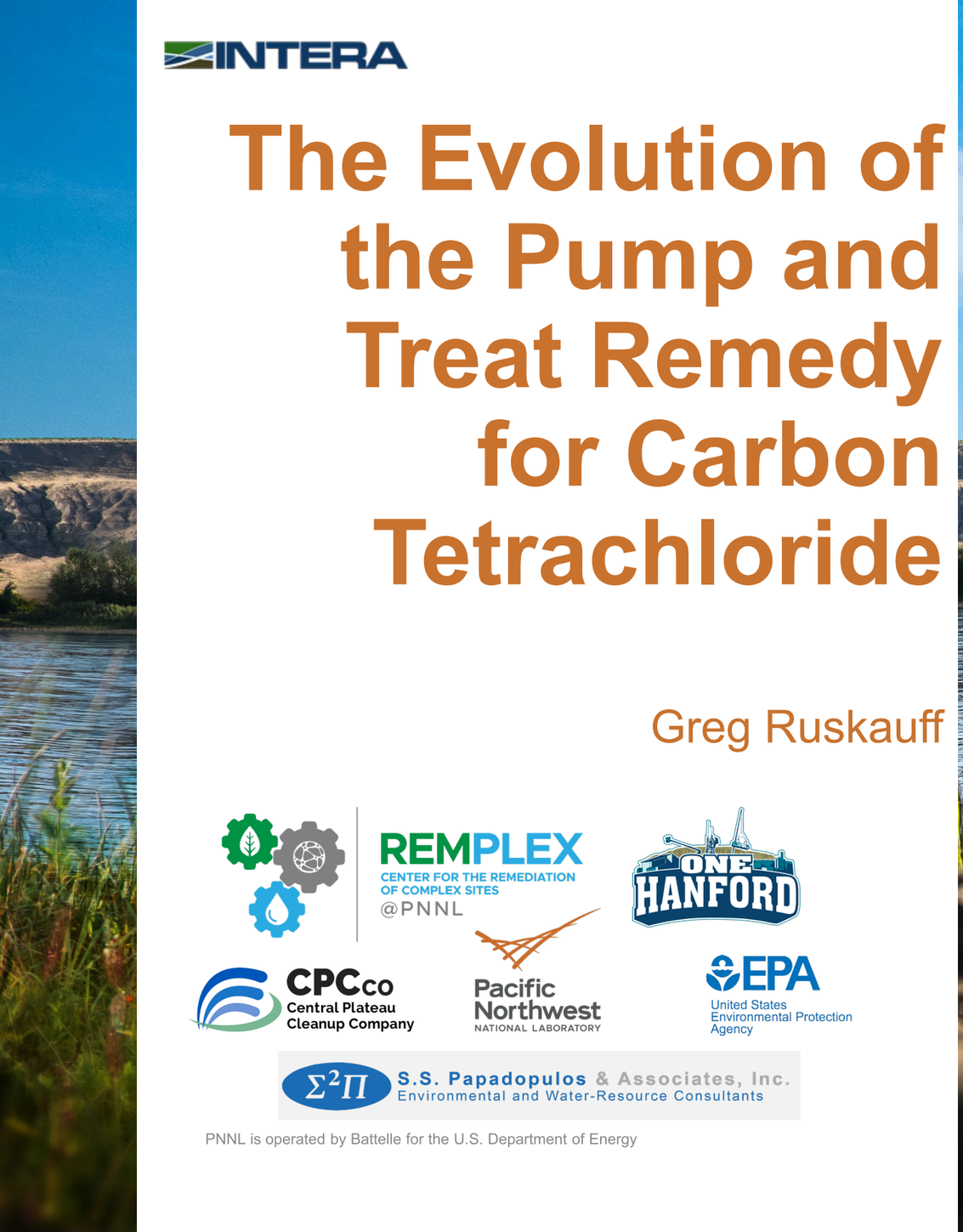
The Evolution of the Pump and Treat Remedy for Carbon Tetrachloride

Greg Ruskauff



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Topics

- Objective: Inform participants with modeling results about the complex cleanup of the carbon tetrachloride plume on the Hanford Site Central Plateau
  - 2008 Record of Decision remedy approach and design
  - The implication of data collected after 2008 on the remedy
  - The 2019 Optimization Study Plan (OSP)
  - Changing design concept
  - Prototype results
  - Path forward

Remedy Design - 2008

- Design approach:
  - Surround the plume at concentrations near the MCL with injection wells for flow-path control and pore-volume flushing
  - Extract from high-concentration areas
  - About 1 pore volume (PV) flushed
- 25 years of operation followed by 100 years of monitored natural attenuation (MNA)

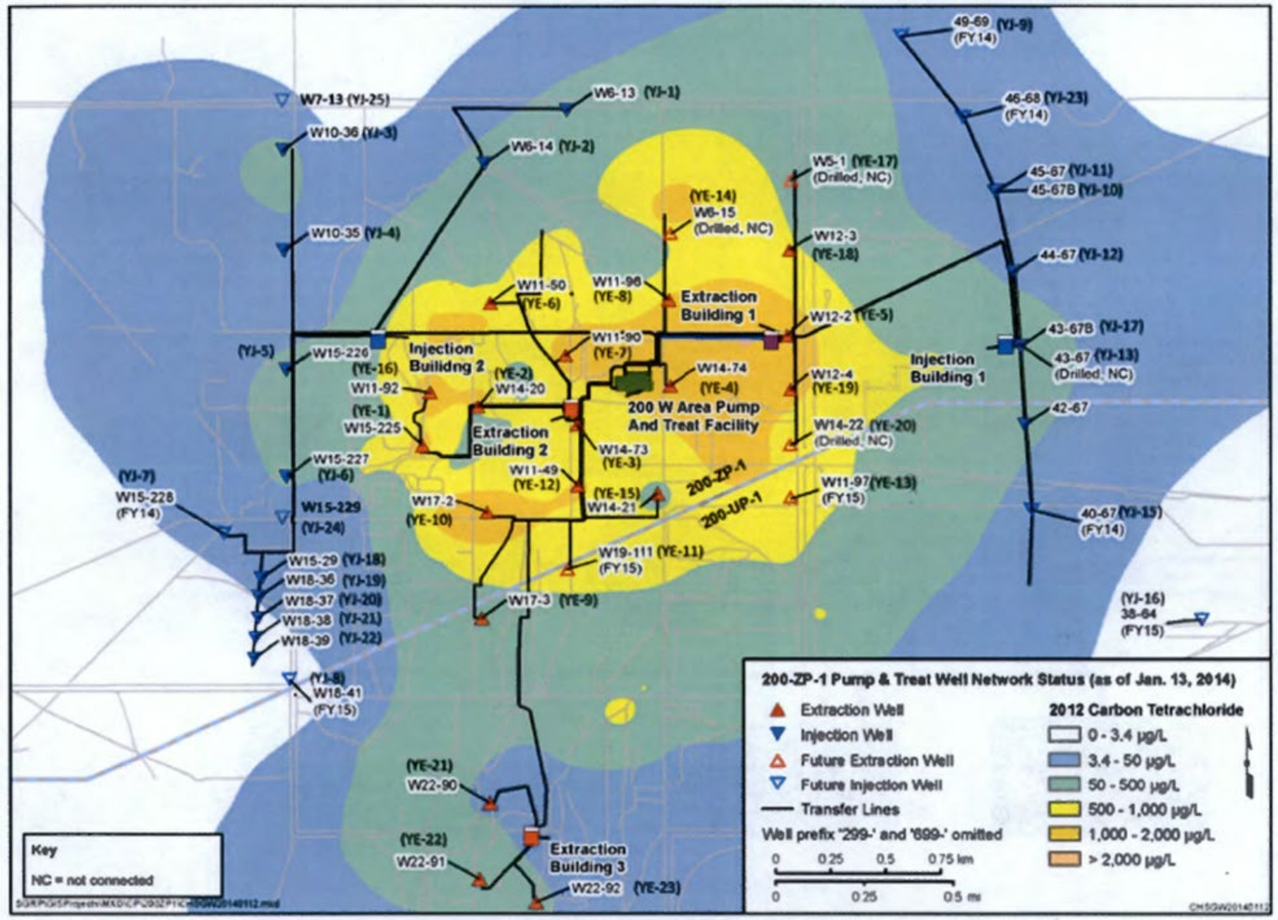
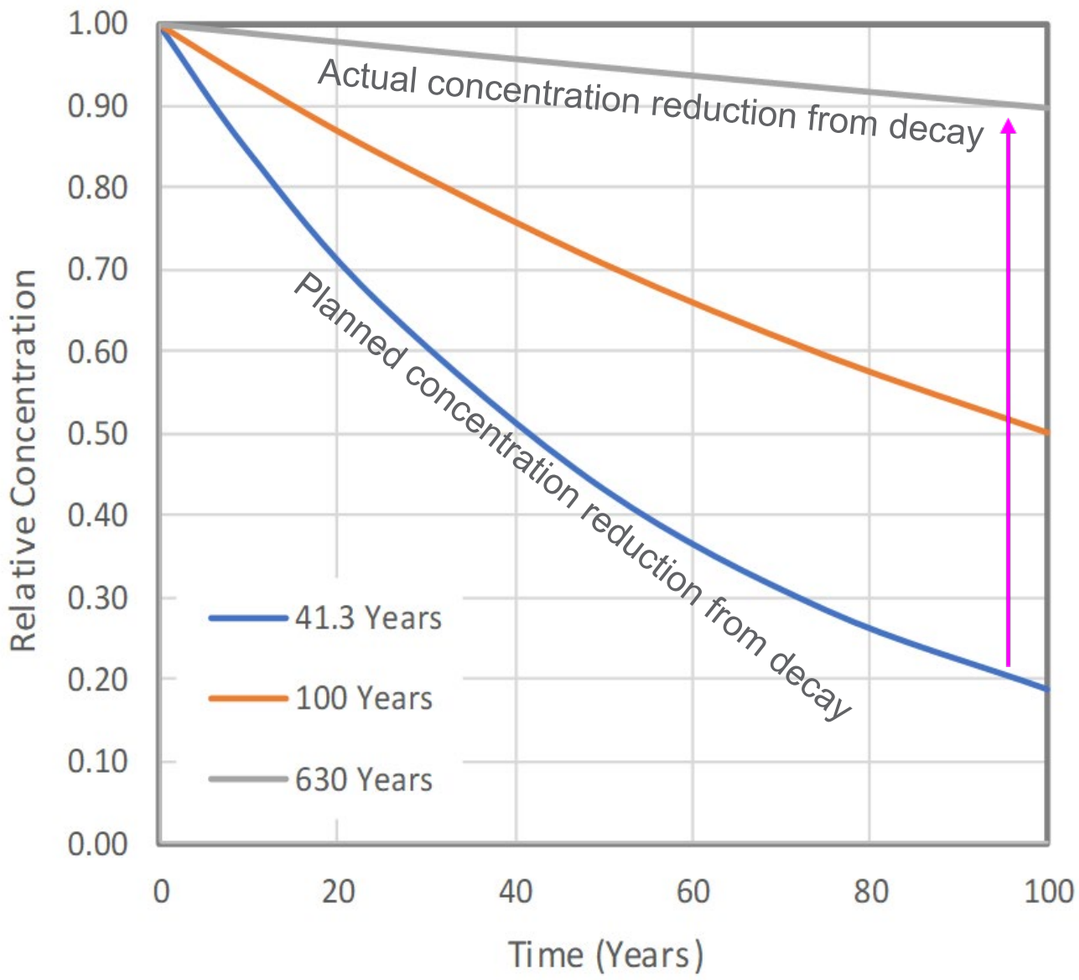


Figure 3-2. 200 West P&T with Project Components, Well Locations, and Piping Routes

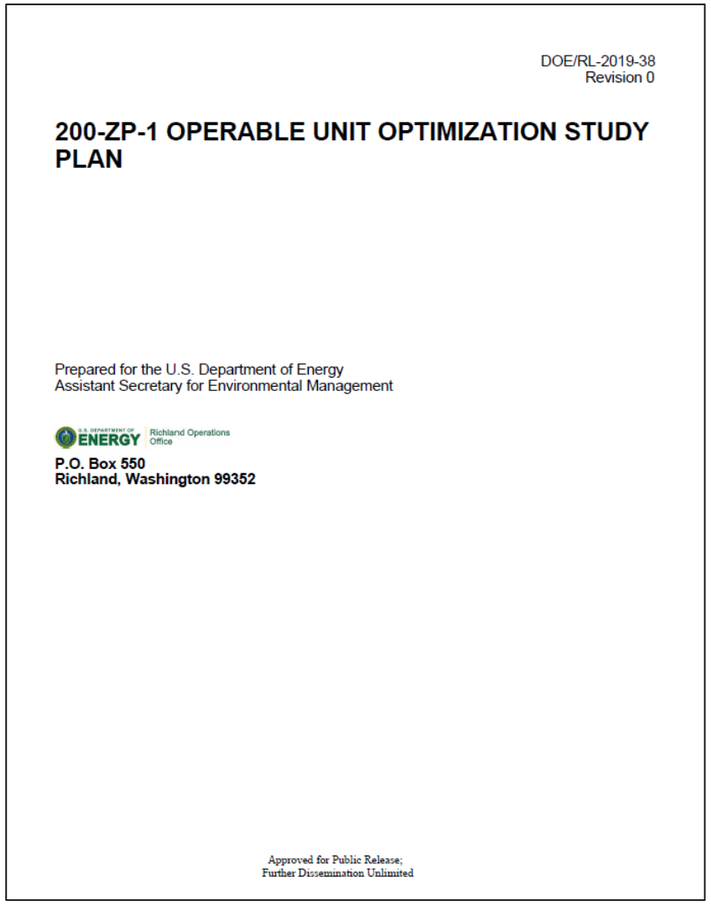
Data after 2008

- System began full-scale operation in 2012
- ROD-specified hydraulic containment achieved along with plume mass reduction
- Continued well drilling and characterization showed the following:
  - More extensive and higher concentration CCl_4 contamination in the Ringold E and Ringold A formations
  - Site-specific abiotic decay was determined to be over 10x slower than assumed in the 2008 remedy design
- Less decay means more plume concentration reduction from pump and treat
  - Requiring more pore volume flushing



The 2019 Optimization Study Plan

- EPA and DOE recognized the changed, less favorable conditions in 200-ZP-1 and put in place an *Optimization Study Plan*
  - DOE/RL-2019-38, *200-ZP-1 Operable Unit Optimization Study Plan*
- This plan's purpose is to "generate information to evaluate potential remedy configuration modifications"
- Includes:
  - Increasing capacity by ~1,000 gpm to ~3,000 gpm
  - Additional air stripper
  - Additional aquifer characterization and hydraulic testing



DOE/RL-2019-38
Revision 0

200-ZP-1 OPERABLE UNIT OPTIMIZATION STUDY PLAN

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

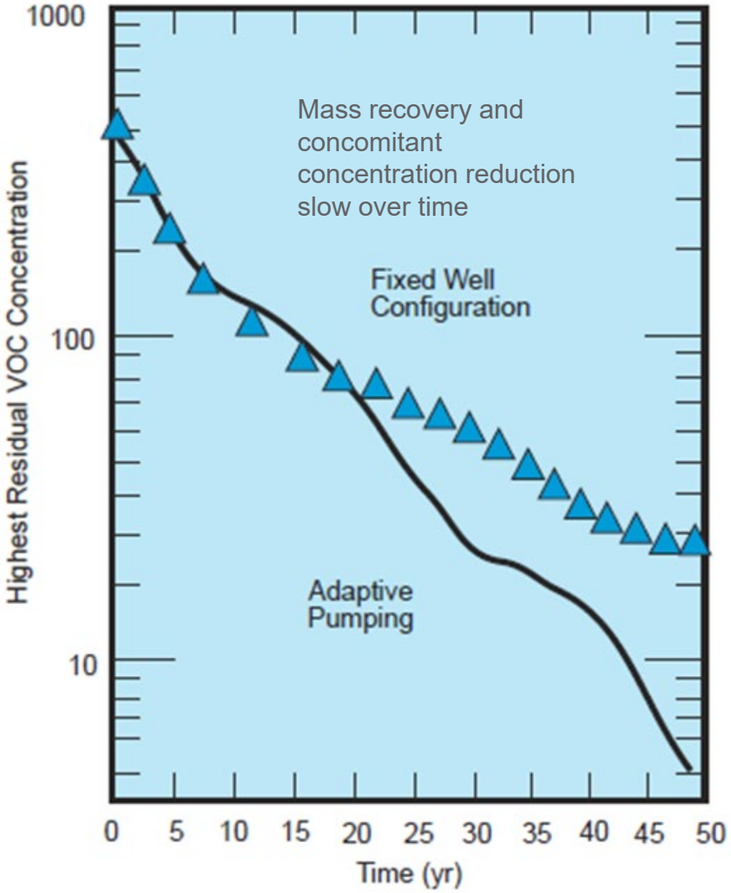
U.S. DEPARTMENT OF ENERGY Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

Adaptive Management and Enhanced Groundwater Recirculation

- Also called “smart” or “flexible” management
- Suthersan et al. developed an updated concept of P&T (*Resurgence of Pump and Treat Solutions: Directed Groundwater Recirculation*, Groundwater Monitoring & Remediation, v. 35, no. 2)
  - Extraction and re-injection well configuration with adaptive operation
- Rule of optimization:
  - *Maximize contaminant recovery by focusing groundwater extraction from the highest concentrations within treatment areas of the plume while injecting clean water on the periphery to enhance flushing*



Pump-and-Treat Ground-Water Remediation A Guide for Decision Makers and Practitioners, EPA/625/R-95/005

Another Wellfield Concept

- One of many investigated
- Increase flushing by moving injection wells inward toward the pumping center
- Increase flow to ~3,000 gpm
- Work from the top aquifer (Ringold E) where the current infrastructure is largely located downward into the Ringold A

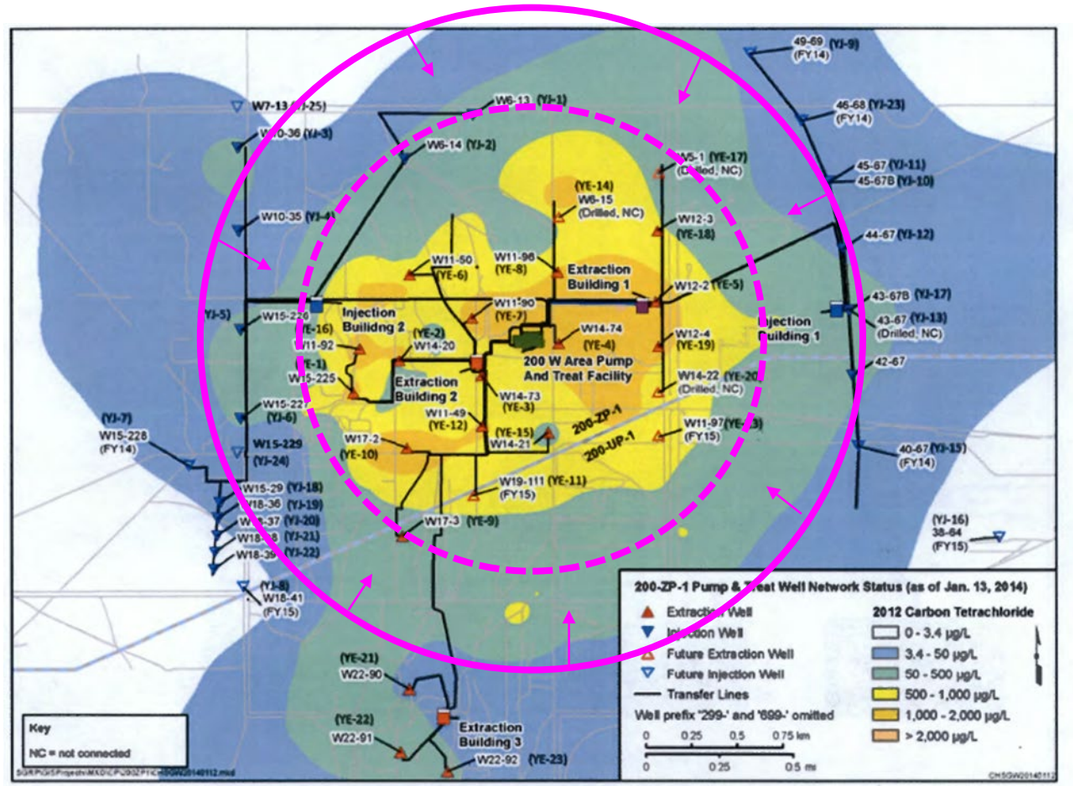
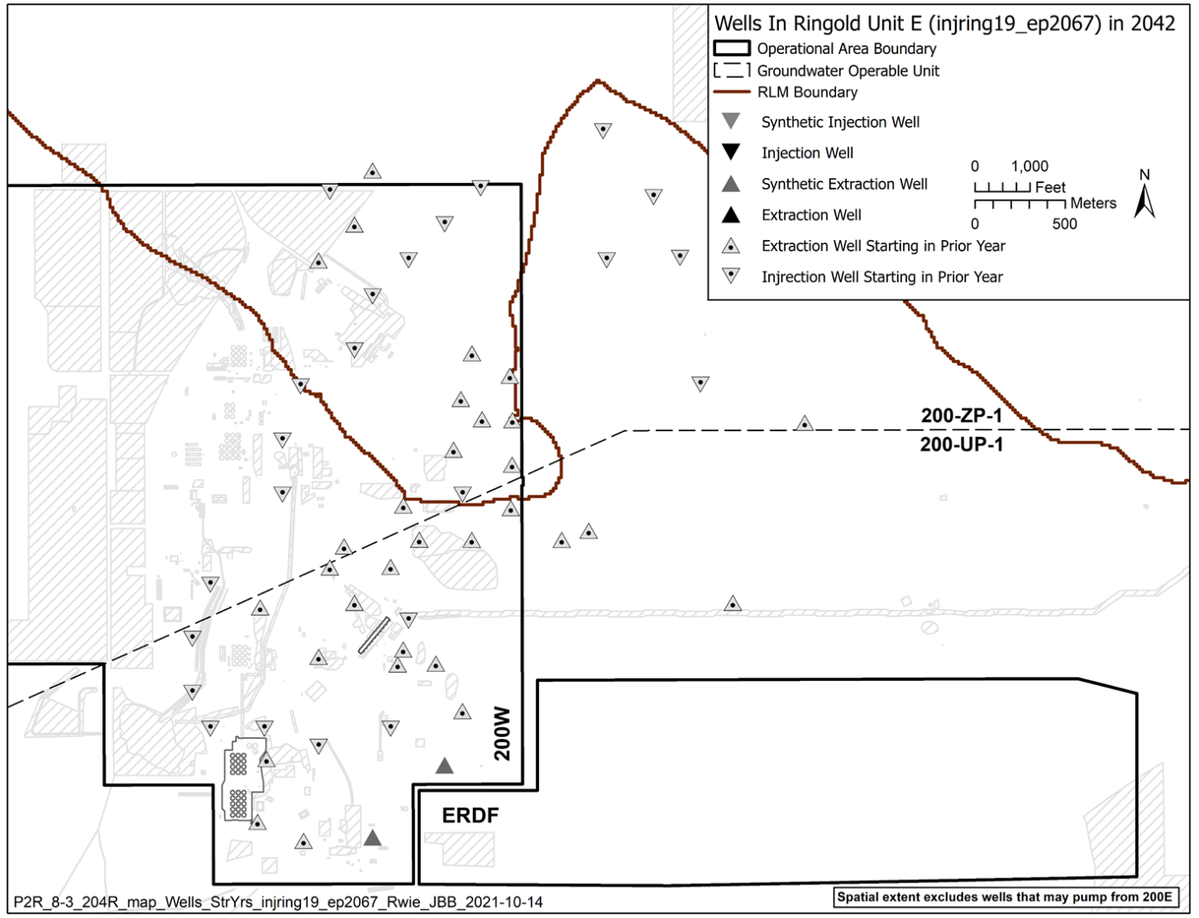


Figure 3-2. 200 West P&T with Project Components, Well Locations, and Piping Routes

Well Configuration Changes to Accelerate Plume Cleanup

- Each well installation involves radiological, ecological, and cultural surveys
- Site still has substantial old infrastructure that can limit access

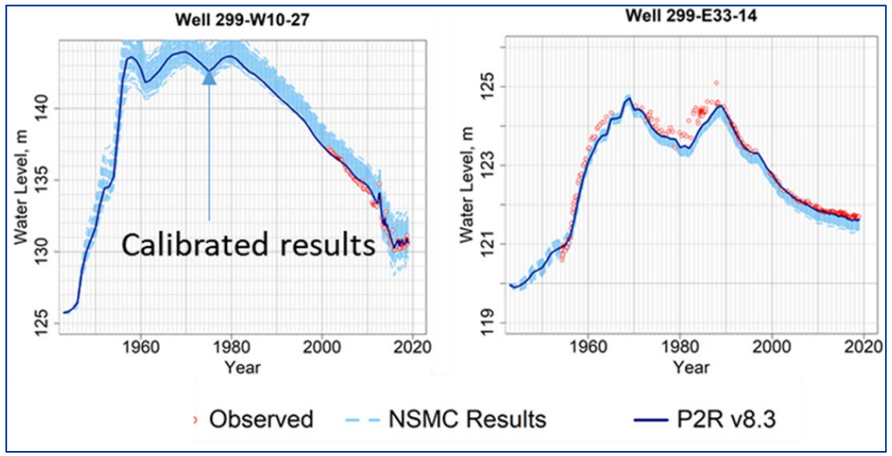


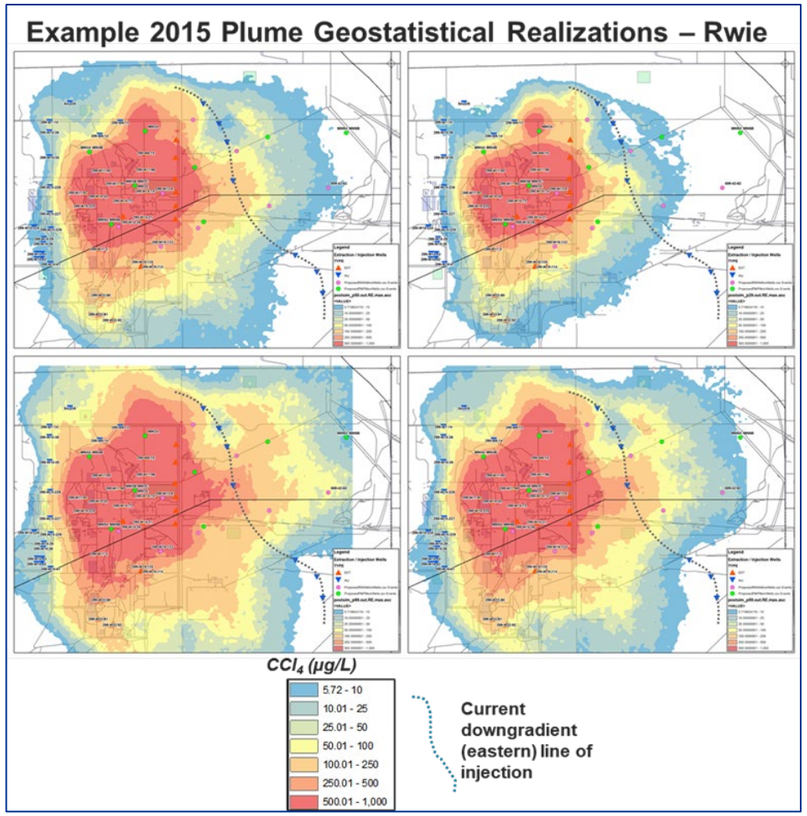
Initial Modeling Results

- Only one of many scenarios
  - 91 billion gallons of water pumped
  - ~100 additional extraction and injection wells over the life of the remedy
  - 55 years of P&T (from 25 years originally planned) followed by 71 years of MNA
  - Complete rebuild of the treatment plant (design life is to 2037)

Including Uncertainty

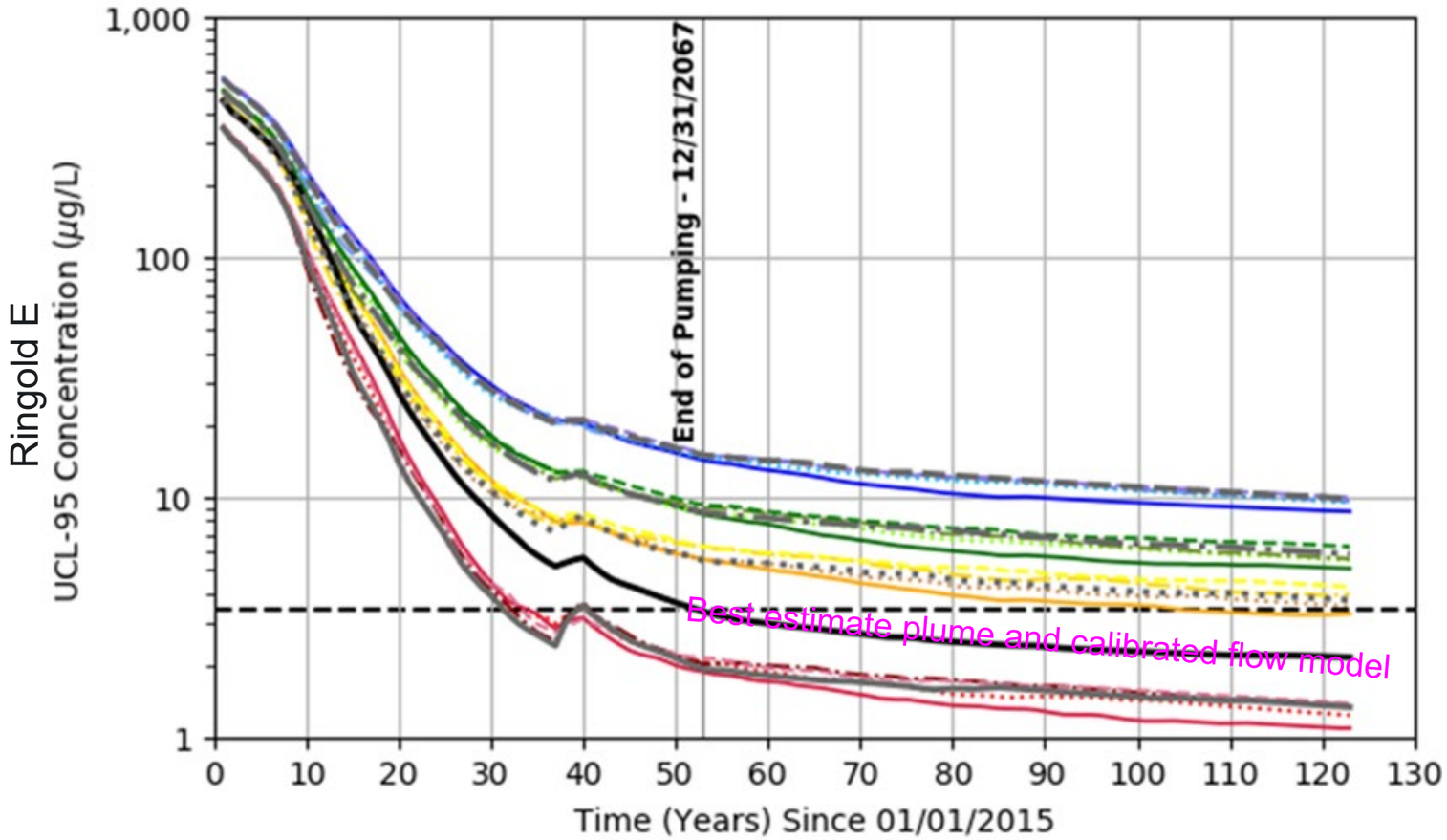
- Uncertainty in CCl_4 extent/concentration and decay half life have been realized by the project
- Products have been evolving that can support uncertainty analysis
  - Flow model uncertainty
  - Plume uncertainty





Evaluating Uncertainty

- Prototype calculation that draws from the risk-cost-benefit decision framework of Freeze et al. (1990)
- One performance metric is UCL95 plume concentration
- Colored curves reflect plume realizations
  - Line type is flow model realizations

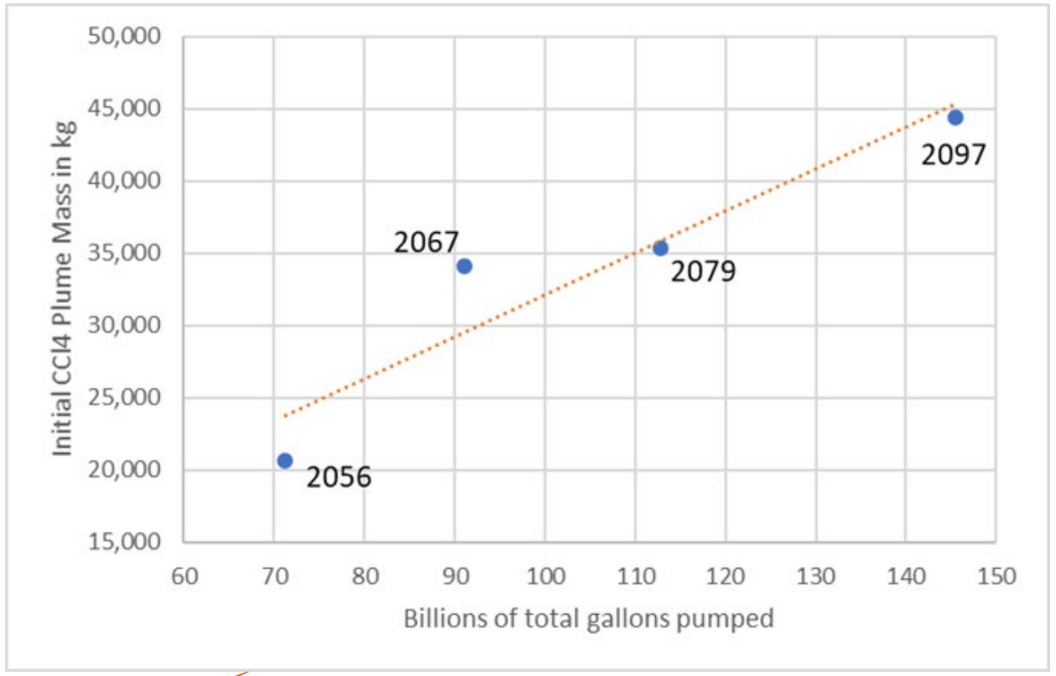


Freeze, RA, J Massman, L Smith, T Sperling, and B James, 1990, "Hydrogeological Decision Analysis: 1. A Framework", Ground Water **28**(5): 738-766.

Optimization Under Uncertainty

- Combine flow model and plume uncertainty
  - Plume uncertainty can result in more or less pore volume flushing than estimated from a single estimate of the plume
  - Reoptimize the design for each realization
  - What are the consequences on the design?
    - ✓ The remediation timeframe required to achieve the RAO can vary by decades

Initial Plume Mass vs. Groundwater Volume Pumped and Ending Pumping Year



Conclusions and Next Steps

- Modeling shows that even with Adaptive Management practices in place, a fair amount of hardware installation would be needed to achieve the RAOs as they are written in the 200-ZP-1 Record of Decision
  - Note – The OSP purpose is to “generate information to evaluate potential remedy configuration modifications”
- Following the continued data collection, additional modeling and decision making will be necessary to inform a ROD modification.
- Initial modeling results shows the need for jointly evaluating uncertainty, ROD requirements, and further remediation system modifications

Thank you

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