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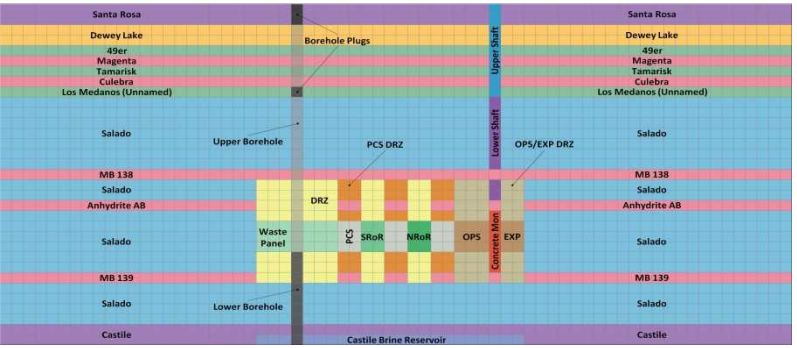

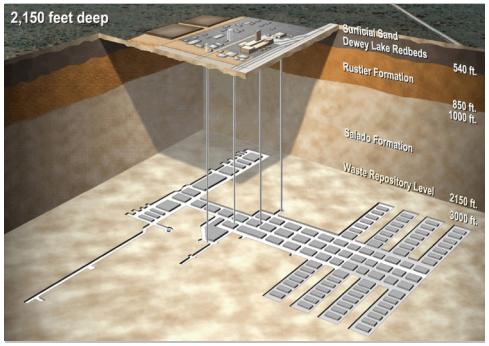

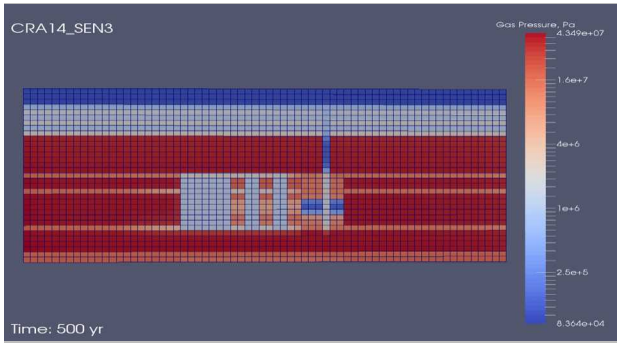

WIPP PERFORMANCE ASSESSMENT: RADIONUCLIDE RELEASE SENSITIVITY TO DIMINISHED BRINE AND GAS FLOWS TO/FROM TRANSURANIC WASTE DISPOSAL AREAS

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Sandia National Laboratories

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NNSA National Nuclear Security Administration

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- Sensitivity Analyses and Parameters
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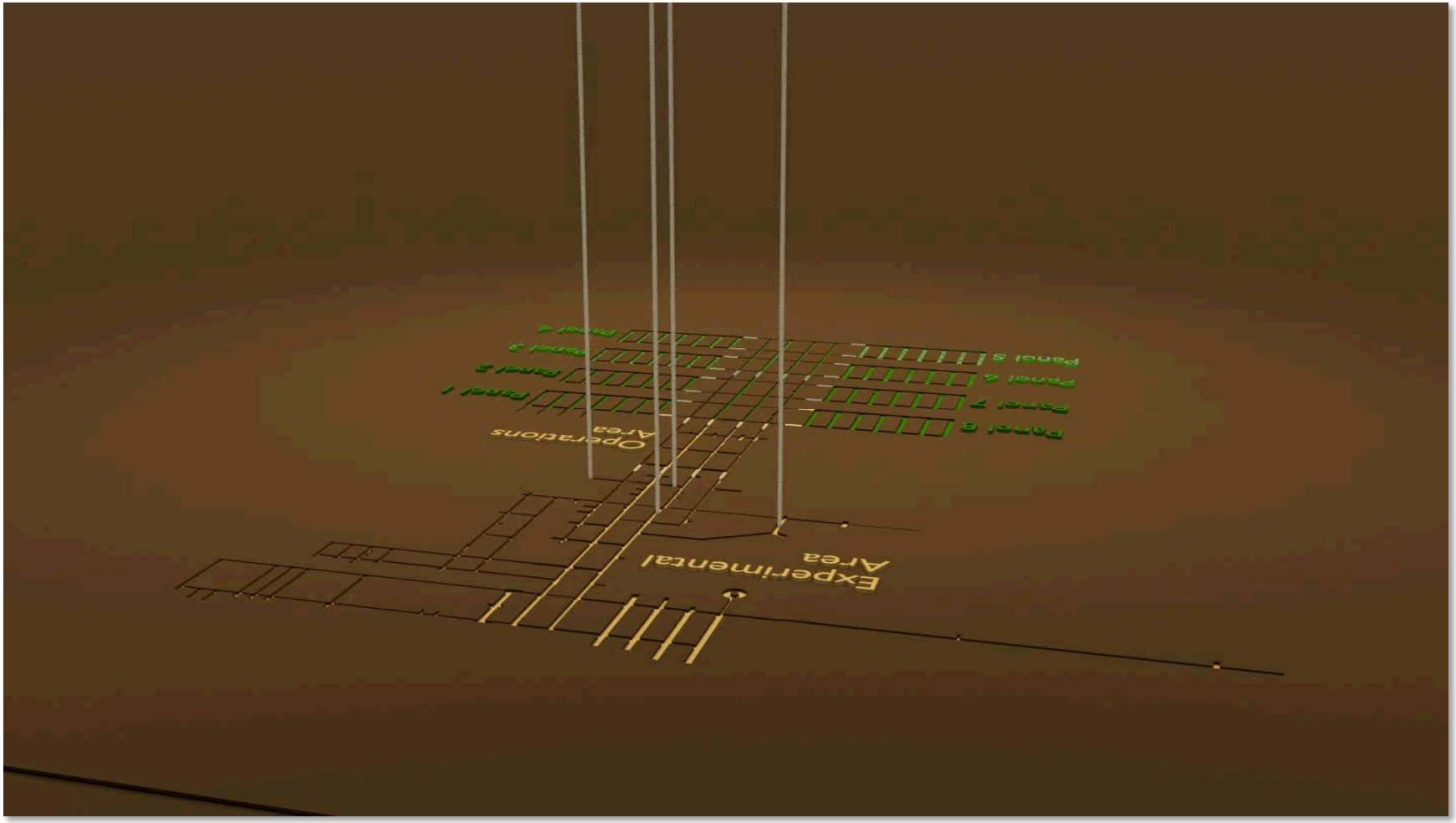
  - Brine and Gas Flows across Northernmost and Southernmost Panel Closures
  - CCDF Releases
- Summary and Conclusions

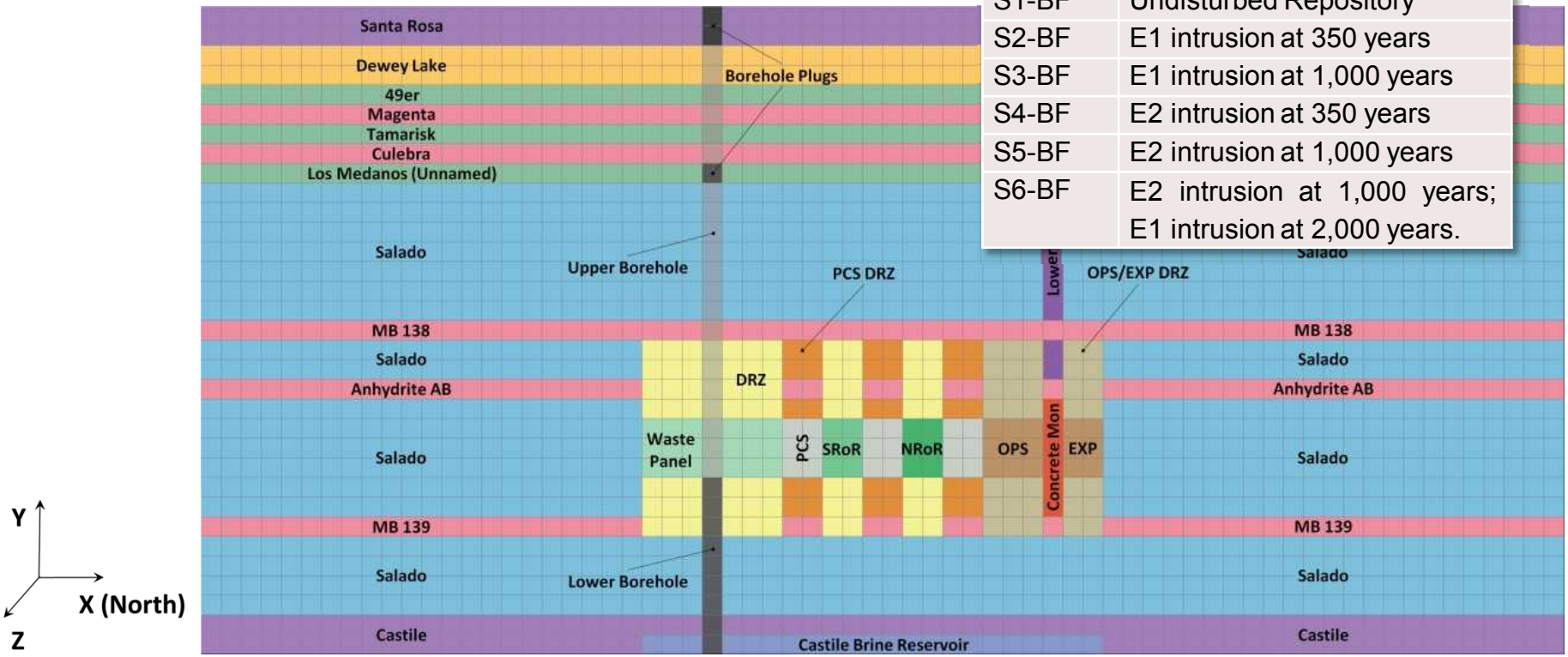
Introduction



Salado Flow Model

- BRAGFLO code used to simulate 2-D representation of repository domain; 6 scenarios, 3 replicates, 100 vectors/replicate = 1,800 runs for full PA

Scenario	Description
S1-BF	Undisturbed Repository
S2-BF	E1 intrusion at 350 years
S3-BF	E1 intrusion at 1,000 years
S4-BF	E2 intrusion at 350 years
S5-BF	E2 intrusion at 1,000 years
S6-BF	E2 intrusion at 1,000 years; E1 intrusion at 2,000 years.



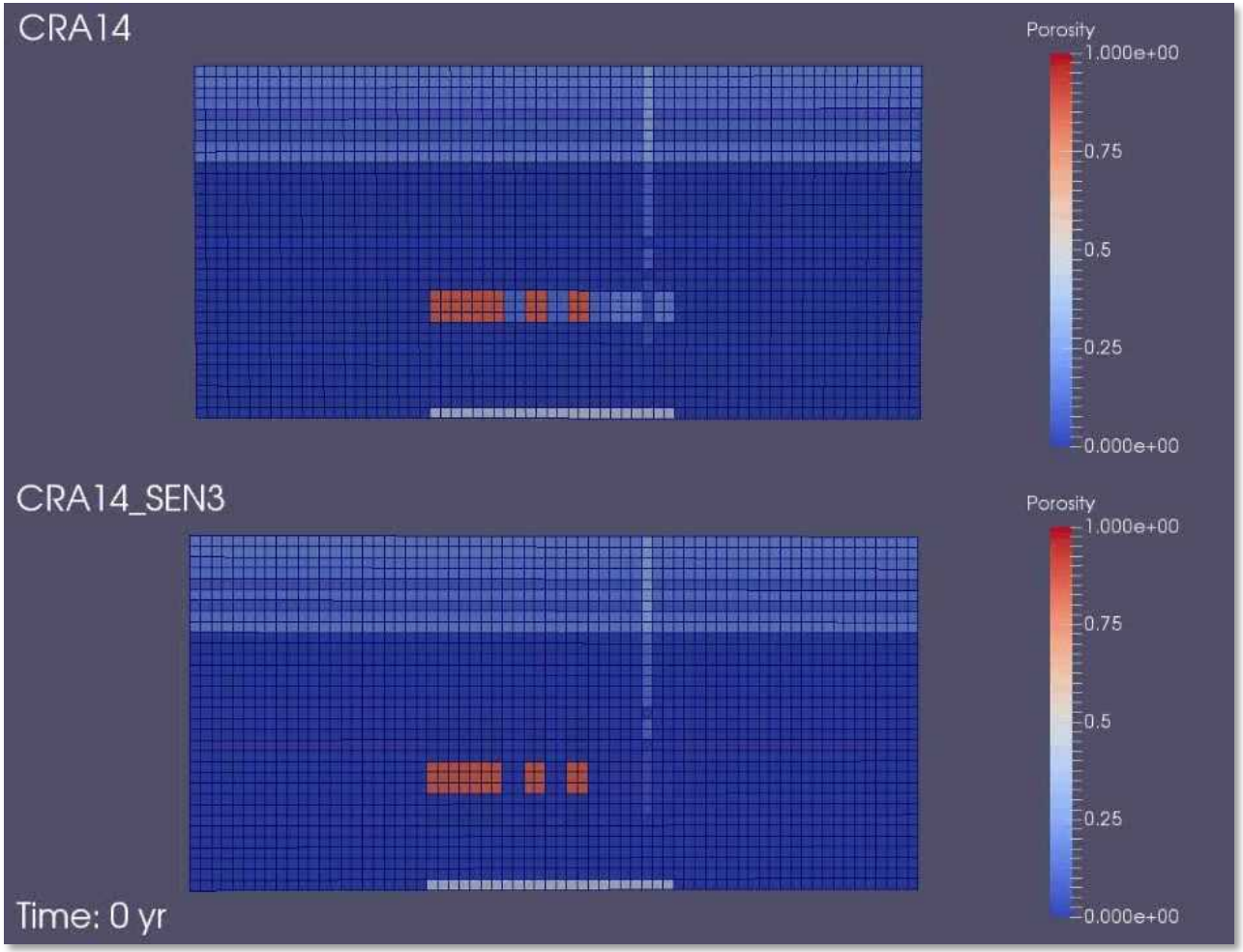
Sensitivity Analyses and Parameters

- Operations (OPS) and Experimental (EXP) cavities are historically modeled as a material with constant porosity (18%) and intrinsic permeability (log k = -11)
  - Relatively low porosity and relatively high permeability (compared to intact Halite) has been employed in these areas to maximize brine flow to waste areas resulting from 1° dip in Salado formation
- CRA14_SEN2 Sensitivity Analysis
  - Evaluate the OPS/EXP and associated DRZ at a lower porosity, with increased residual brine and gas saturations, and with two-phase flow properties activated (i.e., 2nd Modified Brooks-Corey relative permeability model with capillary pressure)
  - Porosity given as function of intact Halite (cumulatively sampled from 0.1% to 5.19%, plus ½ standard deviation)
  - Permeability given as a function of intact Halite (uniformly sampled from log k = -24 to -21, plus 1 order of magnitude)

Sensitivity Analyses and Parameters (cont.)

- Panel Closure Systems (PCS) previously modeled to simulate creep closure-induced healing during the first 200 years after closure
  - Porosity and permeability parameters established through a planned change request and rulemaking process approved by the U.S. EPA in 2013 with uniformly sampled porosity of 0.1% to 5.19% and permeability log *k* = -19.1 at 200 years
- CRA14_SEN3 Sensitivity Analysis
  - Use CRA14_SEN2 parameters plus evaluate the PCS and associated DRZ at a constant lower porosity and permeability equal to intact Halite, with increased residual brine and gas saturations, and with two-phase flow properties activated
  - Porosity cumulatively sampled from 0.1% to 5.19%
  - Permeability uniformly sampled from log *k* = -24 to -21

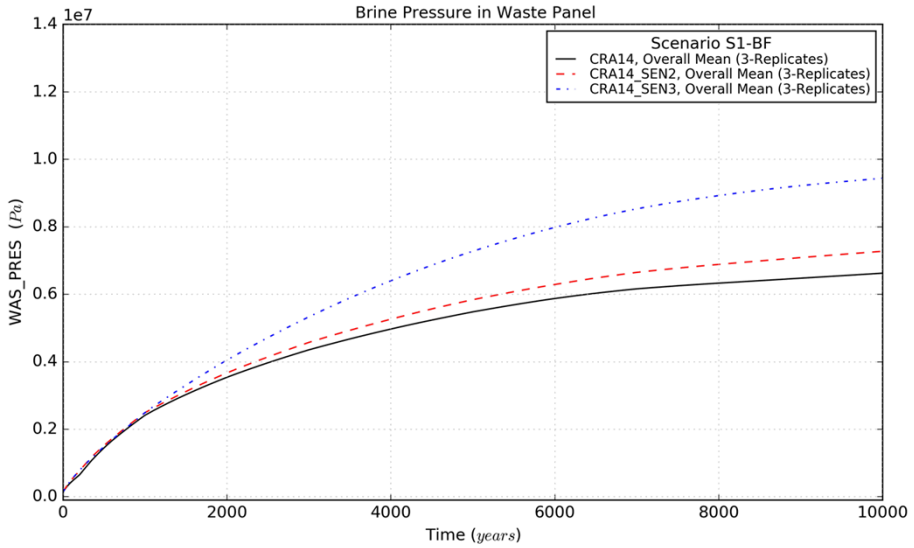
Analysis Results

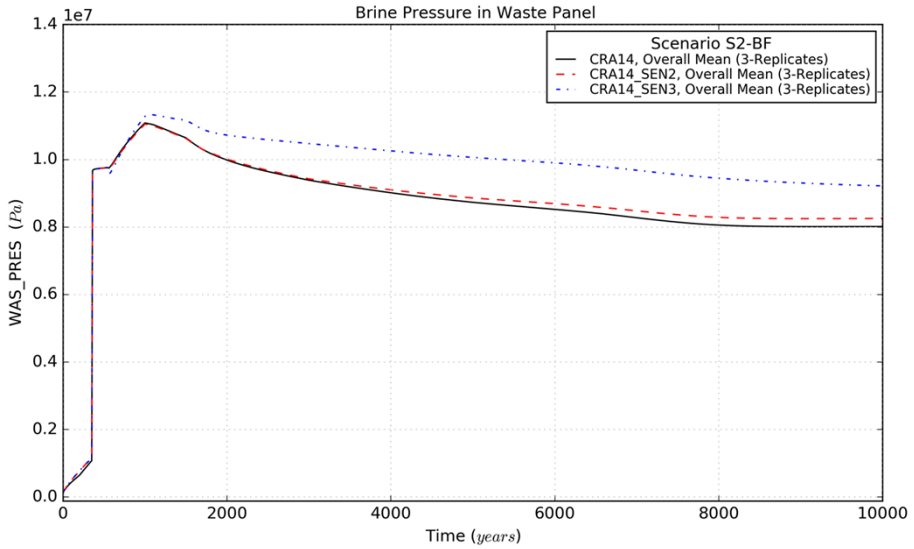


- CRA14 – baseline analysis for sensitivity studies
- CRA14_SEN2 – ϕ reduced, k reduced, k_r nonlinear, C_p nonzero, s_r increased in OPS/EXP
- CRA14_SEN3 – ϕ reduced, k reduced, k_r nonlinear, C_p nonzero, s_r increased in OPS/EXP + PCS

Waste Panel Pressures – Scenarios 1,2

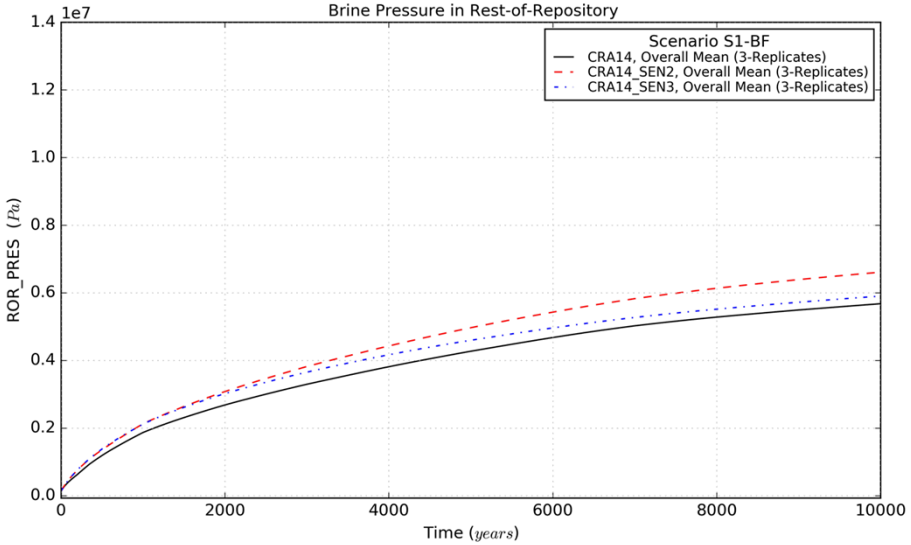
- Increase in pressure results from reduced brine and gas flows from the Waste panel across the PCS and reduced gas flows across the PCS and northward to the OPS/EXP areas
- Scenario 1 WAS_PRES Function Average
  - CRA14 - 4.92E+06
  - CRA14_SEN2 - 5.27E+06
    - Increase = 7% over CRA14
  - CRA14_SEN3 - 6.53E+06
    - Increase = 33% over CRA14
- Scenario 2 WAS_PRES Function Average
  - CRA14 - 8.64E+06
  - CRA14_SEN2 - 8.76E+06
    - Increase = 1% over CRA14
  - CRA14_SEN3 - 9.70E+06
    - Increase = 12% over CRA14
- Scenarios 3 thru 6 follow similar trends

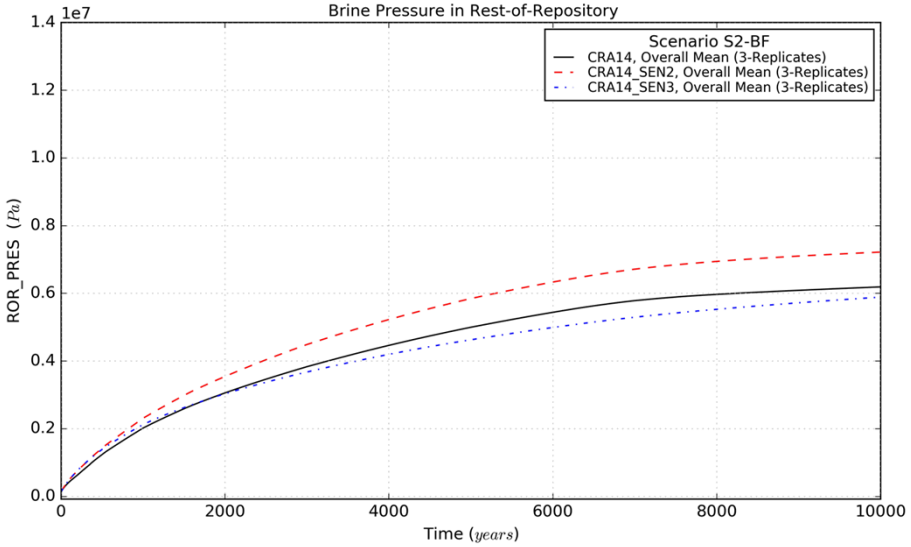




ROR Pressures – Scenarios 1,2

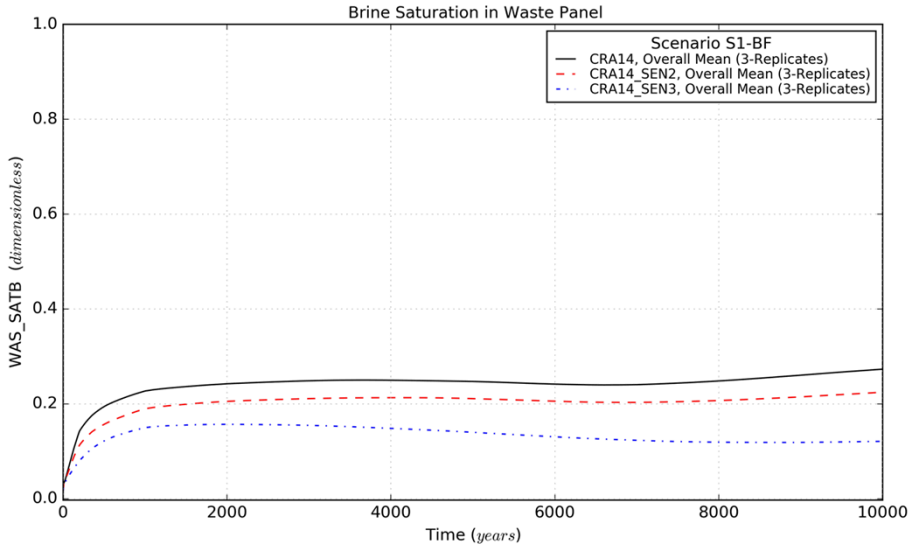
- Pressure change results from reduced brine and gas flows from the Waste panel across the PCS and reduced gas flows across the PCS and northward to the OPS/EXP areas
- Scenario 1 ROR_PRES Function Average
  - CRA14 - 3.95E+06
  - CRA14_SEN2 - 4.58E+06
    - Increase = 16% over CRA14
  - CRA14_SEN3 - 4.23E+06
    - Increase = 7% over CRA14
- Scenario 2 ROR_PRES Function Average
  - CRA14 - 4.50E+06
  - CRA14_SEN2 - 5.24E+06
    - Increase = 16% over CRA14
  - CRA14_SEN3 - 4.25E+06
    - Decrease = 6% under CRA14
- Scenarios 3 thru 6 follow similar trends based on intrusion type

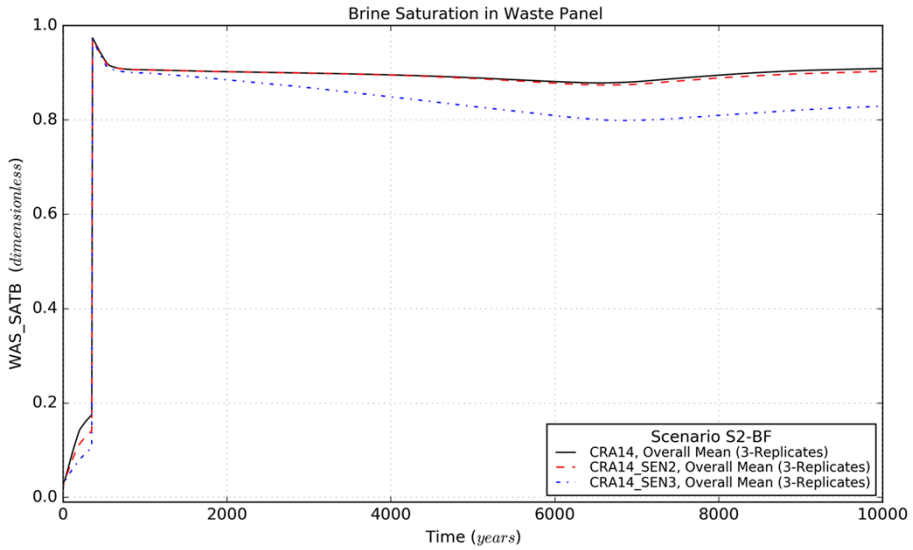




Waste Panel Saturations – Scenarios 1,2

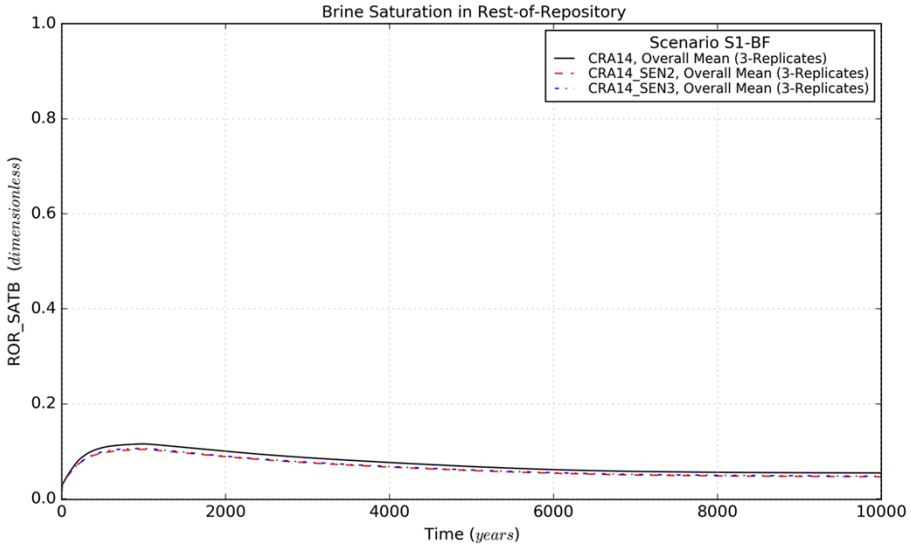
- Reduced brine saturation results from an increased pressure within the waste panel
- Scenario 1 WAS_SATB Function Average
  - CRA14 - 2.40E-01
  - CRA14_SEN2 - 2.02E-01
    - Decrease = 19% under CRA14
  - CRA14_SEN3 - 1.34E-01
    - Decrease = 79% under CRA14
- Scenario 2 WAS_SATB Function Average
  - CRA14 - 8.69E-01
  - CRA14_SEN2 - 8.66E-01
    - Decrease = 1% under CRA14
  - CRA14_SEN3 - 8.15E-01
    - Decrease = 7% under CRA14
- Scenarios 3 thru 6 follow similar trends

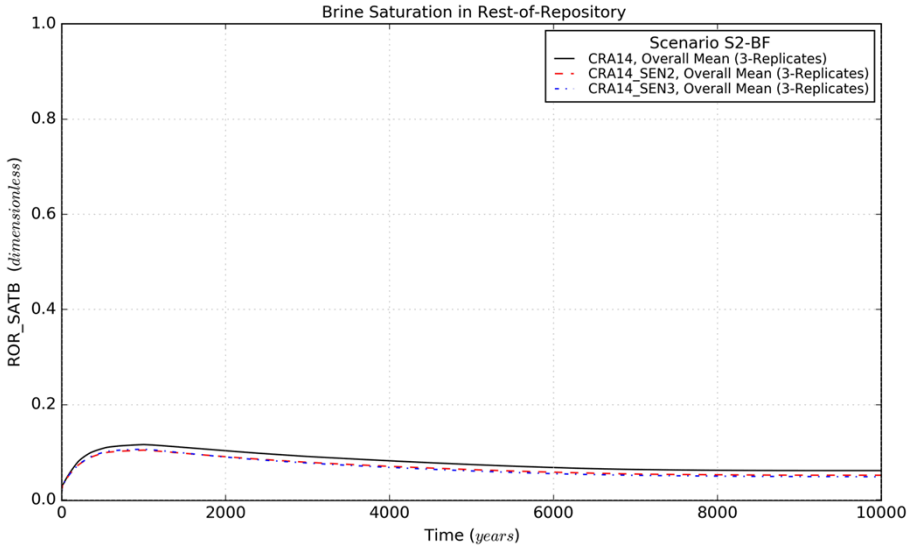




RoR Saturations – Scenarios 1,2

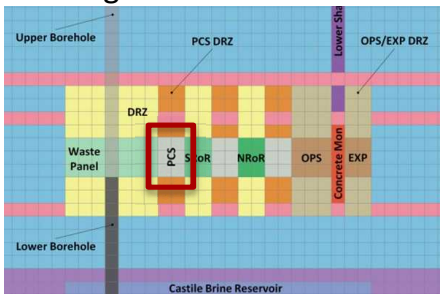
- Reduced brine saturation results from an increased pressure within the rest-of-repository
- Scenario 1 ROR_SATB Function Average
  - CRA14 - 7.44E-02
  - CRA14_SEN2 - 6.54E-02
    - Decrease = 14% under CRA14
  - CRA14_SEN3 - 6.67E-02
    - Decrease = 12% under CRA14
- Scenario 2 ROR_SATB Function Average
  - CRA14 - 7.93E-02
  - CRA14_SEN2 - 6.87E-02
    - Decrease = 15% under CRA14
  - CRA14_SEN3 - 6.69E-02
    - Decrease = 19% under CRA14
- Scenarios 3 thru 6 follow similar trends

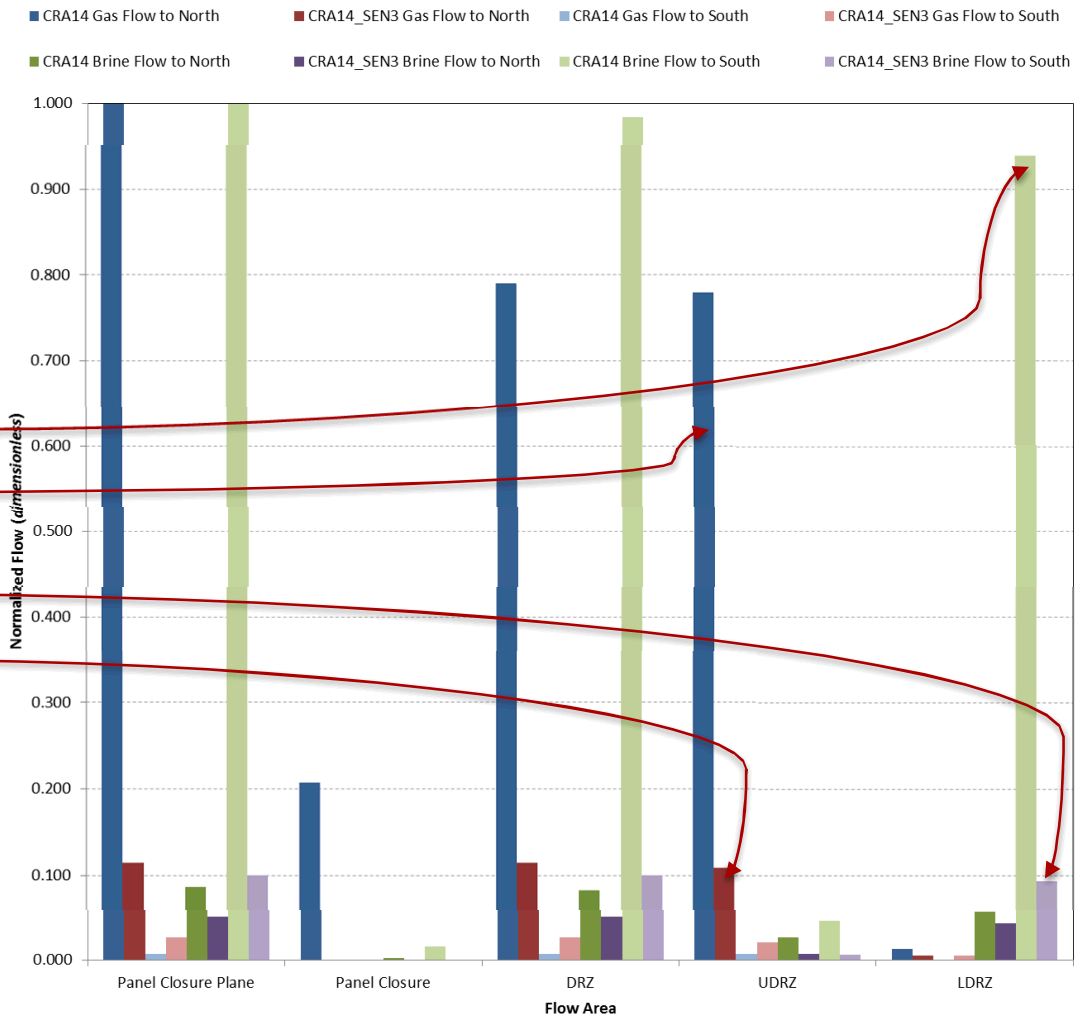




Brine/Gas Flow Across Southernmost Panel Closure – Scenario 1

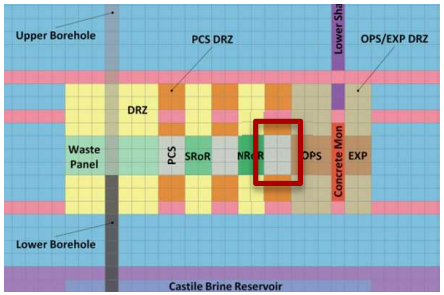
- Evaluated for north and south flows across:
  - entire panel closure plane (panel closure plus upper and lower DRZ)
  - panel closure
  - panel closure DRZ (upper and lower DRZ)
  - upper DRZ
  - lower DRZ
- Normalized by the maximum gas and brine flow in either direction across the full planes
- CRA14
  - Brine flows predominantly south with 94% through the lower DRZ
  - Gas flows predominantly north with 78% through the upper DRZ
- CRA14_SEN3
  - Brine flow is <10% of CRA14; flows south and within lower DRZ
  - Gas flow is <12% of CRA14; flows north and within upper DRZ
- Scenarios 2 through 6 follow similar trends

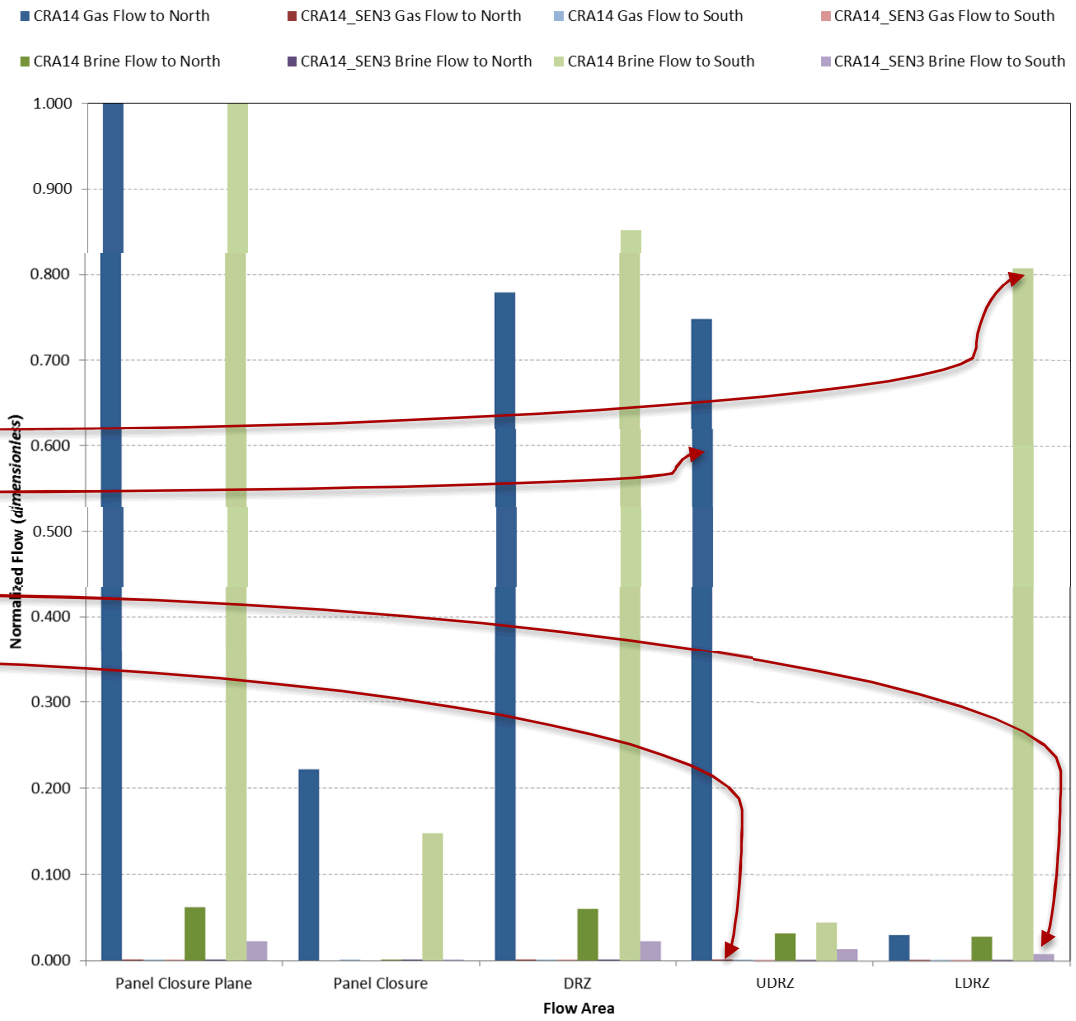




Brine/Gas Flow Across Northernmost Panel Closure – Scenario 1

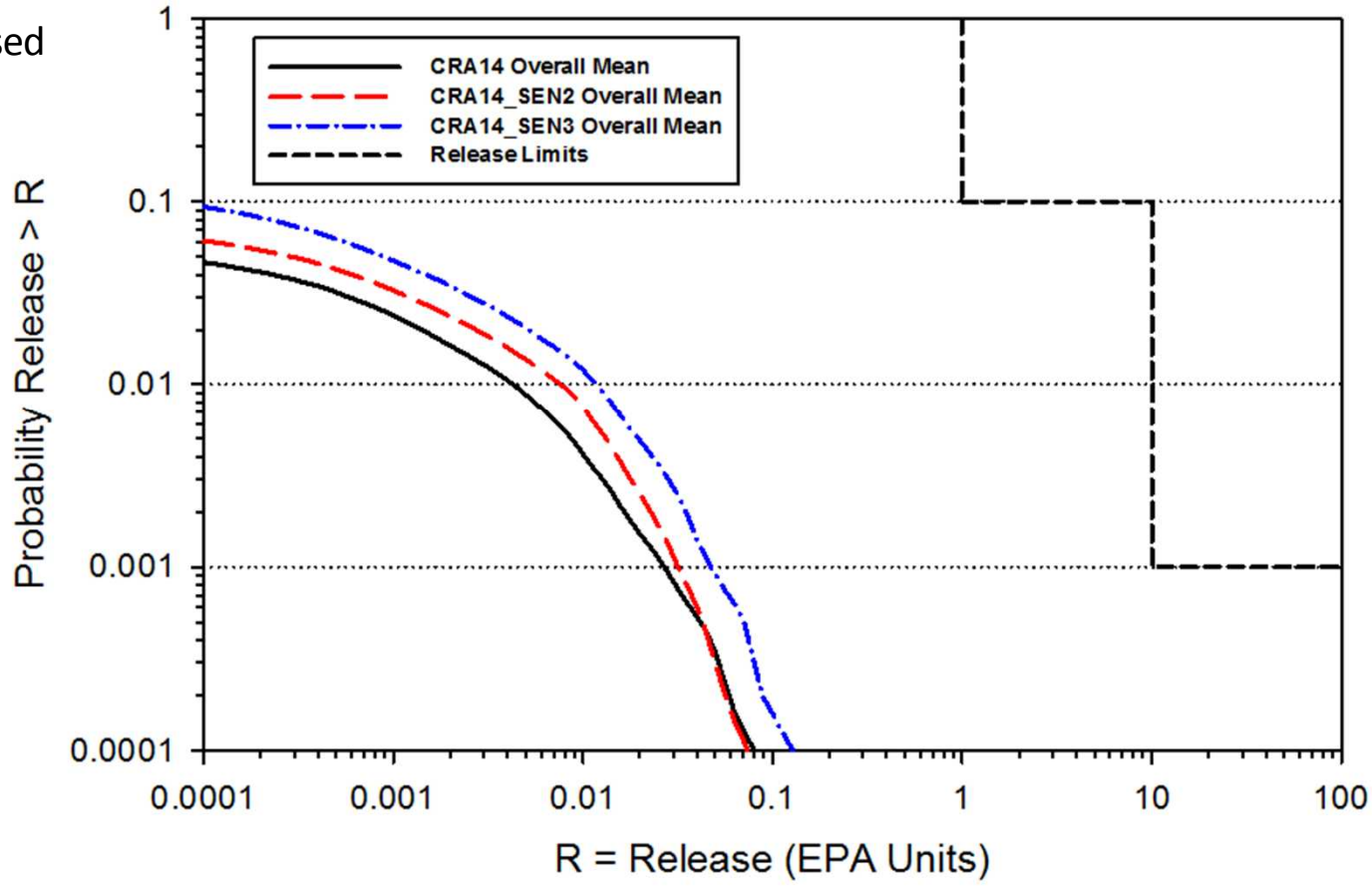
- Evaluated for north and south flows across:
  - entire panel closure plane (panel closure plus upper and lower DRZ)
  - panel closure
  - panel closure DRZ (upper and lower DRZ)
  - upper DRZ
  - lower DRZ
- Normalized by the maximum gas and brine flow in either direction across the full planes
- CRA14
  - Brine flows predominantly south with 80% through the lower DRZ
  - Gas flows predominantly north with 75% through the upper DRZ
- CRA14_SEN3
  - Brine flow is <3% of CRA14; flows south and within lower DRZ
  - Gas flow is essentially zero
- Scenarios 2 through 6 follow similar trends





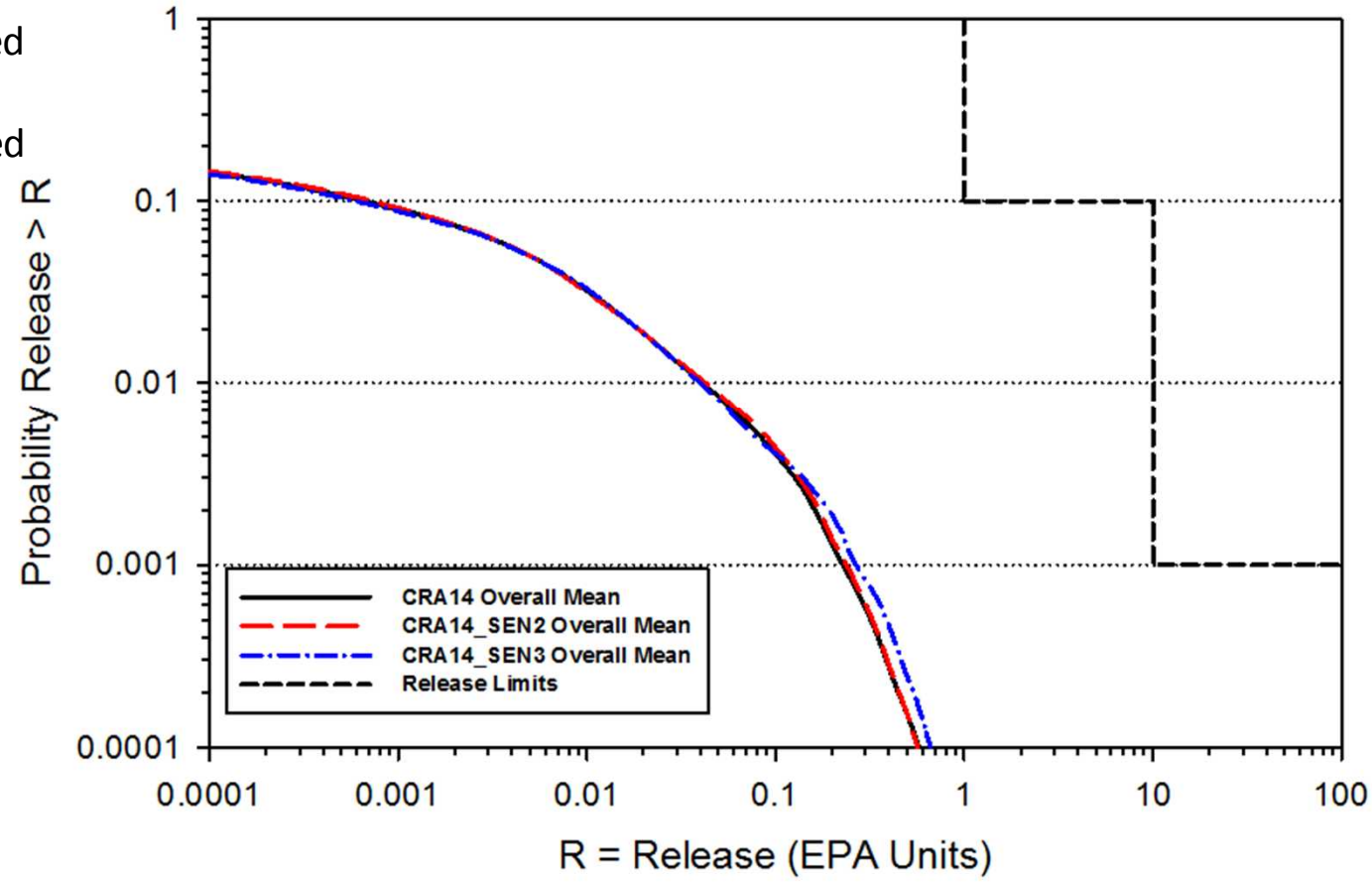
Spallings Releases

- Overall Mean CCDFs (3-replicate)
- Marginally increased due to increased pressure in waste areas



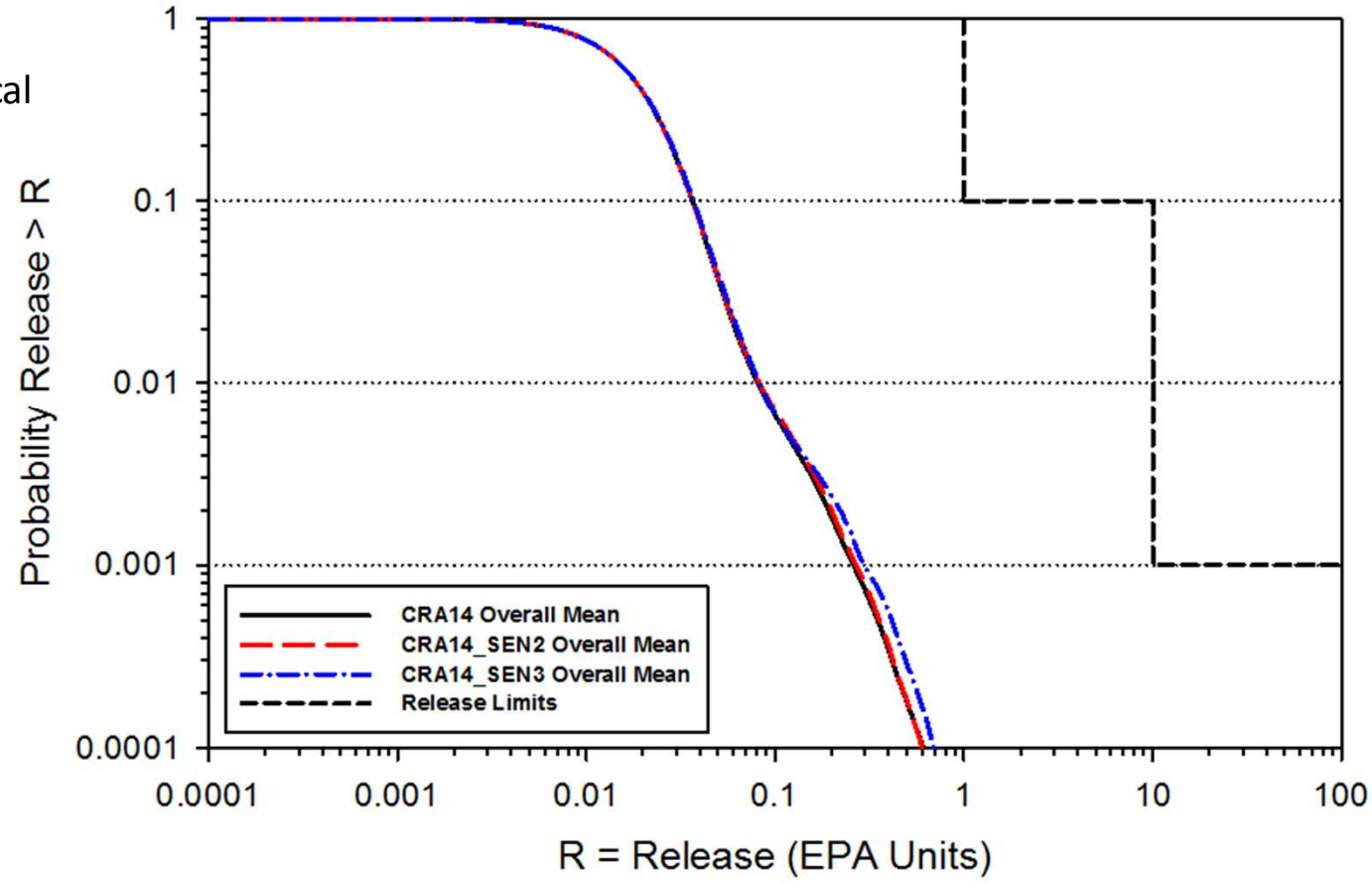
Direct Brine Releases

- Overall Mean CCDFs (3-replicate)
- Minimally changed due to trade-off between increased waste panel pressures and reduced waste panel saturations



Total Releases

- Overall Mean CCDFs (3-replicate)
- 0.1 Probability essentially identical
- 0.001 Probability minimally increased by 15% for CRA14_SEN3



Summary and Conclusions

- Release Summary
  - Cuttings and Cavings – no change
  - Spallings – marginally increased
  - From Culebra – negligibly changed
  - Direct Brine – minimally increased
  - Total – 0.1 probability unchanged, 0.001 probability increased 15%
- Study Conclusions
  - Modeling assumptions associated with the operations and experimental areas of the repository and the panel closure system have only a small effect on the prediction of total releases from the repository such that the results from the sensitivity studies support the reasonableness, computational efficiency/stability, and adequacy of the current (CRA14) model to demonstrate compliance with the regulatory limits

Questions?

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