Understanding the RPPCR PA:

Inherent Conservatisms

Andy Ward[1] and Vann Bynum[2]

[1]U.S. Department of Energy, Carlsbad Field Office, Carlsbad NM

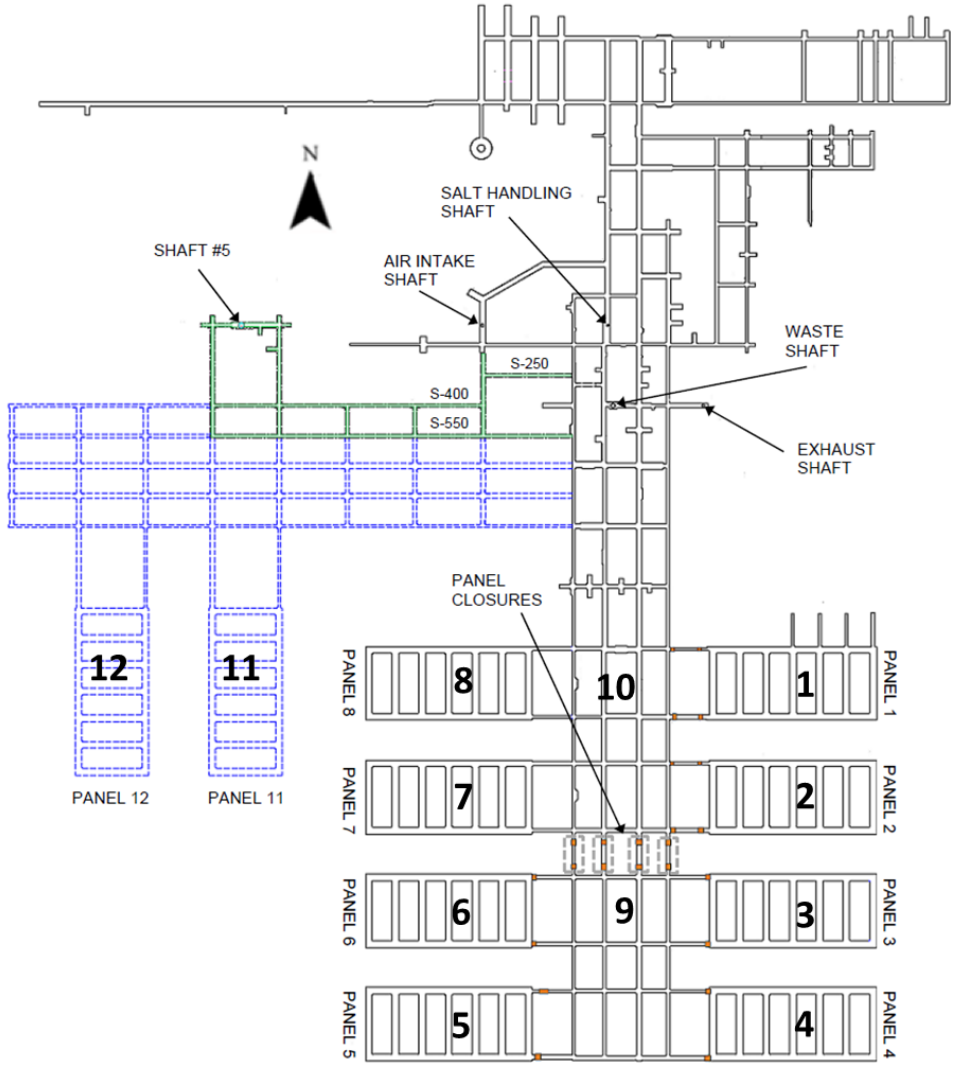
[2]Carlsbad Technical Assistance Contractor, Navarro Research & Engineering Inc., Carlsbad NM, 88220.

EPA's Expectations Letter, April 2021

- **General Design of the repository**
  - General design of repository that would accommodate total anticipated waste
  - PA calculations for the anticipated repository at the time of closure
- **Site Characterization**
  - Potential for brine in the Castile at the location of replacement panels
  - Incorporating new data into the probability of encountering pressurized brine in the Castile
  - More refined hydrologic characterization, including new wells
- **Creep Closure of Open Areas**
  - More open areas in the repository than originally assumed at closure
  - Improved predictions of salt creep in open areas and access drifts in the absence of panel closures
- **Range of Potential Waste**
  - Pit production waste
  - 34 MT surplus Pu
- **Actinide Solubility**
  - More reducing conditions, increased Pu solubility, higher releases of radionuclides
  - The DOE's model of plutonium solubility needs to be updated

Replacement Panels: No significant Additional Capacity

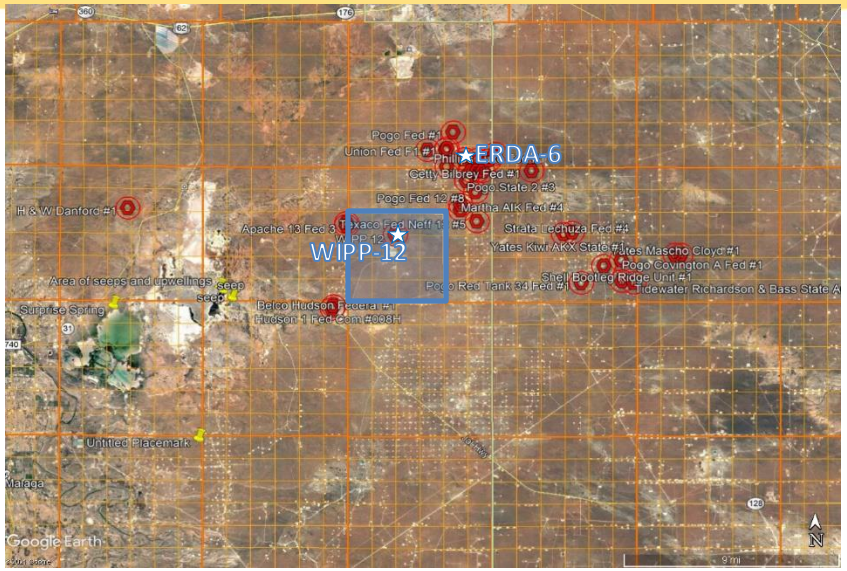
- Lost capacity
  - Panels 1 & 7 > 50%
  - Panel 9 = 100%
  - Panel 10 not used in calculations
- Net impact, a loss of ~2 panels
- Panels 11 and 12
  - similar design as Panels1 - 8
  - same stratigraphic horizon
- Disposal of anticipated LWA volume
  - Conceptually 19 panels
- DOE seeking to replace lost capacity only
  - 2 panels (11 and 12)

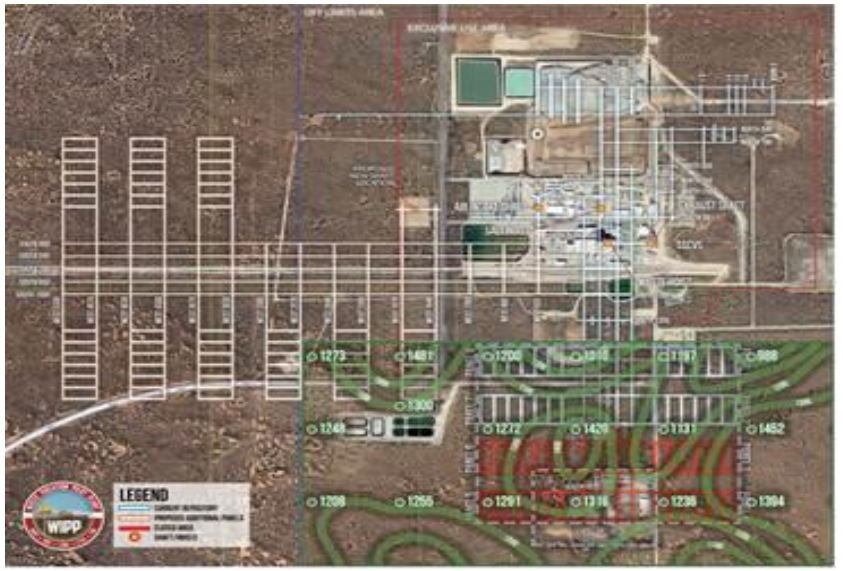


Brunell and King (2024)

Site Characterization

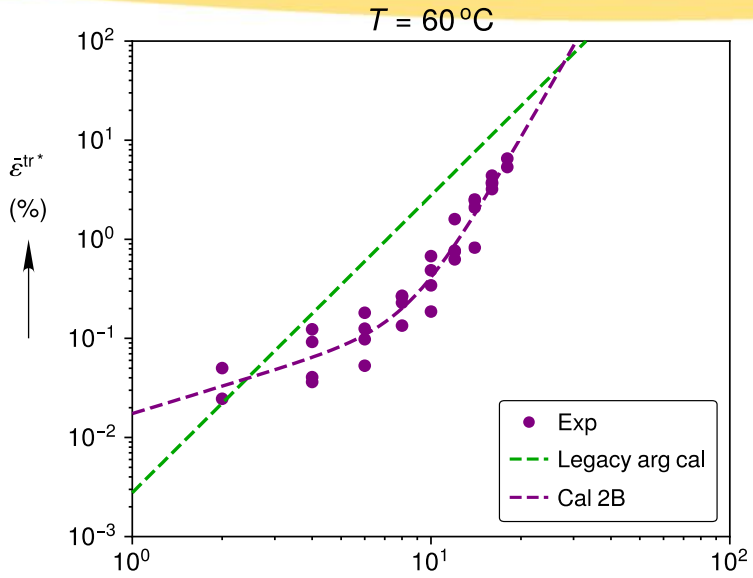
- Very few brine encounters west of WIPP
  - encounters associated with deformation in the Castile Formation
- Legacy TDEM data re-evaluated to include location of replacement panels
  - PBRINE value < EPA prescription
  - PBRINE in RPPCR is a conservative estimate for the 12-panel configuration
- Hydrologic data
  - T-fields recalibrated with additional data
  - Culebra Transport model refined to account western releases



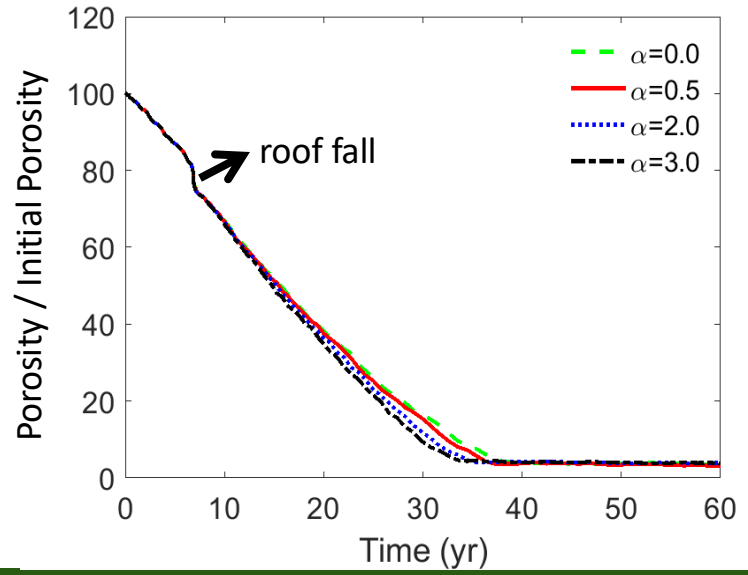


Creep Closure

- Revised porosity response surface
  - improved geomechanical submodel
  - improved waste compaction submodel
  - improved gas generation submodel
- Collapse and reconsolidation of empty rooms
  - gradual room closure
  - fracturing around room
  - rubble pile reconsolidation
  - flow through rubble piles



Transient Strain Limit



Room Collapse With Clay Seam

Figures courtesy Ben Reedlunn (August, 2024)

Range of Potential Waste

- Current and projected waste streams are similar, ratios may differ
  - Idaho waste will decline (including compacted waste)
  - EM waste will increase; general composition will be similar
  - Surplus Plutonium Disposition (SPD) will continue
  - Pit production waste will increase; composition similar to existing pit production waste
  - Hanford waste
- SPD waste has been emplaced
  - similar to waste previously accepted from Rocky Flats
- SPD waste has no new components that challenge existing models

Waste Impacts on Performance

- Repository designed to control the chemical conditions affecting actinide mobility
  - pH, a measure of acidity
  - E_h, an indicator of oxidation state
- SPD waste does not change chemical conditions
- Pu in SPD waste is a calcined oxide
  - difficult to dissolve, even in hot nitric acid
  - PA assumes that it is readily dissolved
- No credit taken for robust packaging
  - Degradation
  - Deflection of drill bit during intrusion

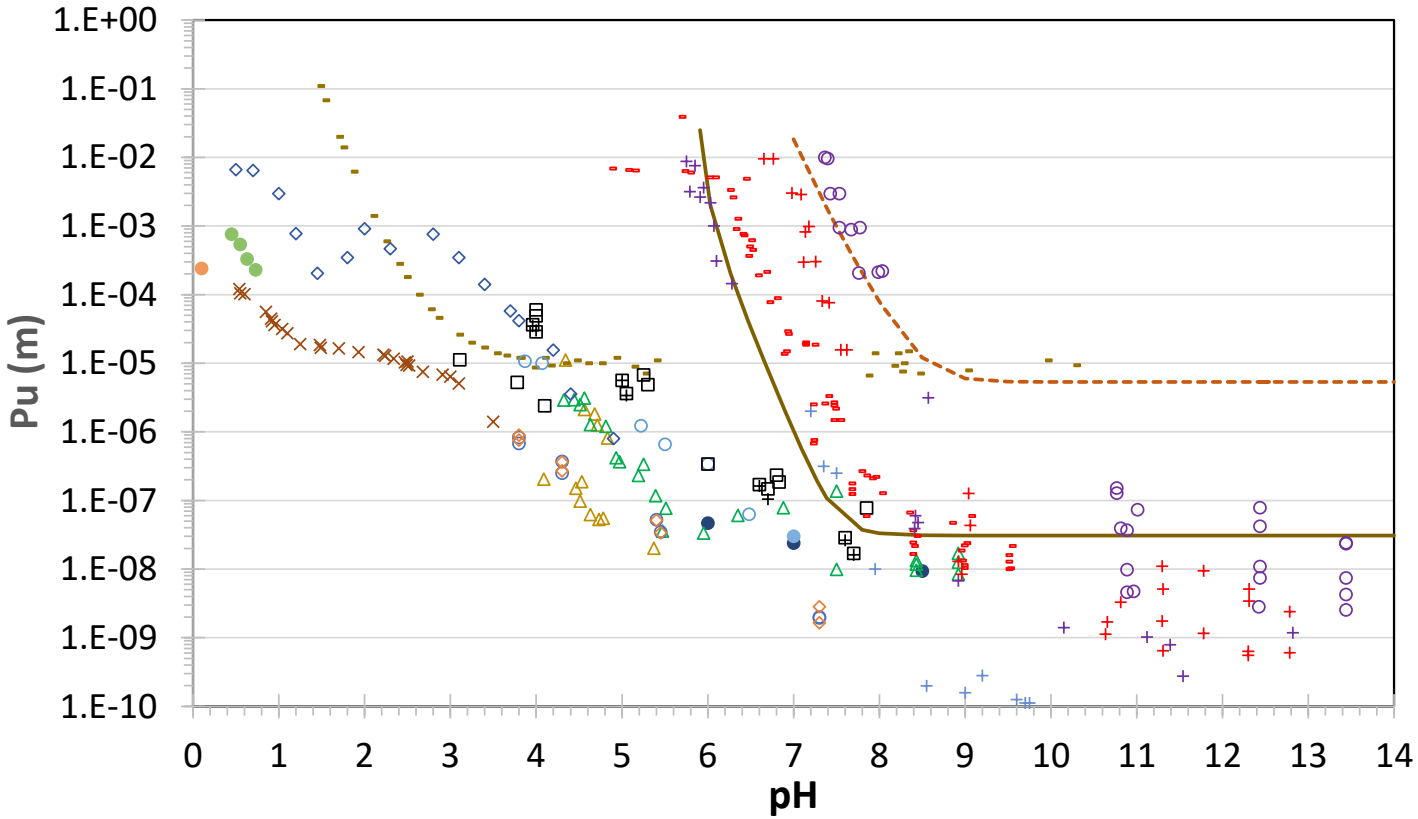
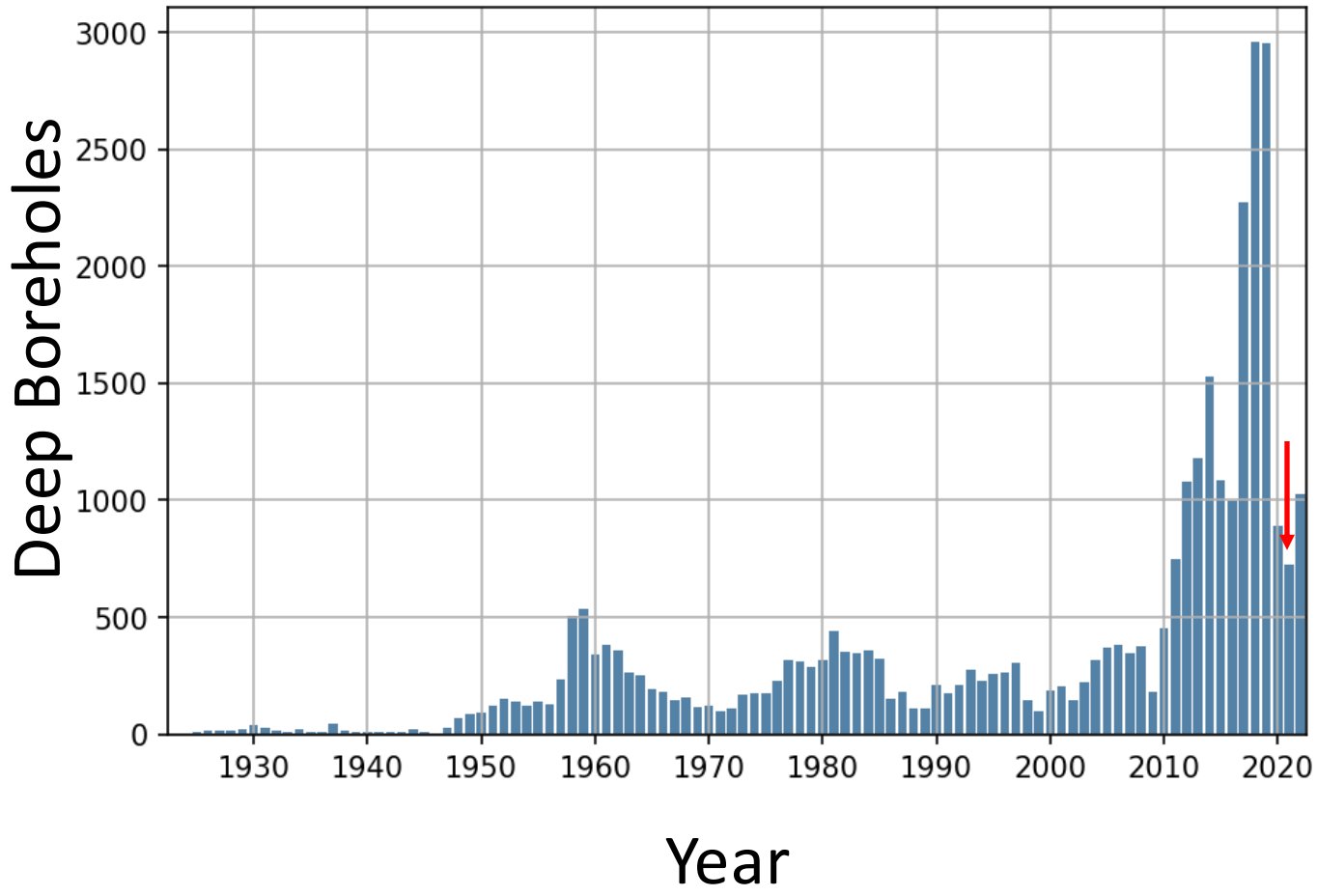


Figure courtesy of Charles Oakes (January, 2024)

Drilling Rate

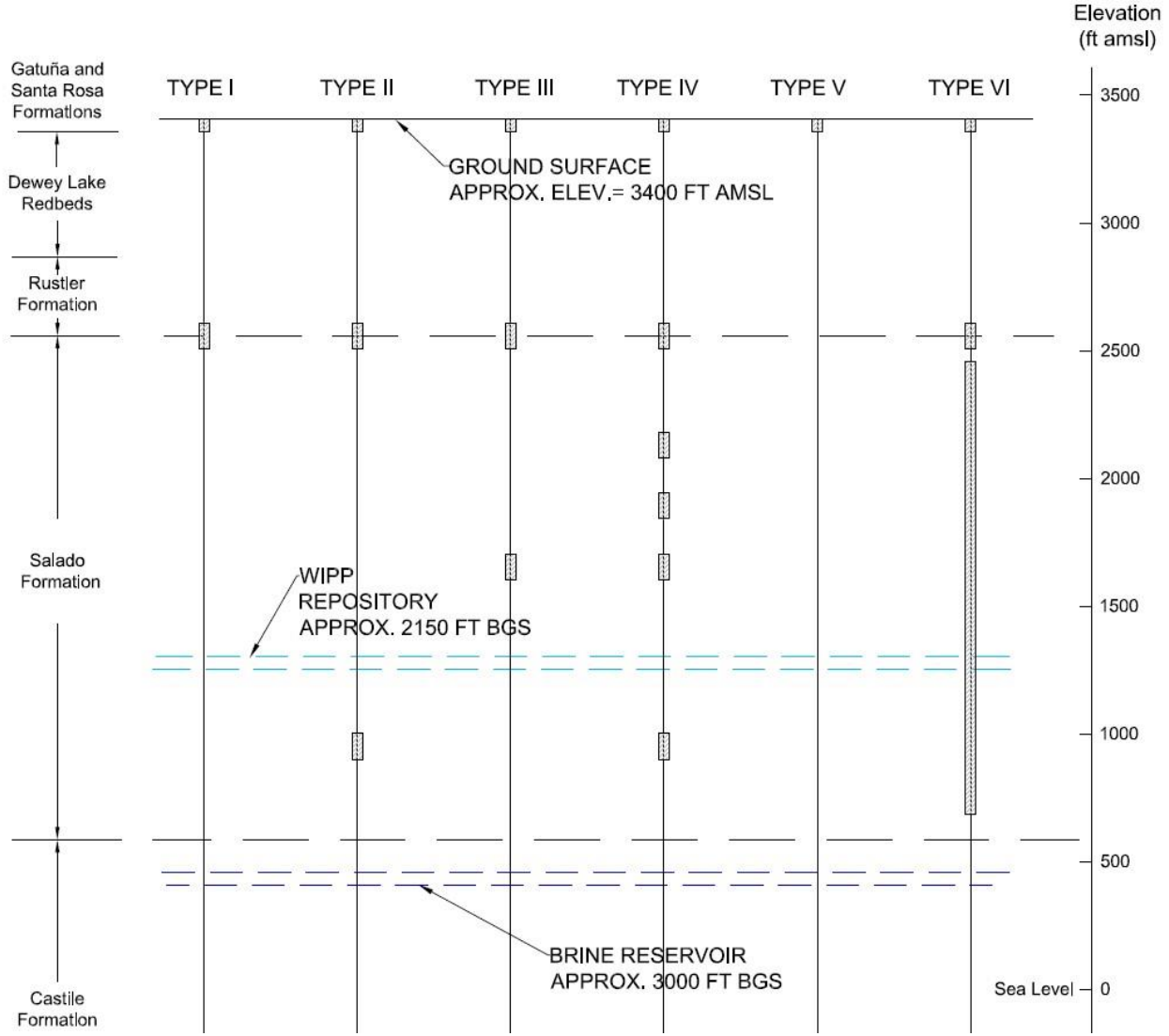
- 40 CFR § 194.33 defines a drilling *rate* as the average rate of deep drilling events (i.e., holes ≥ 660 m) over the 100 years before the PA calculation

Compliance Analysis	Drilling Rate (bh/km^2/yr)	Increase From CCA rate
CCA (1996)	4.68×10^{-3}	-
CRA-2014	6.73×10^{-3}	44%
CRA-2019	9.90×10^{-3}	112%
RPPCR (2024)	13.89×10^{-3}	197%



Borehole Permeability

- Currently six plugging patterns
  - pattern probability reassessed with each CRA
  - continuous plugs do not degrade in 10 ka
- Legacy approach
  - plugs degrade 200 yr. after an intrusion
  - permeability ranges from a silty-sand to gravel
- New approach
  - degraded grout behaves like silt
  - degraded steel behaves like granular iron
  - permeability at least 1,000 times smaller



Note: Plug thickness is exaggerated approx. 27 to 40 times

Conclusions

- PA continues to use *conservatisms* to account for uncertainties in long-term performance
- Releases from the replacement panels and existing panels are essentially the same
- The DOE has shown that changes in the RPPCR do not cause a significant departure from CRA-2019