



ICMGP 2024
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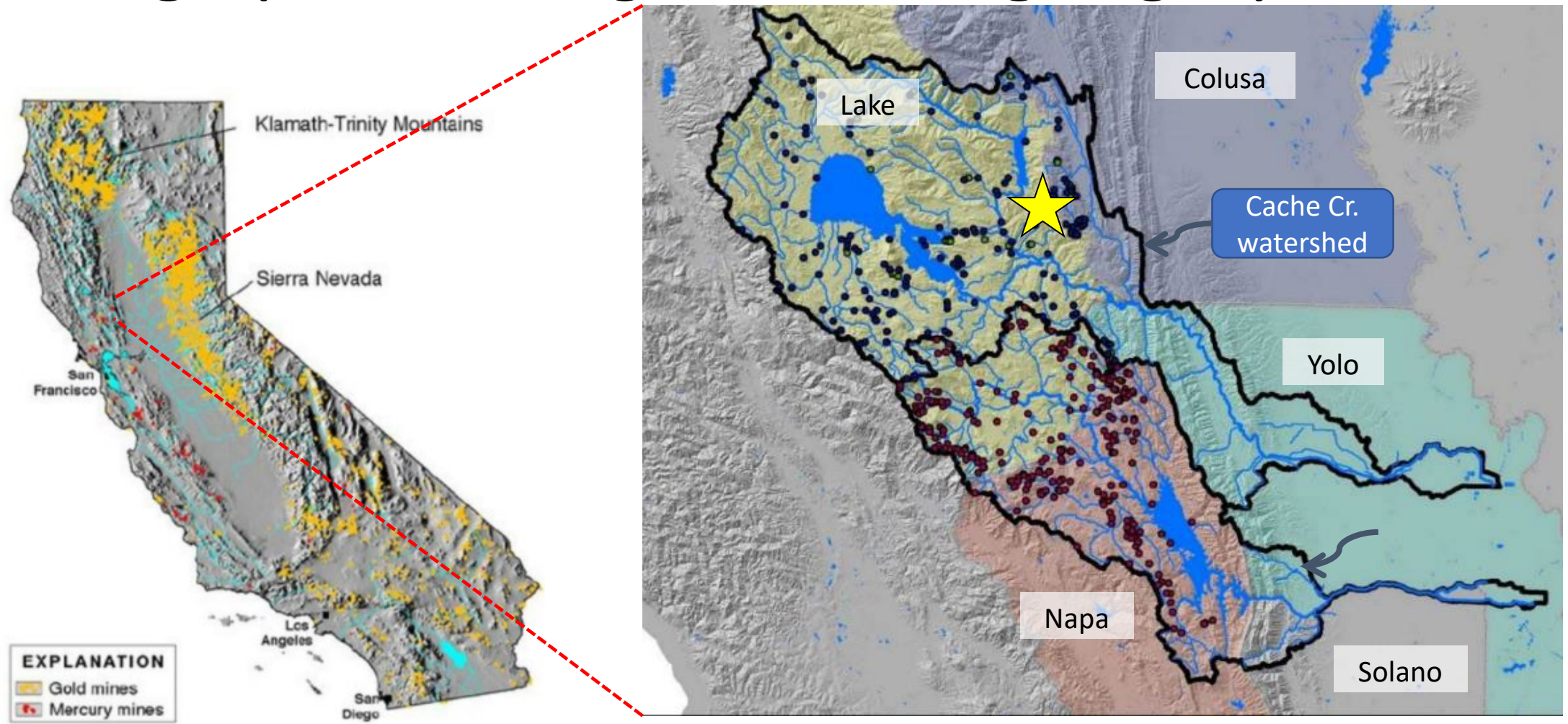
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In-Situ Remediation of Mercury-
Contaminated Mining Calcines Using
MercLok™ P-640



Geographic Setting and Mining Legacy



Calcine Management Options

Default/General Practice:

- Off-site transport for disposal as a hazardous waste
- On-site engineered repository with liner(s); surface & groundwater monitoring



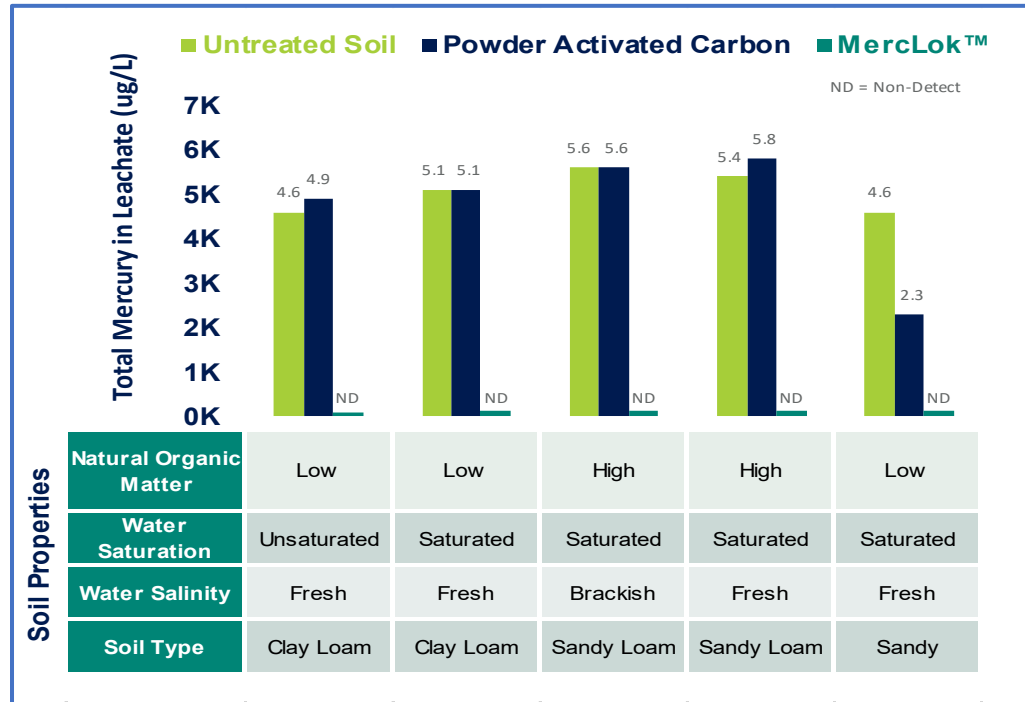
Conceptual Alternative:

Amend & manage on-site in accordance with Title 27:

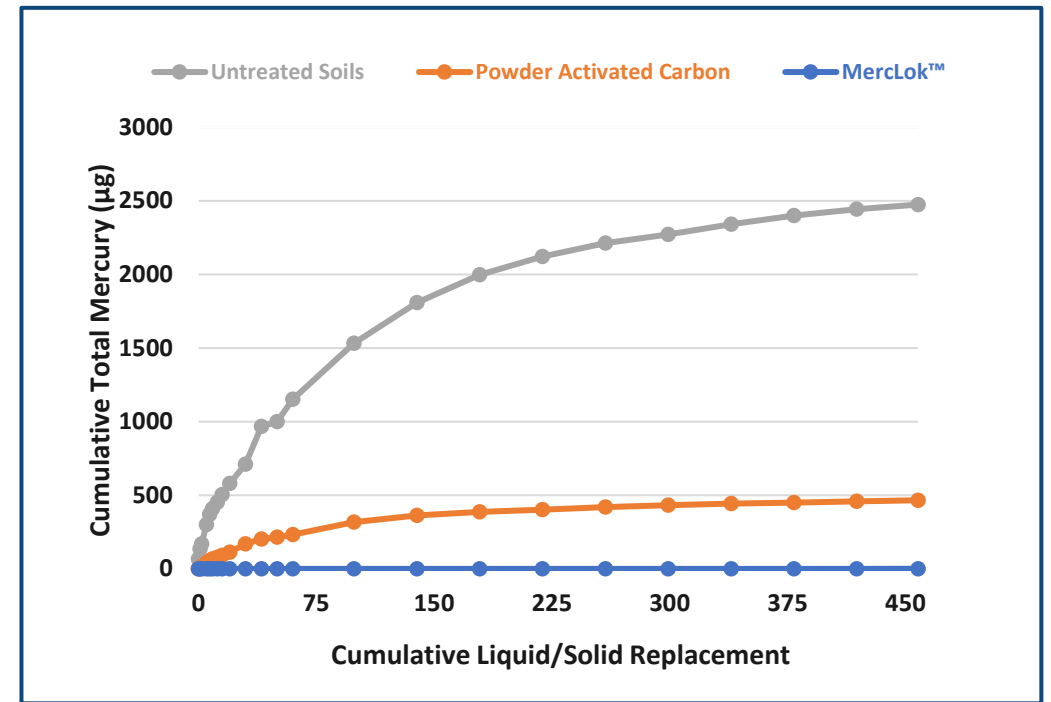
- Minimize Hg leachability (<0.2 mg/L by STLC hazardous material limit)
- Title 27-compliant with exemptions: no liner & minimal monitoring



Source Control



- The soils treated with **Merclok P-640** showed reductions in the amount of leachable mercury by over 99%
- Leachability of treated soils is not subject to interference by presence of natural organic mater, soil type, salinity, or saturation.
 - Data indicates similar performance across a wide range of pH.



- The column treated with **Merclok P-640** showed 99.9% reduction in cumulative mercury leached from the soil.
- The stability of mercury on **Merclok P-640** treated material was maintained even when extending the cumulative liquid/ solid (L/S) replacement in the EPA Method 1314 to 45 times more than the prescribed value of 10 L/S.



Pilot Study Calcine Categorization

Material	Location	Total Hg (mg/kg)	Cal WET (mg/L)	DI-WET (µg/l)
Calcines	AOC-6	360	0.025	0.3
	AOC-4	750	0.39	5.6
	AOC-X	2,700	1.1	51
Background Soil	B-1	11	0.0024	0.26
Regulatory Limit	---	<20	<0.2	<0.05

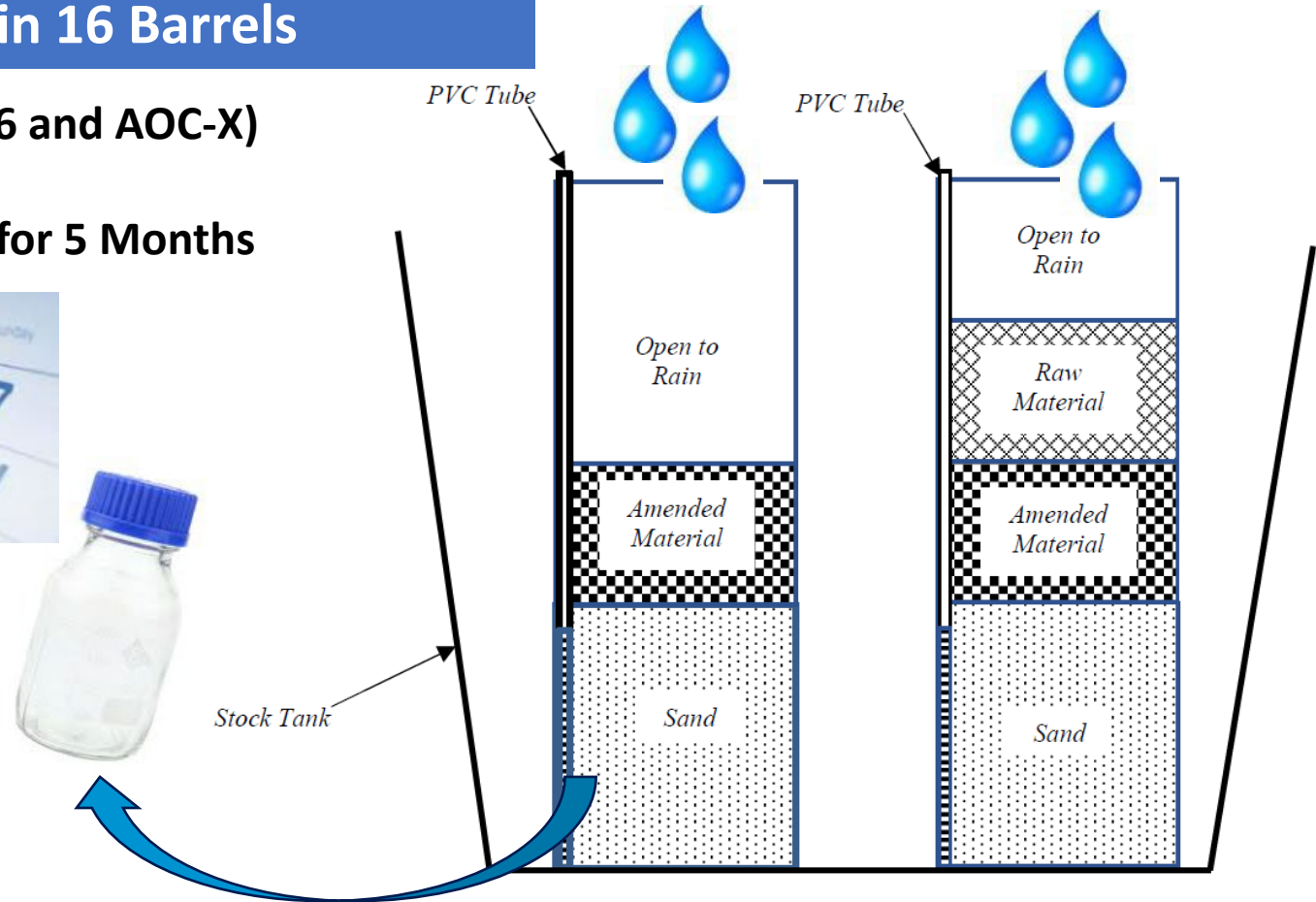


Pilot Study



Pilot Study in 16 Barrels

- **Two Materials (AOC-6 and AOC-X)**
- **Two Techniques**
- **Exposed to Weather for 5 Months**

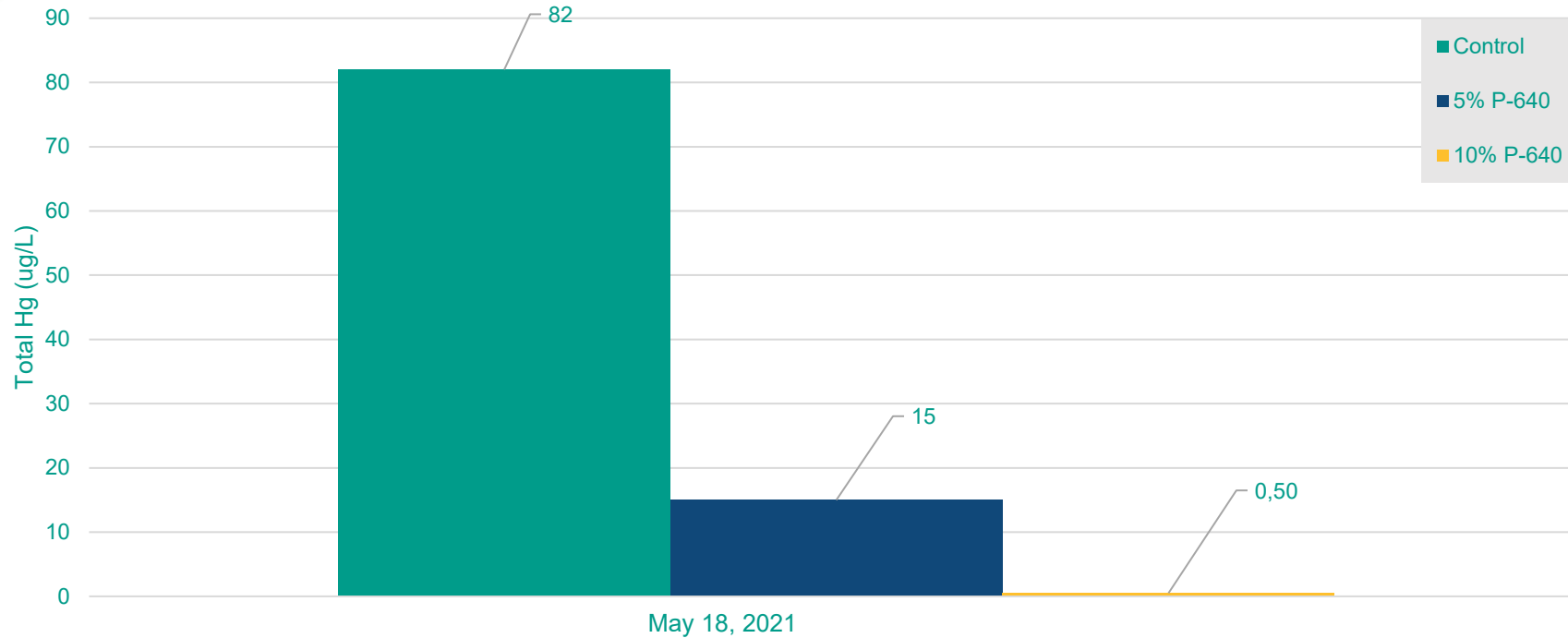


AOC-X Leachability of Solids



Solids Sampled after 5 Months

DI-WET Extraction Test of AOC-X



Up to 99% Reduction by DI Wet Method

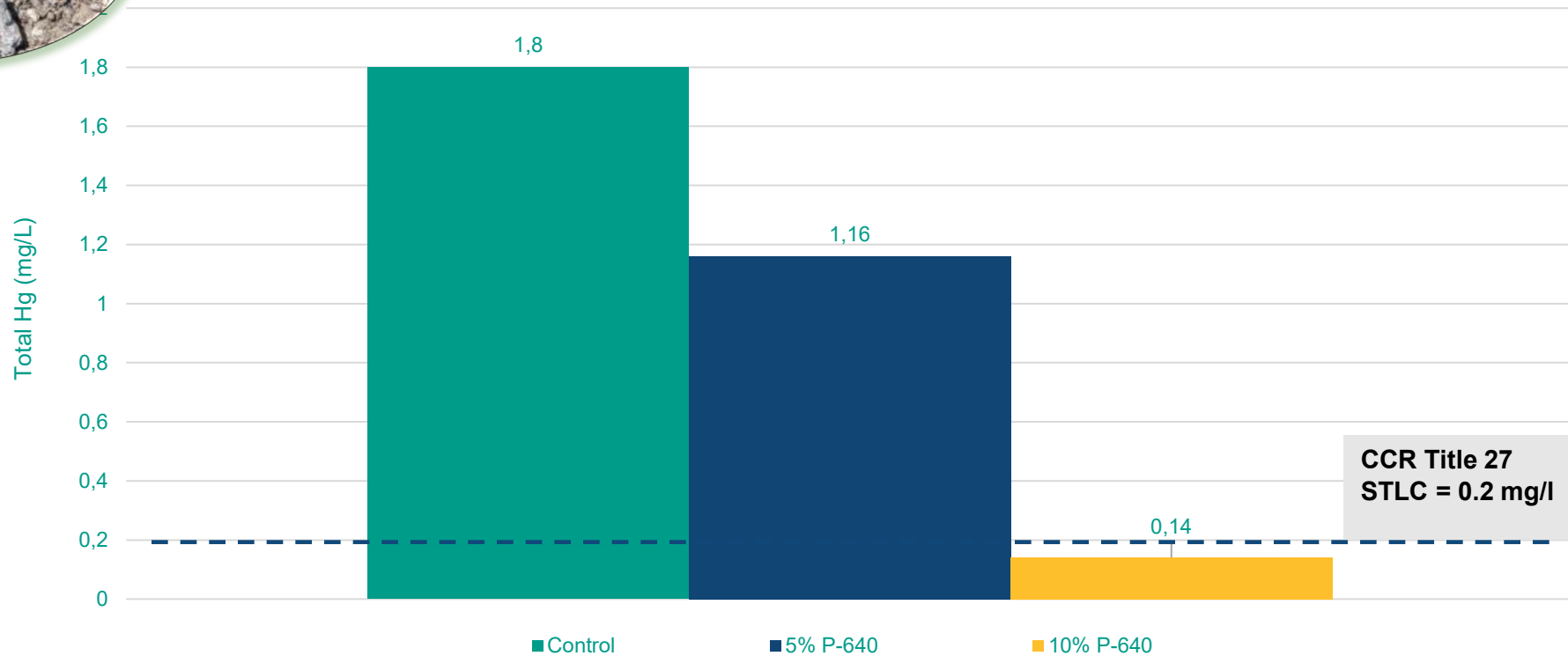


AOC-X Leachability of Solids



AOC-X Results of Solids Sampled after 5 Months

WET Extract Comparison with STLC, AOC-X - May 18, 2022

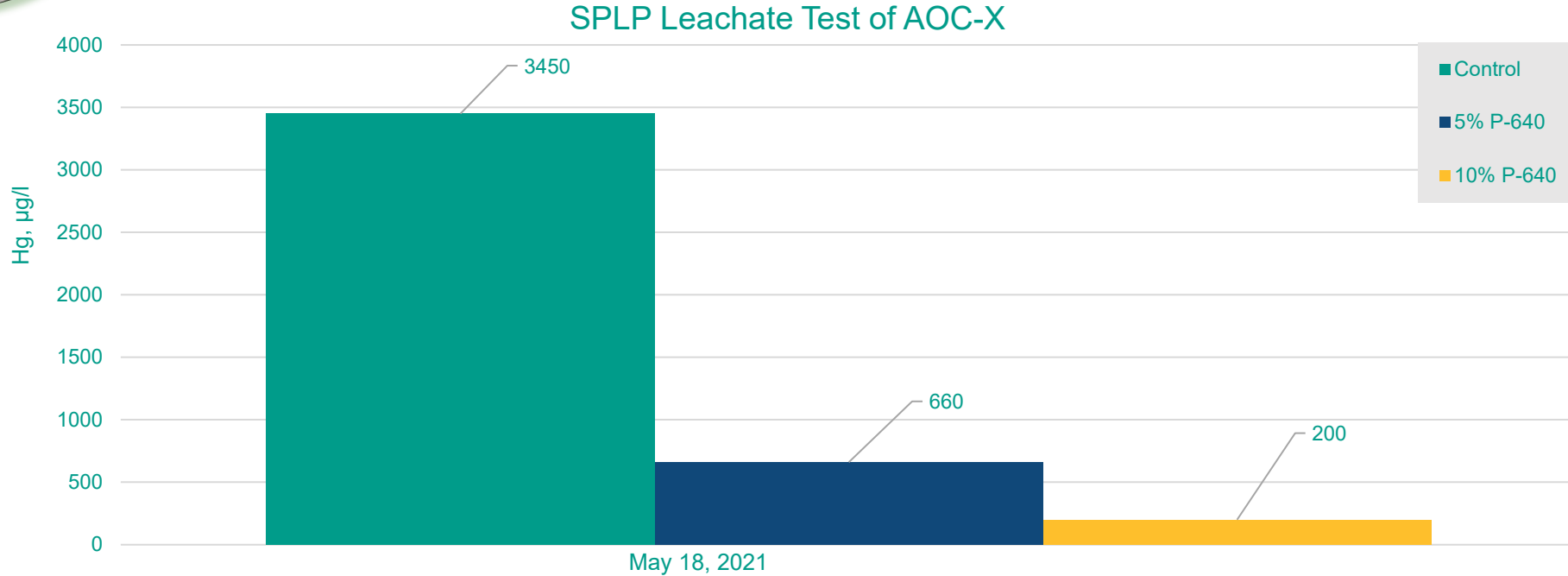


STLC Reduced to <0.2 Limit



AOC-X Leachability of Solids

Hg Leaching Tests of Solids Removed from the Barrels after 5 Months



Up to 96% Reduction by SPLP Method

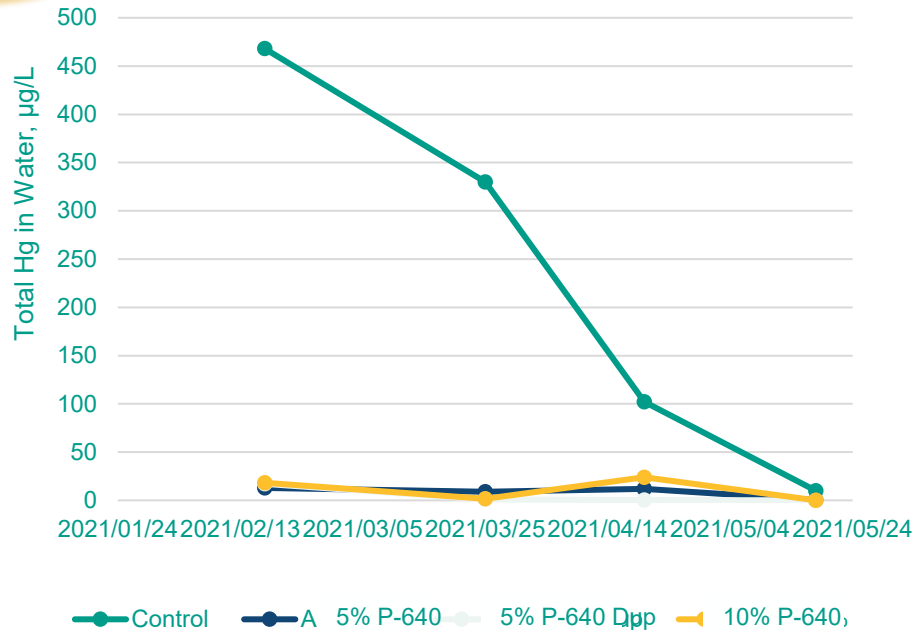


AOC-X Rainwater Concentrations



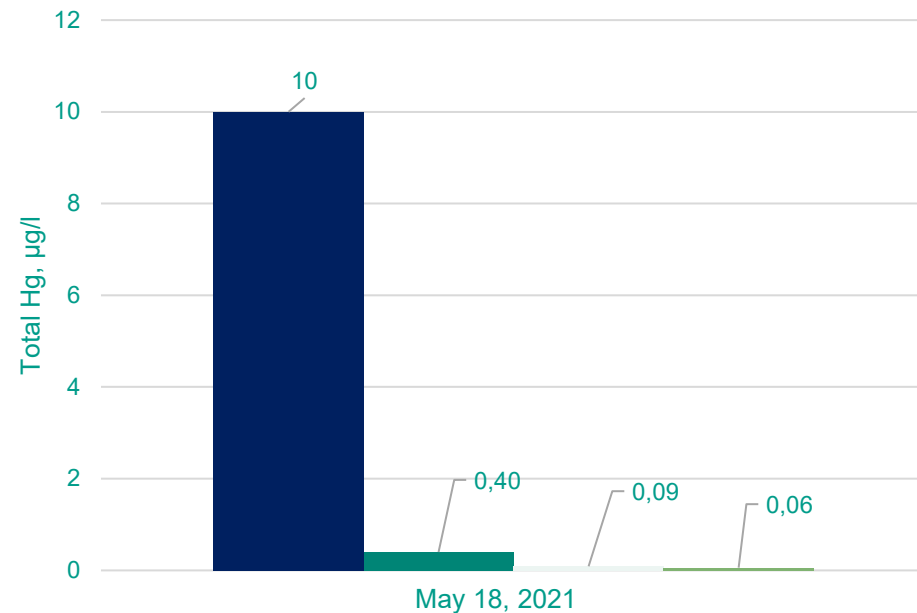
Leaching of Calcines in Barrels by Rainwater

Total Hg in Leachate from AOC-X



96%-97% Reduction After 1 Month

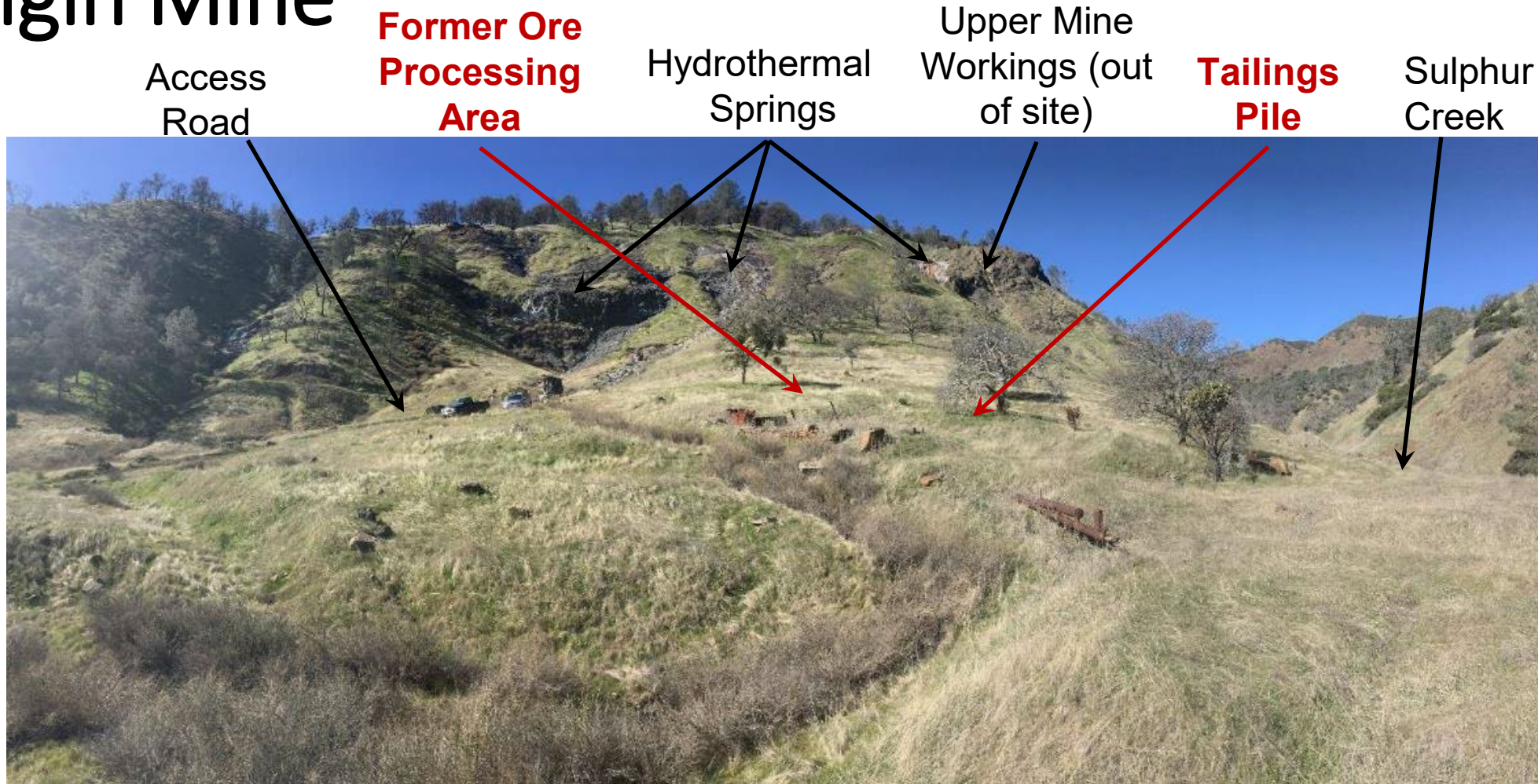
Total Hg in Leachate from AOC-X, May 2021



96%-99% Reduction After 5 Months



Elgin Mine



Panoramic view of Elgin Mine from Sulphur Creek, view to west. Remnant processing equipment is in foreground, hot spring seeps are above on the steep slope, and mine workings are in the upper right (beyond rock).

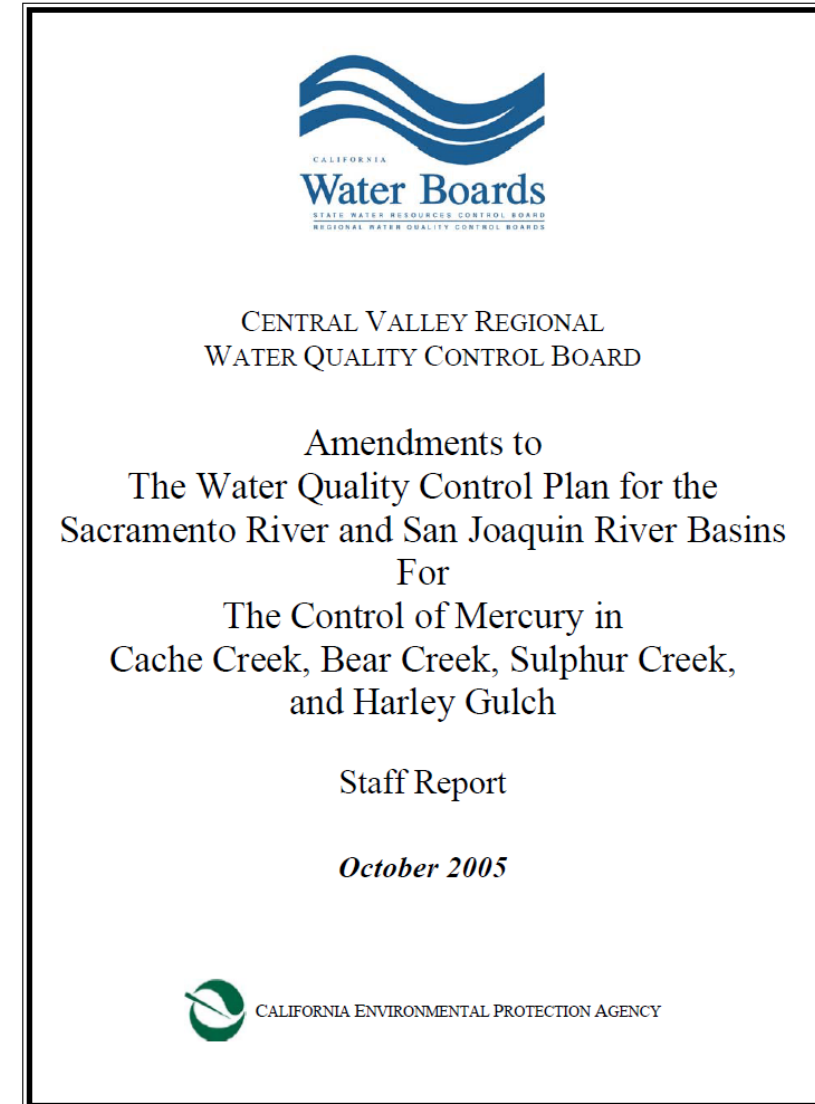


Regulatory Plan 2005

- Sulphur Creek Hg TMDL:
est. 3 kg THg/yr
- Remediation Goal: 95%
THg load reduction

Regulatory Order - 2009

- 4,000 yd³ waste rock: \$400K +
\$18.5K/yr O&M
- 0.3 cfs hotspring: \$800K + \$300K/yr
O&M



Revised Plan

- **Crossings** - protect road, restore original flow of hydrothermal spring (away from calcine material)
- **Earth Berm** - control run-on
- **Treated Calcines** - minimize Hg mobility
- **Brick repository** - prevent exposure
- **Reactive Barriers** - control seepage



Calcine Characterization and Testing

Table 4: Comparison of Mercury in Untreated and Amended Calcines

Material	Total Hg mg/kg (wet weight)	TCLP Extract Hg mg/L	STLC Extract Hg mg/L	DI WET Extract Hg mg/L
Untreated Retort Calcines	379	<0.010	0.441	0.2
Amended Retort Calcines	239 to 318	NA	0.119 to 0.184	<0.0010
N Pile Calcines	865	0.0496	1.13	3.46
Background Soil	259	<0.010	0.0224	0.0445
Regulatory Threshold	20	0.2	0.2	0.00005

Notes: TCLP = Toxicity Characteristic Leaching Potential

STLC = soluble Limit Threshold Concentration

DI WET = Deionized Waste Extraction Test

mg/kg = milligrams per kilogram

mg/L = milligrams per liter



Application

900 lb. P-640 + 160 gal. water



Cap/Calcine Mixing

- Grid areas for even dosing
- Manual & machine to spread, mix, level (5% P-640)
- Spray water to distribute/flatten, maintain dust control.

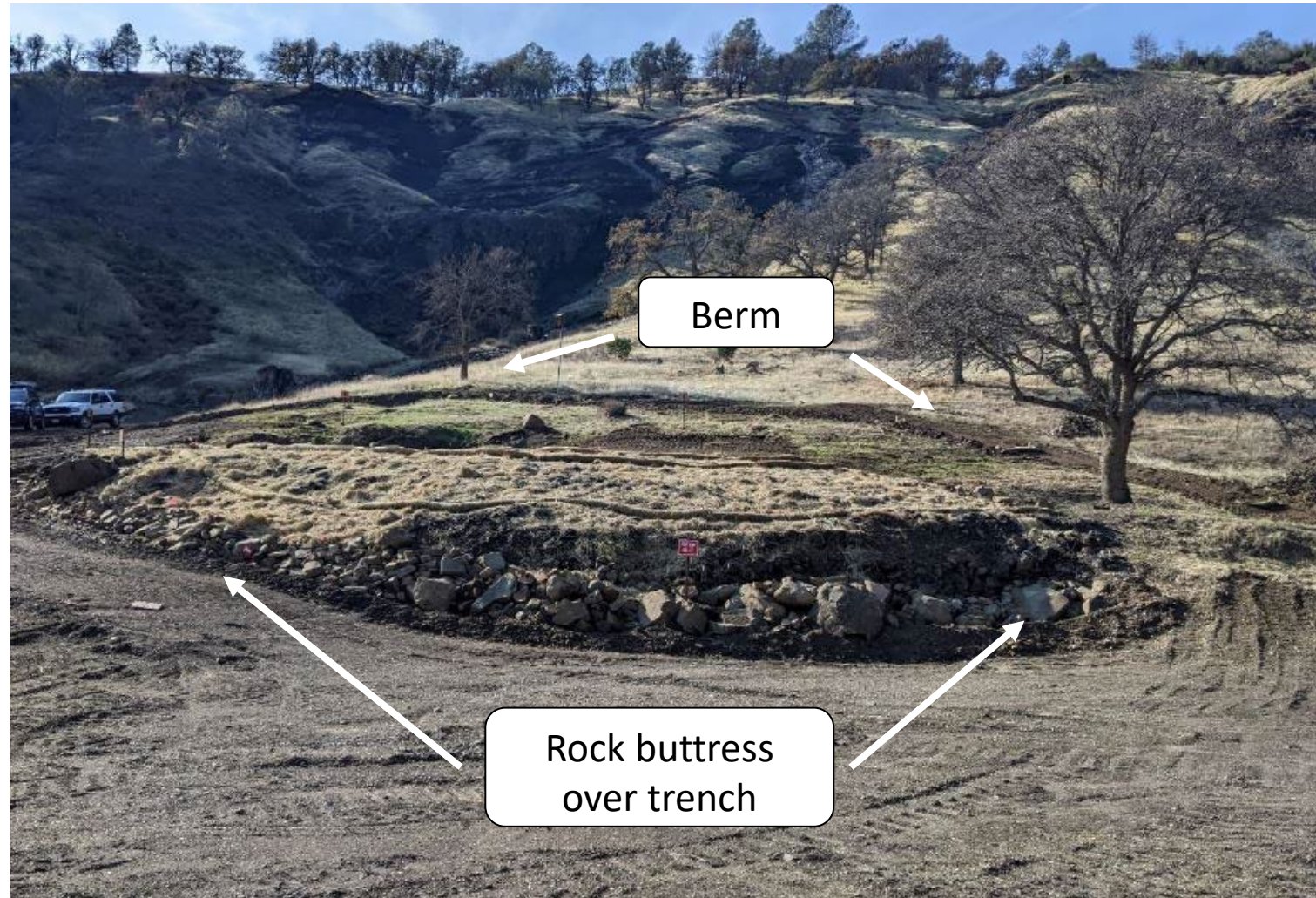


Reactive Barrier

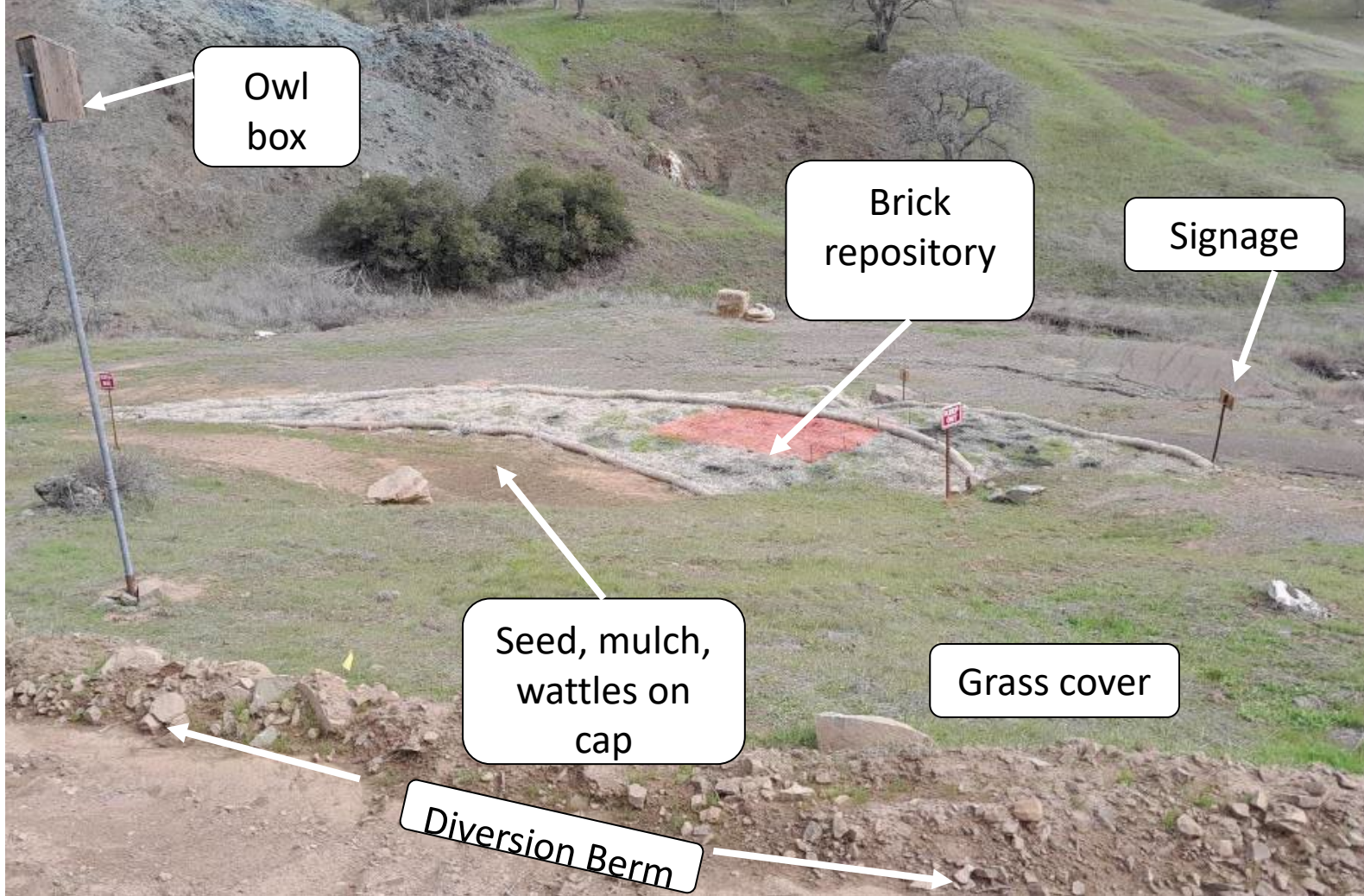
10% P640, 90% sandy fill



Hydraulic Controls and Slope Reinforcement



Site Near Completion



Results

Material	Total Hg (mg/kg wet wt.)	TCLP Extract Hg (mg/L)	STLC Extract Hg (mg/L)	DI WET Extract Hg (mg/L)
N Pile Calcines	865	0.0496	1.13	3.46
Untreated Retort Calcines	379	<0.010	0.441	0.2
Amended Retort Calcines	239-318	NA	0.119-0.184	<0.0010
Trench 1	19.9	NA	NA	NA
Trench 2	25.3	NA	0.00548	<0.0010
Area 1	66.9	NA	0.00710	<0.0010
Area 1 Duplicate	27.7	NA	0.00621	<0.0010
Area 2	48.5	NA	0.00493	<0.0010
Hg naturally high → Background Soil	259	<0.010	0.0224	0.0445
Regulatory Thresholds*	20	0.2	0.2	0.00005

Combined Calcine/Cap Materials

MercLok significantly lowered leachable Hg



Restored Site After 6 Months



Q&A



Elgin Mine Site in May 2024

For more information about MercLok™ P640



The Albemarle-funded projects were supported by the collaborative efforts of:



BURLESON CONSULTING INC.
A Terracon COMPANY



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