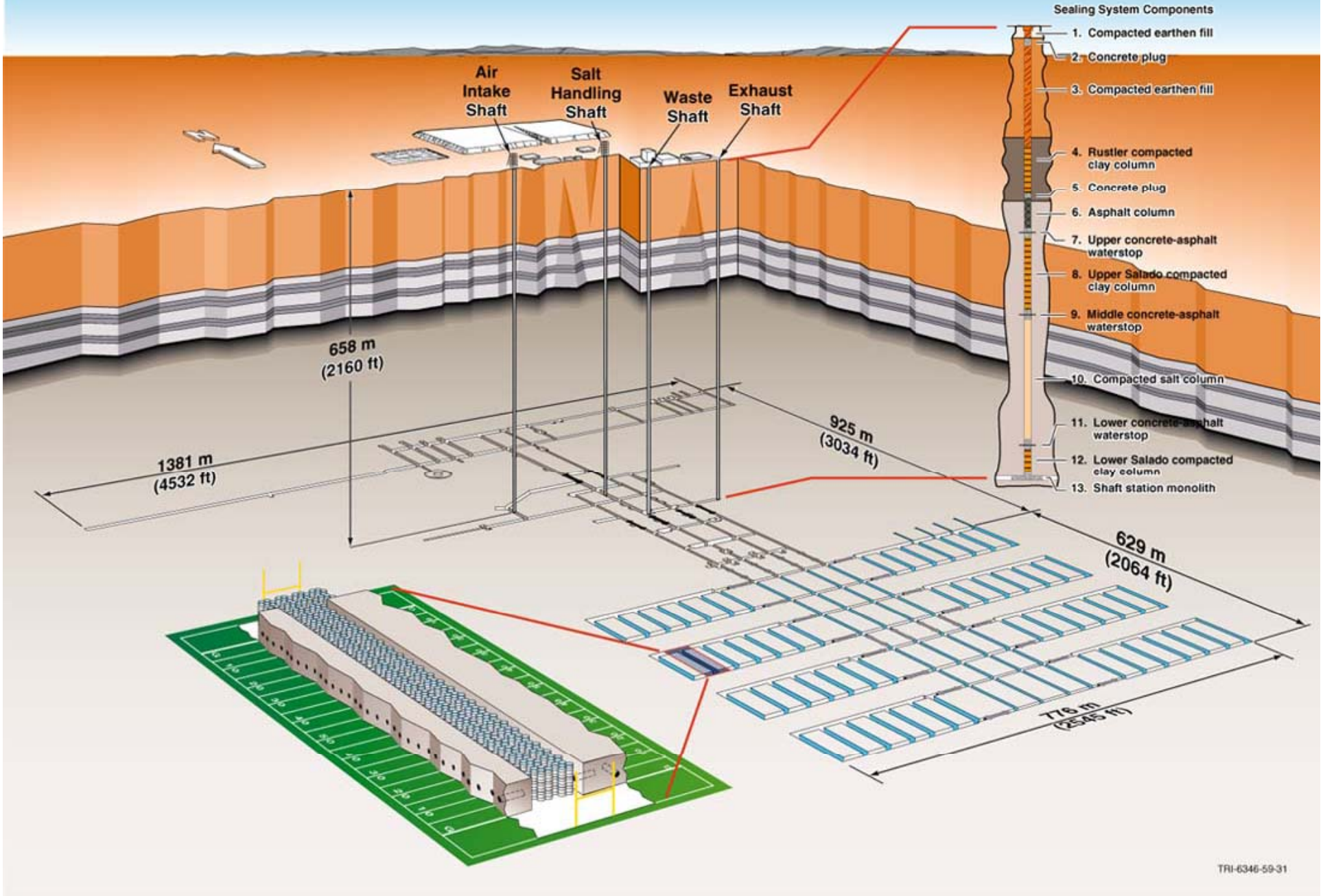
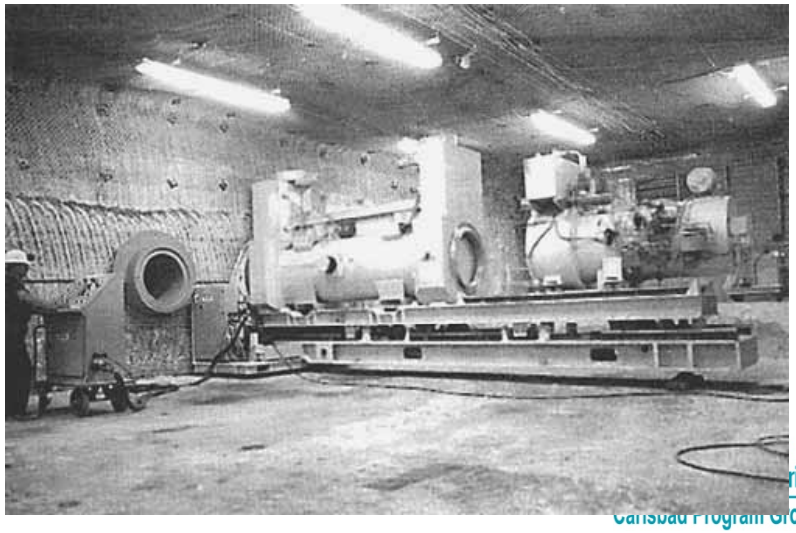
WIPP Layout


Air Intake Shaft
Salt Handling Shaft
Waste Shaft
Exhaust Shaft
Sealing System Components
1. Compacted earthen fill
2. Concrete plug
3. Compacted earthen fill
4. Rustler compacted clay column
5. Concrete plug
6. Asphalt column
7. Upper concrete-asphalt waterstop
8. Upper Salado compacted clay column
9. Middle concrete-asphalt waterstop
10. Compacted salt column
11. Lower concrete-asphalt waterstop
12. Lower Salado compacted clay column
13. Shaft station monolith
658 m (2160 ft)
1381 m (4532 ft)
925 m (3034 ft)
629 m (2064 ft)
776 m (2545 ft)
TRI-6346-59-31

WIPP Wastes

- Contact-handled (CH)
  - Large volume
    - ~169,200 m^3 capacity
  - No shielding required
  - Stacked on floor of waste rooms
- Remote-handled (RH)
  - Small volume
    - ~7,000 m^3 capacity
  - Contains short-lived gamma emitters
  - Shielding required
  - Emplaced in horizontal boreholes in waste room walls



Regulatory History

- DOE submitted Compliance Certification Application (CCA) in 1996
  - WIPP was certified in 1998
- Waste first received in 1999
- DOE submitted Compliance Recertification Application (CRA-2004) in 2004
  - WIPP was recertified in 2006
- DOE submitted Compliance Recertification Application (CRA-2009) in 2009
  - Currently in EPA's review

WIPP Regulatory Requirements

- **Regulatory requirements were primary determinant for the development of the PA structure**
  - **The WIPP must be designed to provide *reasonable expectation* that *cumulative releases* of radionuclides to the accessible environment for *10,000 years* after disposal from all *significant processes and events* shall be less than specified *releases limits***

Performance Assessment Objectives

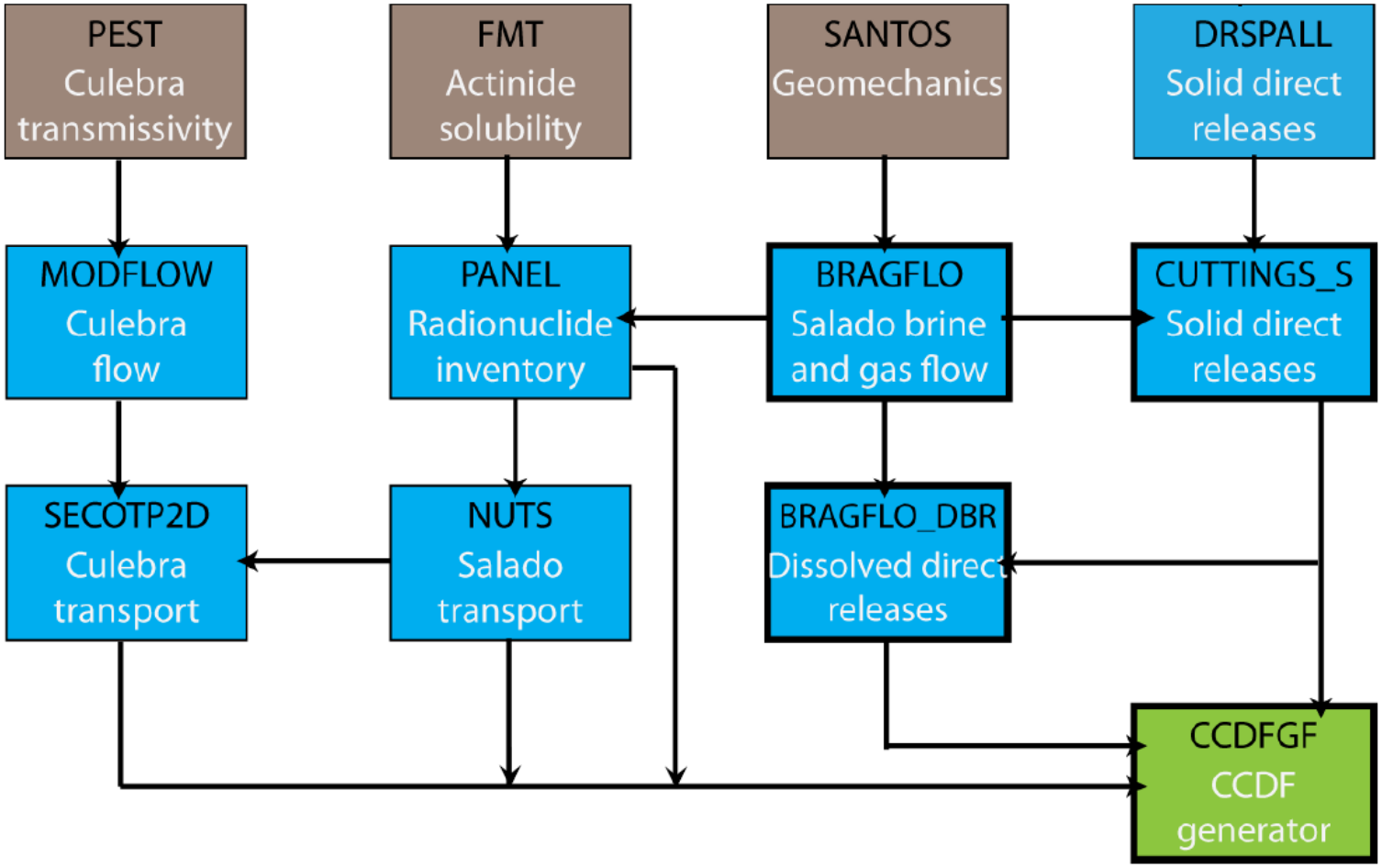
- **Quantitative, probabilistic estimate of the future performance of the repository system**
- **PA answers three questions about the repository system:**
  1. **What can happen after permanent closure?**
  2. **How likely is it to happen?**
  3. **What can result if it does happen?**
- **And one question about the analysis:**

  What level of confidence can be placed on the estimate? (uncertainty in analysis)

WIPP PA Models

- 24 WIPP PA Conceptual Models
  - Developed from features, events and processes evaluations.
  - Implemented in process models.
- Process models simulate distinct processes or groups of processes such as:
  - Flow of brine and gas in the subsurface
  - Radionuclide transport in the subsurface
  - Gas generation
  - Flow of brine and solids up a borehole
  - Permeability enhancement due to fracturing
  - Room closure
  - Solid extraction by drilling

WIPP PA Modeling Codes



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Two Types of Uncertainty

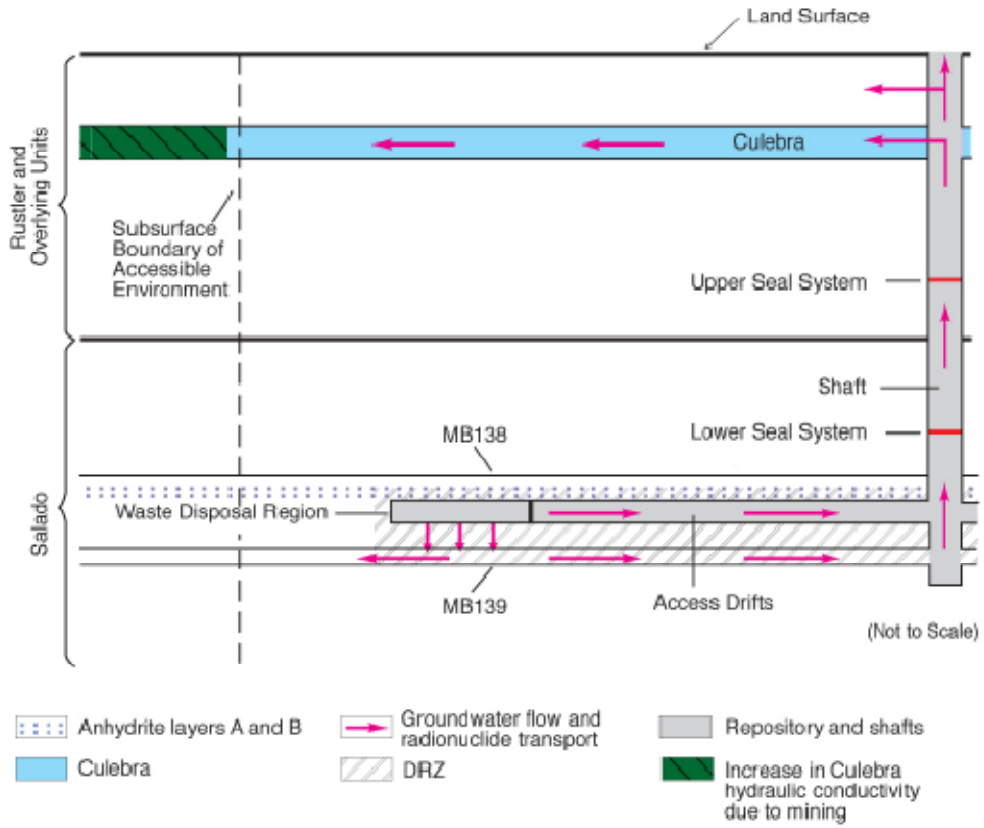
Subjective Uncertainty (epistemic)

- **Arises from a lack of knowledge about parameters assumed to have fixed values within the computational implementation of a PA.**
- **Examples: Permeability, Porosity, etc.**

Stochastic Uncertainty (aleatory)

- **Arises from a lack of knowledge about future events.**
- **Example: Timing and location of future drilling events.**

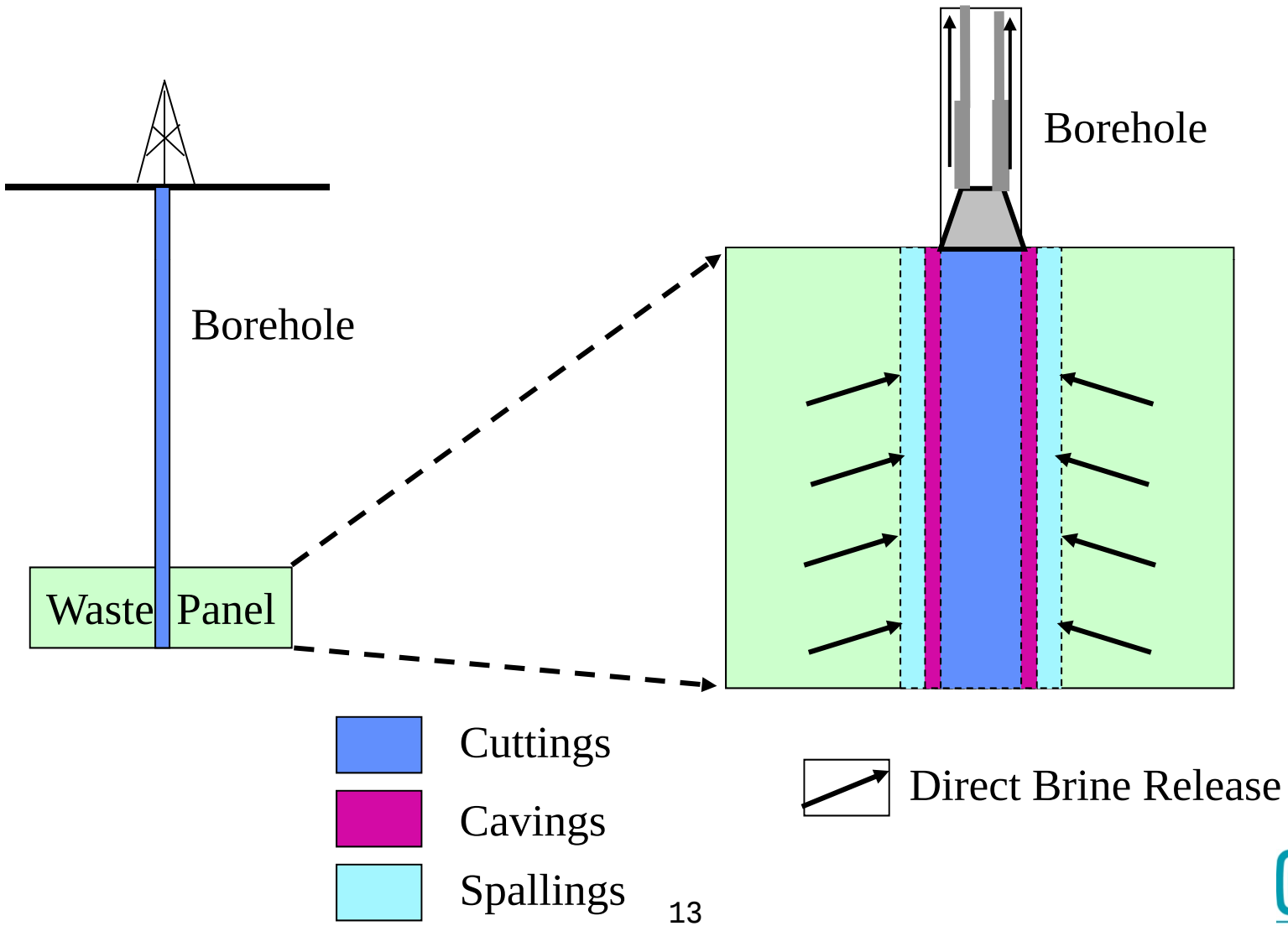
Undisturbed Repository Performance



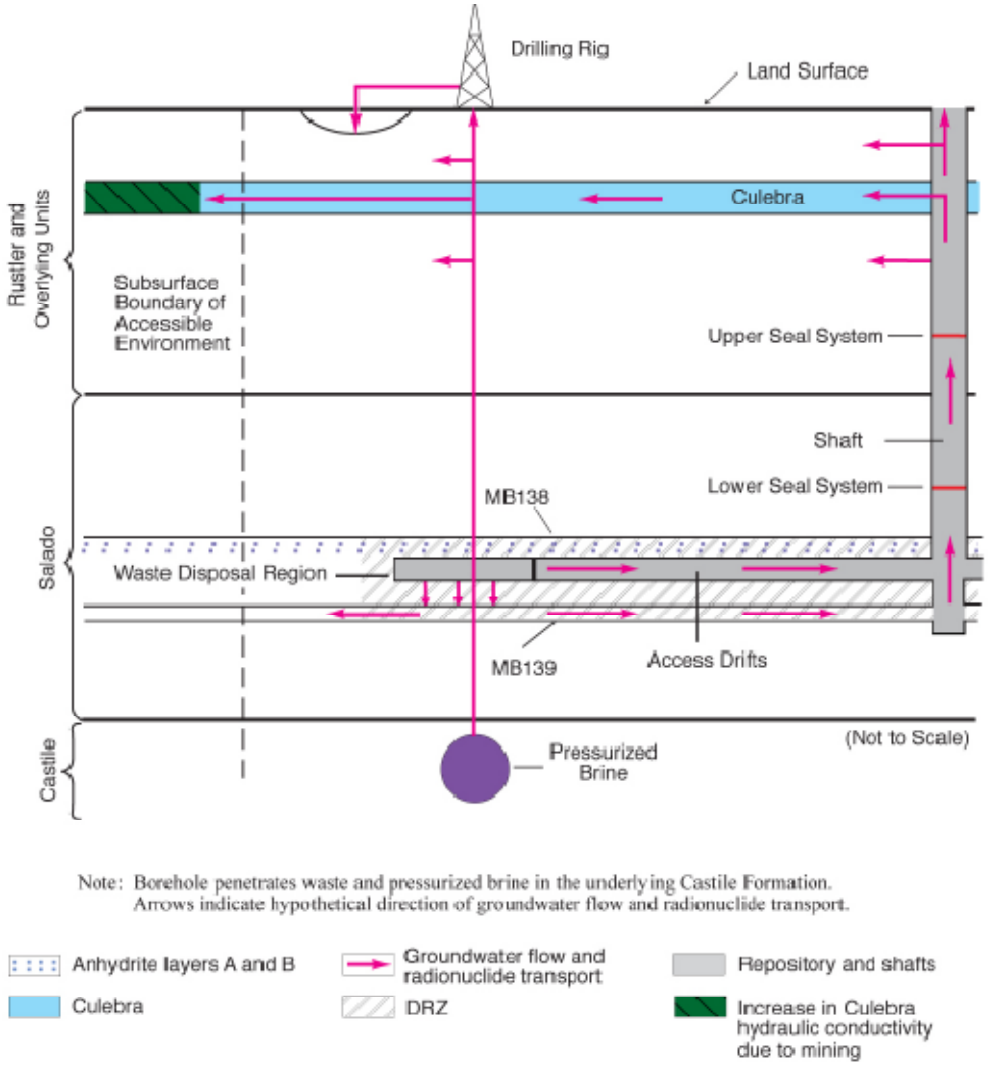
Release Mechanisms

- **Direct Releases (occur during or immediately after drilling)**
  - **Cuttings (Solids from drilling)**
  - **Cavings (Solids from drilling)**
  - **Spallings (Solids from pressure release)**
  - **Direct Brine Release (Brine from pressure release)**
- **Long-term Releases**
  - **Groundwater Transport in Culebra**
  - **Groundwater Transport in Salado**

Schematic of Direct Releases



Disturbed Repository Performance



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Changes in WIPP PA for Recertification

- Over time, DOE has needed to modify repository design and/or operations to:
  - Improve worker safety
  - Reduce costs
  - Improve efficiency
- Some proposed changes have required a formal impact assessment using PA modeling system
- The PA for recertification includes
  - All the planned changes
  - "New" relevant information not previously included

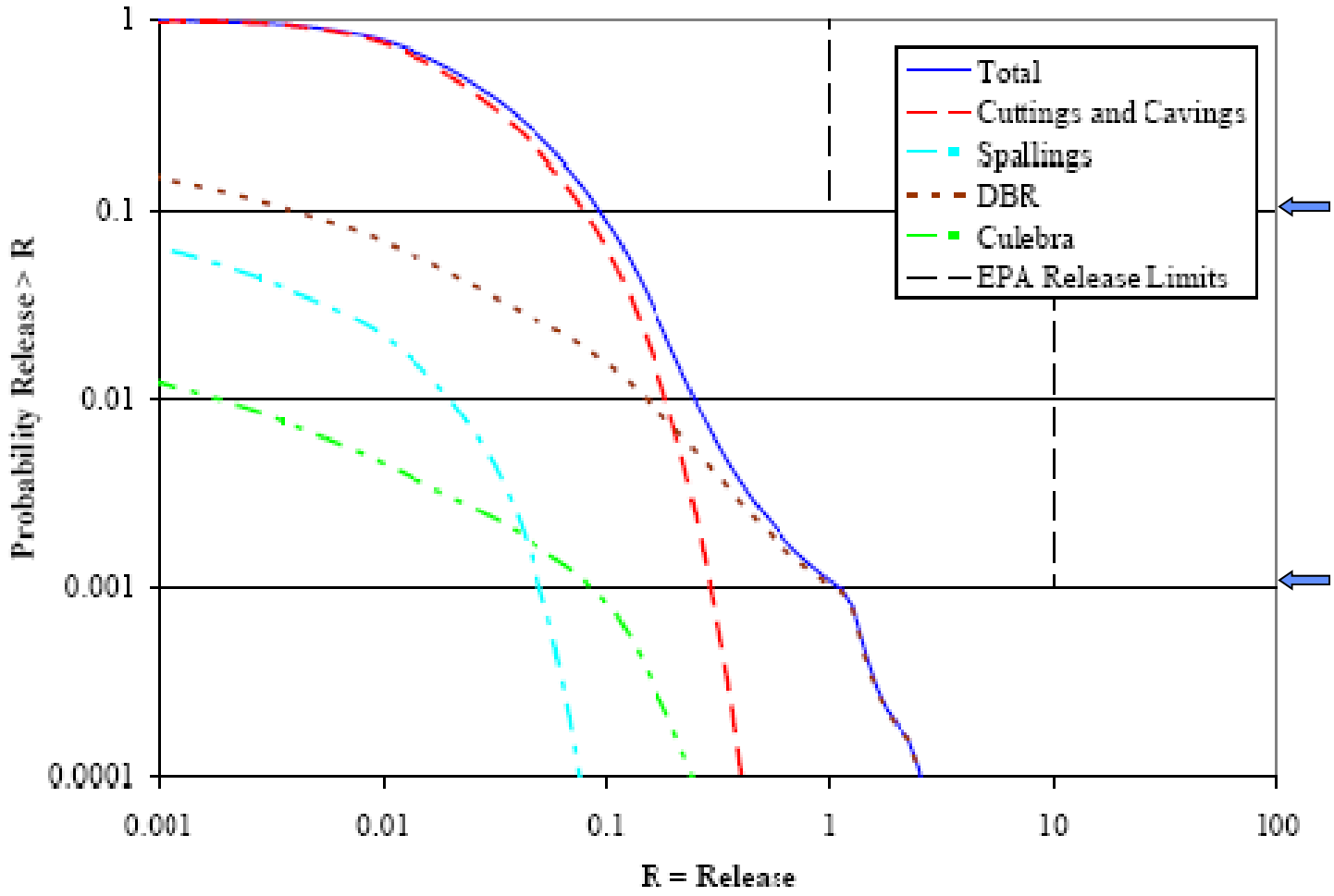
Updated Information in the Latest WIPP PA

- **Modification and improvements to parameters, models and computers codes**
- **Regulatory parameter and model updates**
- **Corrections to all previously identified errors**

Individual Groundwater Protection (Undisturbed Performance)

- **Maximum annual dose**
  - **Regulation: 15 mrem**
  - **Bounding calculation: 0.93 mrem**
- **Gross alpha particle activity**
  - **Regulation: 15 picocuries/liter**
  - **Bounding calculation: 0.384 picocuries/liter**
- **^{226}Ra & ^{228}Ra concentration**
  - **Regulation: 5 picocuries/liter**
  - **Bounding calculation: 1.7×10^{-5} picocuries/liter**

Mean CCDF by Component (Disturbed Performance)



Less than 1 chance in 10 of exceeding 1 EPA unit

Less than 1 chance in 1000 of exceeding 10 EPA unit

CCDF is measure of compliance

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WIPP PA Modeling System

- Demonstrates initial and continued compliance with EPA containment requirements
- Used to evaluate changes in the repository configuration
- Provides quantitative, probabilistic estimate of the future performance of the repository system
- Determines the relative importance of release mechanisms