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Closure Strategy for OU III of the Monticello Mill Tailings Site (MMTS)

Jennifer Nyman, Ph.D., P.E.
Geosyntec Consultants, Inc.

Track 1.1. General Long-Term Stewardship (LTS) Practices

Co-Authors and Contributors

Jason Nguyen

U.S. DOE Office of Legacy Management

Timothy Bartlett

Navarro Research and Engineering, Inc.

Fred Smith

Navarro Research and Engineering, Inc.

Elisabeth L. Hawley

Geosyntec Consultants, Inc.

Dave Donohue

Navarro Research and Engineering, Inc.

Rula Deeb

Geosyntec Consultants, Inc.

Kenneth E. Karp

Navarro Research and Engineering, Inc.

Amoret Bunn

Pacific Northwest National Laboratory

Objectives

- Evaluate closure strategies for MMTS operable unit (OU) III (groundwater and surface water)
- Identify recommended closure strategy
- Describe scenarios for strategy implementation
  - If-then logic, decision points
- Develop recommendations to guide data collection and assessment over the next two to five years

MMTS Overview

- Uranium (U) and vanadium ore processed, 1942 to 1960
  - Produced tailings with radioactivity and metals
  - Impounded on site, used as construction materials
- Tailings impacted groundwater and Montezuma Creek with U
  - Groundwater risk-based goal is 30 µg/L U
  - Surface water mostly below risk-based goal of 44 µg/L U

Context for Evaluating Closure

- Several factors make MMTS OU III a candidate for closure evaluation
- Remedy is protective of human health and environment
  - Institutional controls (ICs) in place
  - Five year review findings
- Source area removal/remediation activities are complete
- Significant groundwater treatment has been conducted
- Stakeholder perspectives
  - Federal Facilities Agreement between Department of Energy (DOE), United States Environmental Protection Agency (EPA), and Utah Department of Environmental Quality
  - Private land owner

Context for Evaluating Closure, Cont'd

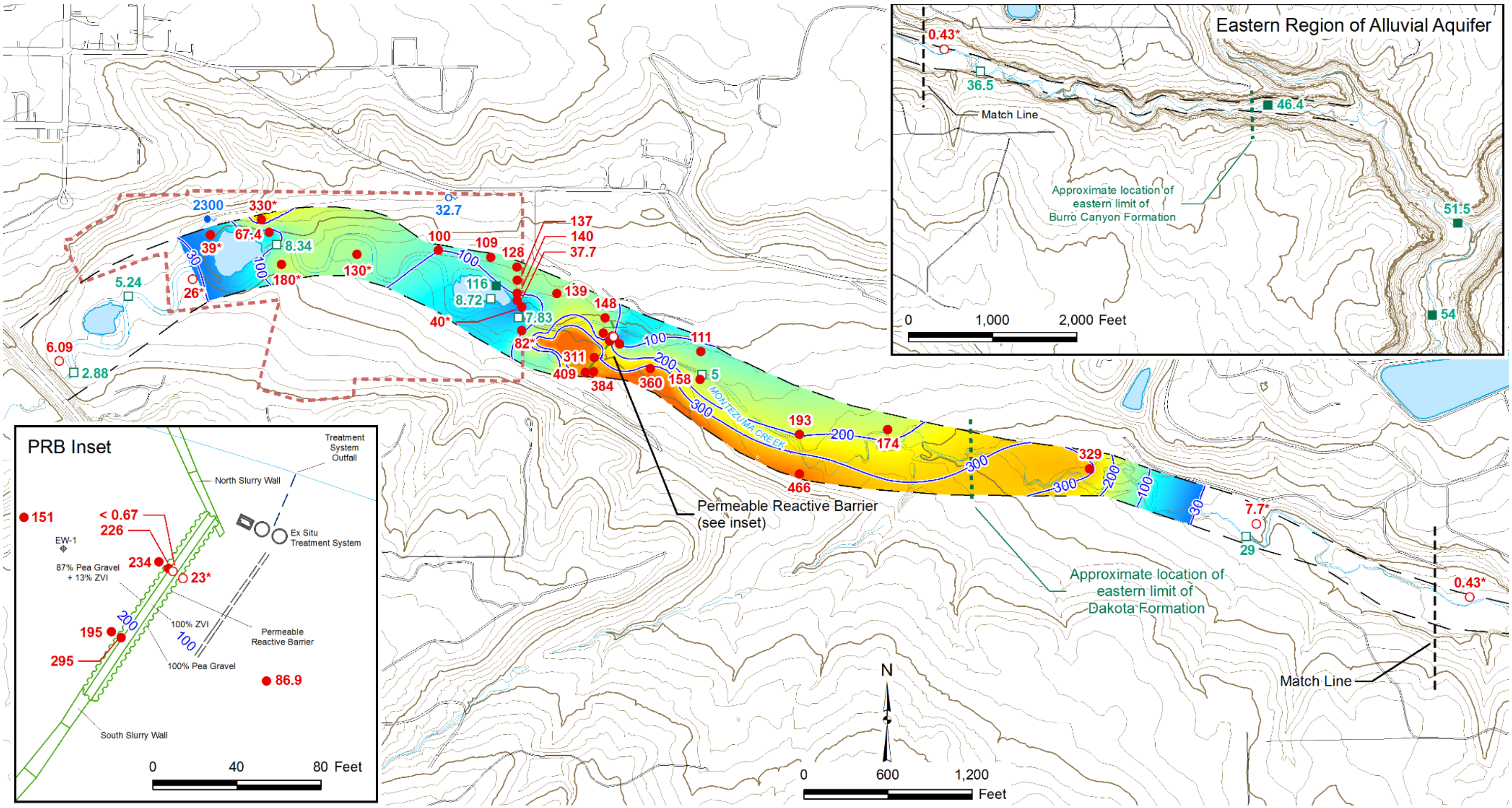
Source Area Remediation

- Excavated 2.54 million cubic yards of soil, sediment, and debris
- Placed in a capped repository on a neighboring DOE property
- Deleted 22 of 34 properties from the National Priorities List (NPL)
  - Properties with groundwater and surface water contamination remain

Groundwater Remediation

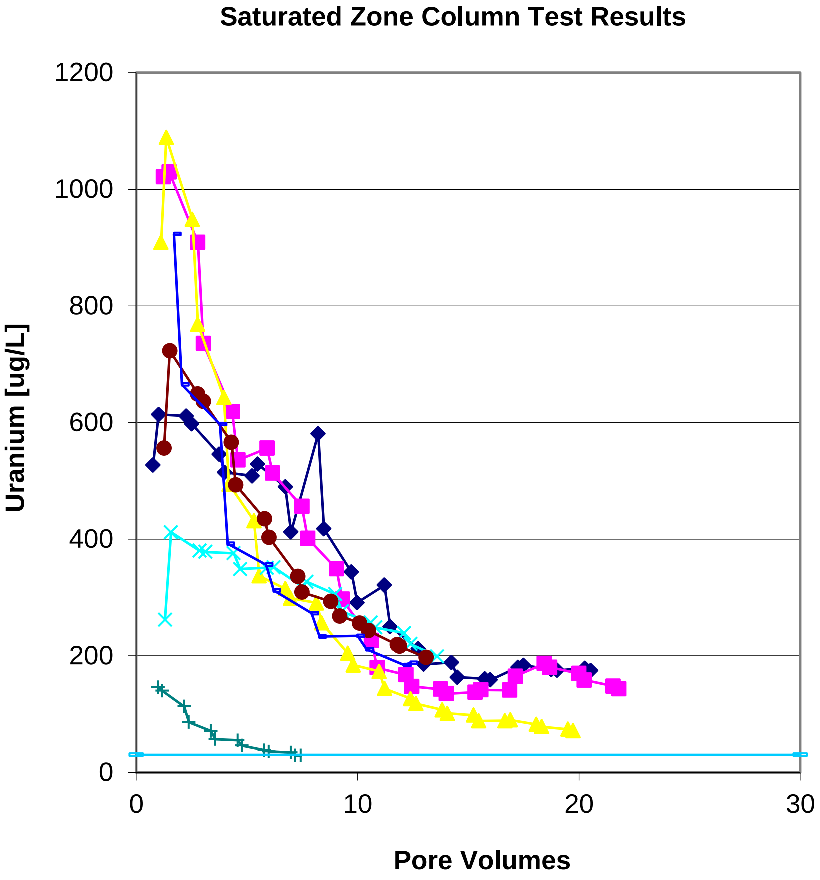
- Constructed zerovalent iron (ZVI) permeable reactive barrier (PRB)
  - Field demonstration in 1999
  - Low permeability slurry walls
- Selected monitored natural attenuation (MNA), ICs as final remedy
- Operated contingency groundwater extraction and treatment
  - Ex situ ZVI/gravel treatment
  - Groundwater remedy optimization (GRO) system

U in Groundwater and Surface Water, 2017

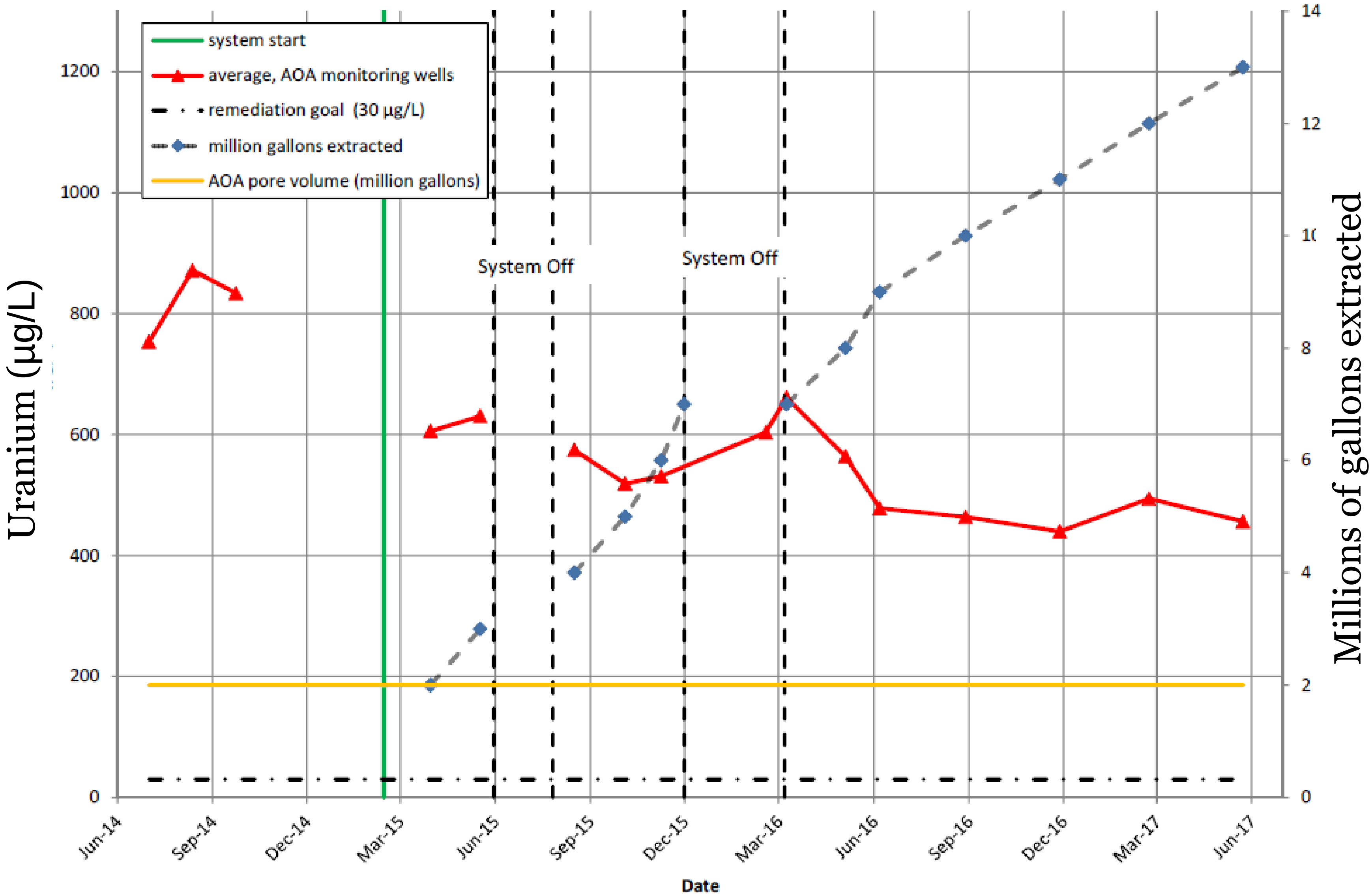


GRO System Design and Performance

- Column studies prediction of U tailing over time
- Performance criteria for GRO system termination to be established
- Remedial progress likely limited by many factors
  - Limited recharge of clean groundwater
  - Subsurface heterogeneity
  - Geochemical complexity
- Restoration of MNA remedy once U tailing is established



GRO System Influent U Trends



Evaluation of Closure Strategies: MNA

COMPLETE

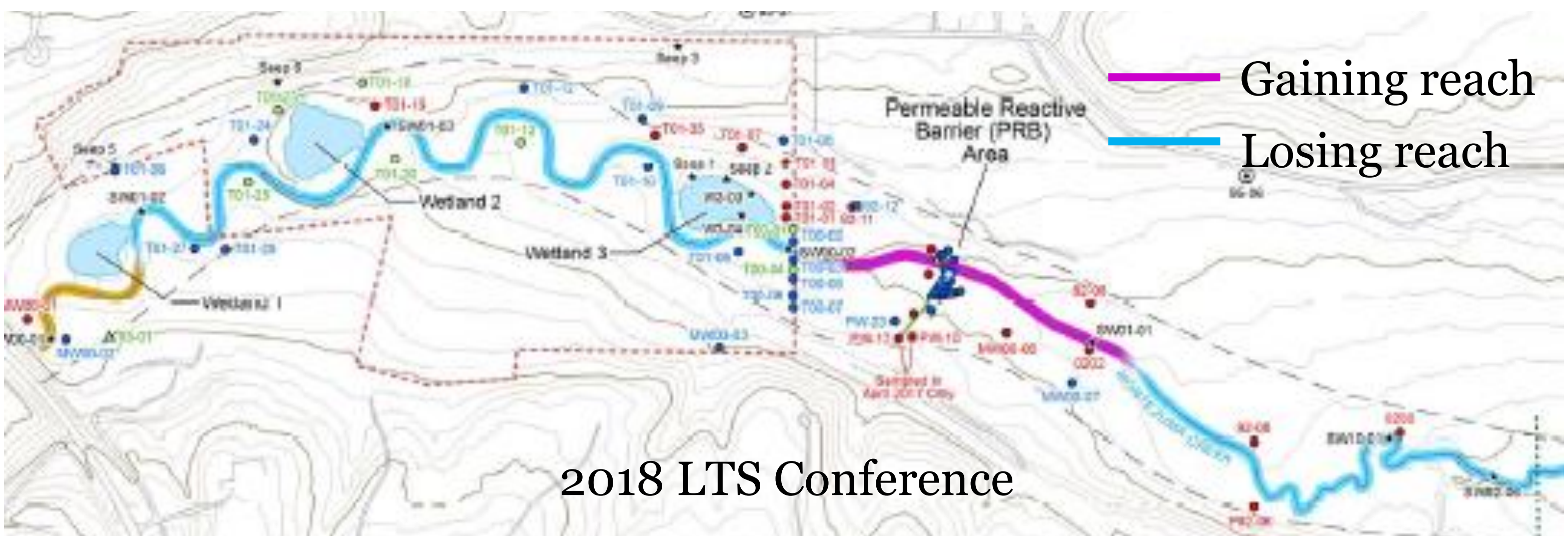
- Already been extensively characterized
- Acceptable human health and environmental risk
  - ICs eliminate exposure pathways
  - Supplemental standards applied to several properties based on risk assessment
- Source control measures already implemented

INCOMPLETE

- Updated conceptual site model for MNA mechanisms, system capacity to sustain MNA, indicators for monitoring performance
- Future trends in U mass, concentrations and metrics for assessing MNA
- Evidence of MNA processes
- Long-term monitoring and contingency plans

Alternate Concentration Limits (ACLs)

- Not viable at this time for MMTS OU III
- Groundwater discharges (variably in time and space) to the creek and may contribute to U detections in surface water
- Does not meet basic ACL criteria for CERCLA sites
  - Additional criteria in EPA 2005 guidance; no recent case studies identified
- As U concentrations in groundwater decline in the future, ACLs may become viable for portions of MMTS OU III



Technical Impracticability (TI) Waiver — More Evaluation is Needed

- Evaluate whether it is "technically impracticable to meet cleanup requirements within a reasonable timeframe"
- Stakeholder consensus is critical
- Conduct a site-specific TI evaluation (EPA 1993)
  - TI zone (area and depth interval)
  - Conceptual site model (CSM)
  - Restoration potential
  - Remedial strategy outside of TI zone
- Document the decision

At MMTS OU III:

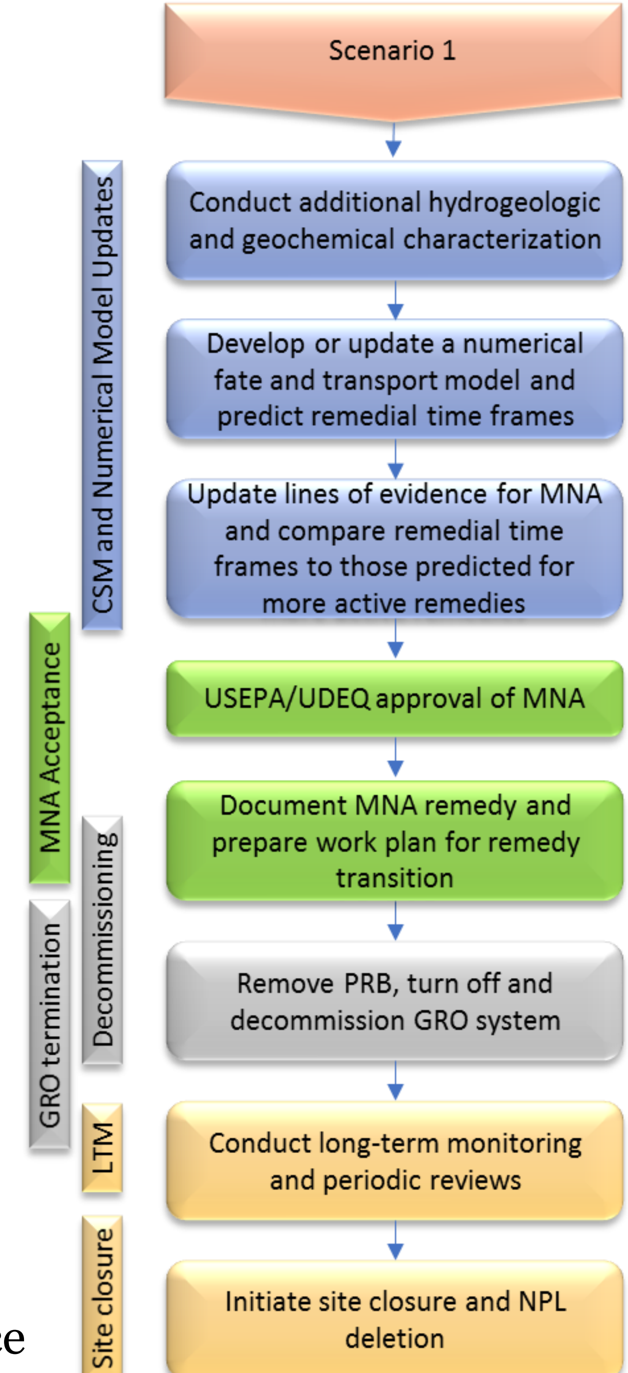
- ✓ Decades of U contact with soils
- ✓ Continued U desorption, dissolution, back-diffusion

Preferred Closure Strategy — MNA and ICs

- Protective of human health and environment
- Consistent with 2004 ROD, accepted by EPA, UDEQ, and DOE
- Consistent with expectations described in previous site reports
- Improvement in CSM and evaluation of other strategies through strengthening MNA basis
- Use of remedial time frame predictions to support TI waiver if MNA is not acceptable

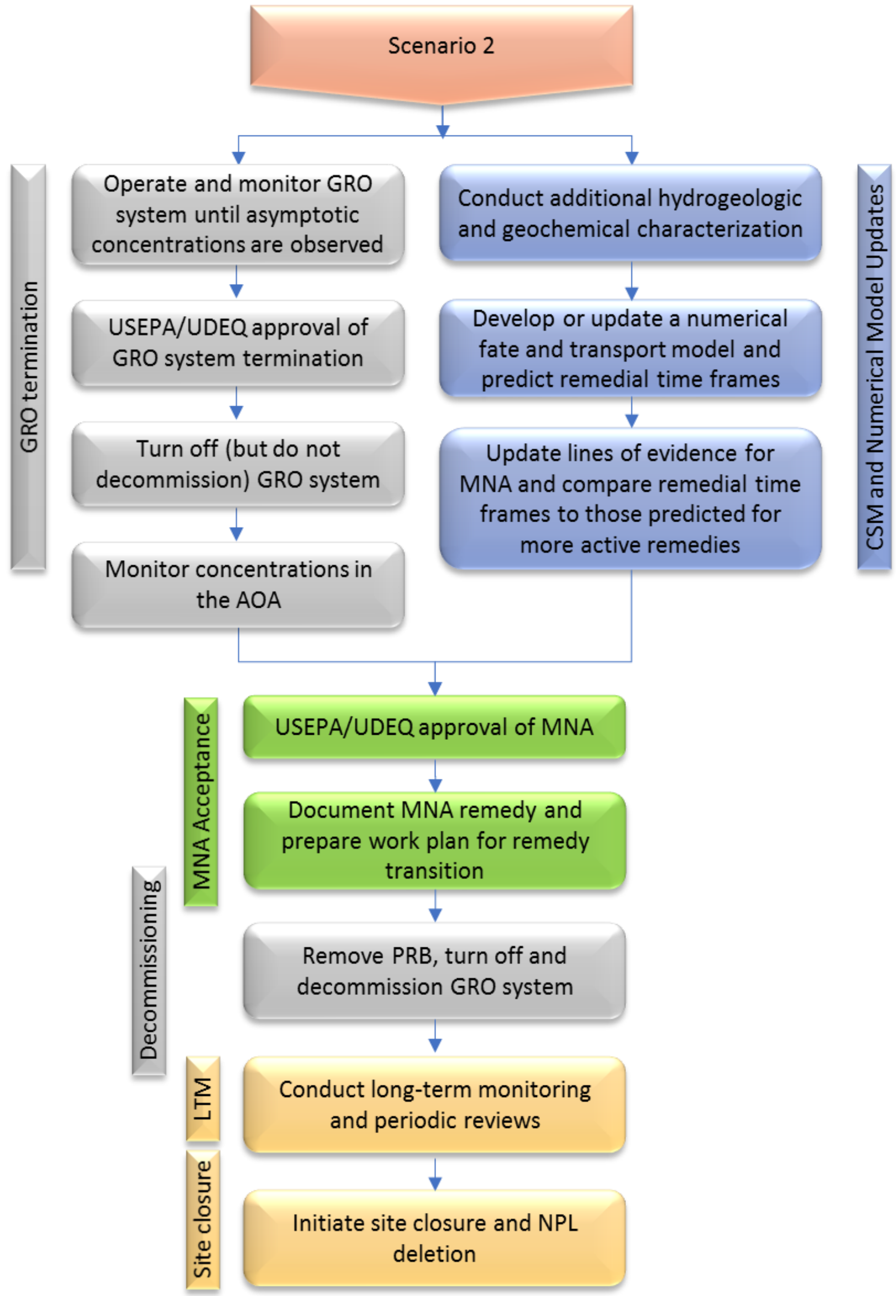
Scenario 1

- CSM updates and numerical model predictions indicate that MNA and ICs are acceptable
- DOE, EPA, and UDEQ approve
- GRO system is terminated, PRB is removed
- Remedy transitions to MNA and ICs

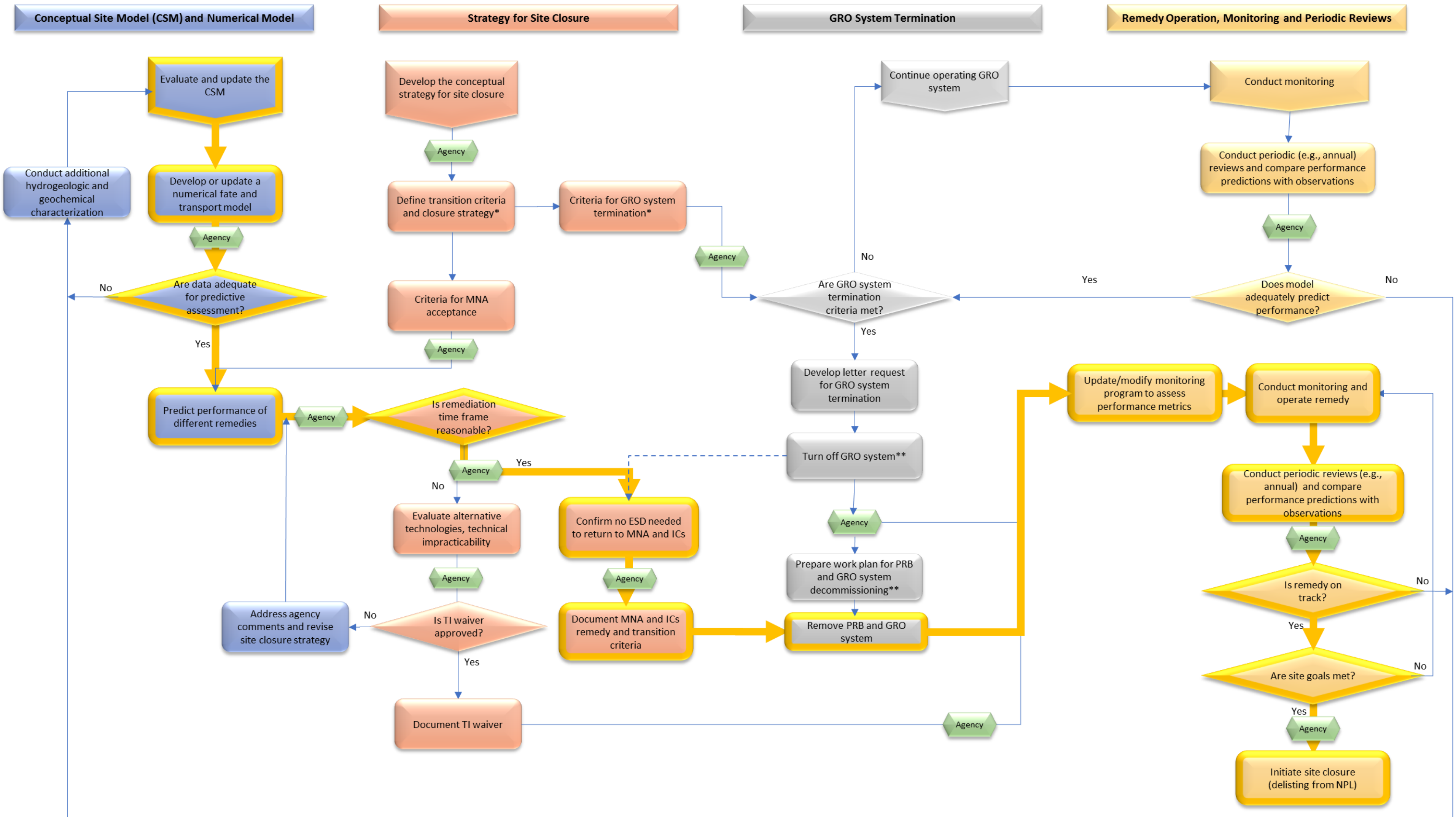


Scenario 2

- Observe asymptotic U concentration trends in AOA monitoring wells
- DOE, EPA, and UDEQ agree to terminate GRO system
- Simultaneously, updated numerical model predicts a remedial time frame for MNA that is acceptable
- GRO system is terminated, PRB is removed
- Remedy transitions to MNA and ICs



If/Then Decision Diagram Example (Scenario 1)



Potential Actions to Transition to MNA, ICs

- Numerical modeling
  - Refine the CSM and numerical model through additional characterization of water budget components
  - Conduct numerical modeling of flow and transport to guide expectations of U concentration trends, predict plume movement, and estimate remedial time frames
- Geochemical studies
  - Conduct bench-scale laboratory studies to evaluate U geochemical behavior
  - Generate data that can be used to improve the CSM and basis for numerical modeling
- MNA lines of evidence
  - Time series analysis of existing and newly-collected water quality data
  - Geochemical studies of U transport
  - Implications of numerical modeling results