# Independent Review of the Chromium Interim Measures Remediation System in Mortandad Canyon Los Alamos, New Mexico

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### **Review Panel Charge Questions:**

- 1. Chromium Plume Control Interim Measure Hydraulic Control
- 2. Chromium Plume Modeling
- NMED Ground Water Quality Bureau Acceptable Corrective Actions and Conditions in September 6, 2023 Letter Appendix A Proposal
- 4. Regulatory Matters
- 5. Well Design

## **Summary of Findings and Recommendations**

Questions 1. Chromium Plume Control Interim Measure Hydraulic Control and 3. NMED Ground Water Quality Bureau Acceptable Corrective Actions and Conditions in September 6, 2023 Letter Appendix A Proposal (Figures 2-2, 3-1, 3-7, and 3-27)

• The IM, at a limited and/or altered capacity, should be restarted as soon as possible.

- The historical configuration and operation of the IM extraction and injection wells likely resulted in incomplete hydraulic containment of the chromium plume.
- The IM needs to be operated in a revised configuration while further analyses improve the remedy.
- Greater effort is needed to obtain consensus on the characterization, modeling, and remediation of the chromium contamination.
- To transition from a limited start-up of the IM to expanded operations, alternative configurations should be considered that may include alternative treated water disposal options.



Figure 2-2. Estimated extents of chromium plume showing monitoring wells, extraction wells (CrEX-1 thru CrEX-5) and injection wells (CrIN-1 thru CrIN-5) and extent of chromium in groundwater as estimated by LANL (2019).



Figure 3-1. Time-series concentrations of chromium (green), nitrate (brown), and sulfate (red) at perimeter monitoring wells in the plume area. The figures were taken from Neptune (2023) with selected locations appended to March 2024 from file Time-Series Quarterly Plots\_FYQ1\_020724.pptx. Plots highlighted in yellow are those with persistent chromium concentrations above background (~6 µg/L).



Figure 3-7. Comparison of effective capture zones, in plan view, inferred in Figure 3-4 (red shaded area) and from two-dimensional models simulating full IM operation (purple line) and partial IM operation with two extraction and two injection wells (red line). Also shown are capture zone limits reported by Neptune (2023) from particle tracking calculations (green line shows capture zone for 50% of particles) and equipotential modeling (blue line, based on hand-drawn contours inferred from three-point problems of hydraulic head). The location of the capture zone boundary with respect to R-70 is in question for all but the two-dimensional, full IM model simulation. The capture zone in that case is only roughly estimated, and should not be regarded as highly accurate. Nonetheless, it suggests a meaningful expansion of the capture zone between partial and full IM operation.



Figure 3-27. NMED's proposed interim measure restart configuration (Letter #3).

## Question 2. Chromium Plume Modeling (Figure 3-19A and Table 3-2)

- Certain aspects of the conceptual site model (CSM) should be reevaluated. In particular, the following should be reassessed:
  - Role of stratigraphy and property contrasts between major hydrostratigraphic units (HSUs) on model design, lateral and vertical hydraulic containment, and contaminant fate and transport.
  - Evaluation of the site-wide measured and estimated horizontal hydraulic conductivity  $(KK_h)$  and vertical hydraulic conductivity  $(KK_{vv})$  values. This evaluation will require understanding to a depth substantially greater than the depth of the plume, including the depths of the PM-series wells.
  - Causes of relatively small (flat) horizontal hydraulic gradient and significance of the notable downward vertical gradients in the IM area.
  - Role of the nearby water supply wells in vertical gradients and lateral and vertical plume migration and spread.
  - Further investigation of potential vadose zone sources of Cr(VI) contributing to the groundwater plume and their impacts through alternative conceptualization of location of fluxes and their time-dependent contributions.
- Transition to a groundwater flow and transport simulator (e.g., MODFLOW-6) that has a wider user community with wellestablished application areas.



Figure 3-19A. Schematic hydrogeologic conceptual site model (CSM) for site modeling purposes: Full section.

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 Table 3-2.
 Comparison of Modeling Platforms

#### Question 4. Regulatory Matters

- Implement an adaptive site management (ASM) strategy.
- Many of the recommendations developed by the IRT would benefit from close collaboration between DOE-EM-LA, NMED, and other stakeholders.

#### Question 5. Well Design (Table 3-3)

 Chromium investigation and remediation efforts would benefit from more rapid and cost-effective drilling and well installation procedures. To facilitate this, the IRT recommends:

- Using coated bentonite granules below the water table (ending just above the capillary fringe) and then using cement throughout the entire vadose zone. Uncoated bentonite granules would be an appropriate alternative to cement for the vadose zone due to their ability to swell in the presence of perched water.
- It would be enormously beneficial if the New Mexico Office of the State Engineer (OSE) would permit dual-screen monitoring wells to be constructed.

	Cement	Cement with Bentonite	Bentonite Slurry	Uncoated Bentonite Chips	Uncoated Bentonite Granules	Coated Bentonite Granules
performance in groundwater zone	*	*	0	6	0	*
performance in vadose zone	0	6	0	<u>©</u>	0	<u>@</u>
geochemical impacts (nominal)	*	*	*	*	*	*
deployment logistics						
field logistics	*	*	0	0	*	•
tremie logistics	*	*	•	0	*	•
tagging logistics	0	0	0	*	*	*
timing logistics (groundwater zone)	0	0	0	6	6	0
Resilience (e.g., self-healing) in perched vadose interval	۲	0	0	0	0	0
potential for adverse collateral impacts						
Geochemical impacts (incursion into screen zone)	0	0	0	0	0	0
leaking/cracking risks (groundwater zone)	*	*	٠	0	0	٠
leaking/cracking risks (vadose zone)	0	0	0	0	0	0
key>	*	= good				
	0	= acceptable	_			
	0	= poor				

#### Table 3-3.Key Characteristics of Potential Annular Sealants for LANL Wells