

Combined Remedy for Rapid Redevelopment of Multi-Acre TCE and 1,4-Dioxane Plumes

Prasad Kakarla, P.E.

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Site History

- 23.65 acre parcel
- Former industrial operations began at site in 1937
 - Smoke & carbon monoxide detectors
 - Produced 1st portable fire extinguisher
 - Industrial fire suppression system
- Innovations during World War II
 - Self-inflating life rafts & flotation vests
 - Specially designed fire extinguishers for tanks & aircraft
 - Fire suppression systems for aircraft engines
 - Compressed oxygen systems for bomber crews

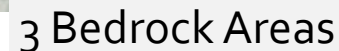


Site History

- Operations ceased in early 1980s
 - Buildings demolished
 - Millions of dollars of tax revenue lost by town
- TCE contaminated groundwater
 - Lawsuit over the contamination in 2010s
- Rehabilitation Plan approved by town in 2019
 - Identifies path for redevelopment
- Property transfer in 2021
- New property owner wanted to initiate construction ASAP



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- Figure 1. Geologic cross-section and map view of the study area.**
- (A) Geologic Cross-Section:** This diagram shows a vertical profile of the subsurface. The vertical axis represents elevation in feet, ranging from 60 at the top to -260 at the bottom. The horizontal axis represents distance, with specific monitoring wells labeled: MW-1500, MW-1502, MW-1504, MW-1506, MW-1508, MW-1510, MW-1512, MW-1514, MW-1516, MW-1518, MW-1520, MW-1522, MW-1524, MW-1526, MW-1528, MW-1530, MW-1532, MW-1534, MW-1536, MW-1538, MW-1540, MW-1542, MW-1544, MW-1546, MW-1548, MW-1550, MW-1552, MW-1554, MW-1556, MW-1558, MW-1560, MW-1562, MW-1564, MW-1566, MW-1568, MW-1570, MW-1572, MW-1574, MW-1576, MW-1578, MW-1580, MW-1582, MW-1584, MW-1586, MW-1588, MW-1590, MW-1592, MW-1594, MW-1596, MW-1598, MW-1600, MW-1602, MW-1604, MW-1606, MW-1608, MW-1610, MW-1612, MW-1614, MW-1616, MW-1618, MW-1620, MW-1622, MW-1624, MW-1626, MW-1628, MW-1630, MW-1632, MW-1634, MW-1636, MW-1638, MW-1640, MW-1642, MW-1644, MW-1646, MW-1648, MW-1650, MW-1652, MW-1654, MW-1656, MW-1658, MW-1660, MW-1662, MW-1664, MW-1666, MW-1668, MW-1670, MW-1672, MW-1674, MW-1676, MW-1678, MW-1680, MW-1682, MW-1684, MW-1686, MW-1688, MW-1690, MW-1692, MW-1694, MW-1696, MW-1698, MW-1700, MW-1702, 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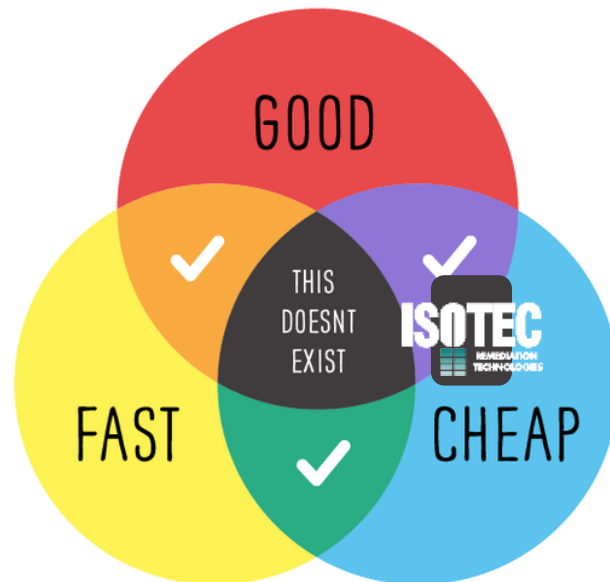
Remediation Overview

- Overburden & bedrock impacted with chlorinated VOCs & 1,4-dioxane
 - TCE = primary COC in all areas
 - CVOCS > 50,000 ug/l in some wells
 - 1,4-Dioxane = primary COC in upgradient areas >150 ug/l in some wells
- Remedial objective - effectively reduce contaminant concentrations with a single injection mobilization to advance the site into the state MNA program.
- Targeted Treatment Areas
 - TCE > 100 ug/L
 - 1,4-Dioxane > 20 ug/L
 - Areas not well characterized
(1 well per 10,000 to 20,000+ sq ft)

Treatment Area	Area (sq ft)	Depth (ft bgs)	Technology
OB-1	27,200	10 – 30	ISCO
OB-2	15,000	10 – 30	
BR-1	71,000	50 – 95	
BR-2	52,000	50 – 90	
OB-3	27,000	10 – 35	EISD
OB-4	126,000	35 – 60	
BR-3	51,000	65 – 90	

Remediation APPROACH

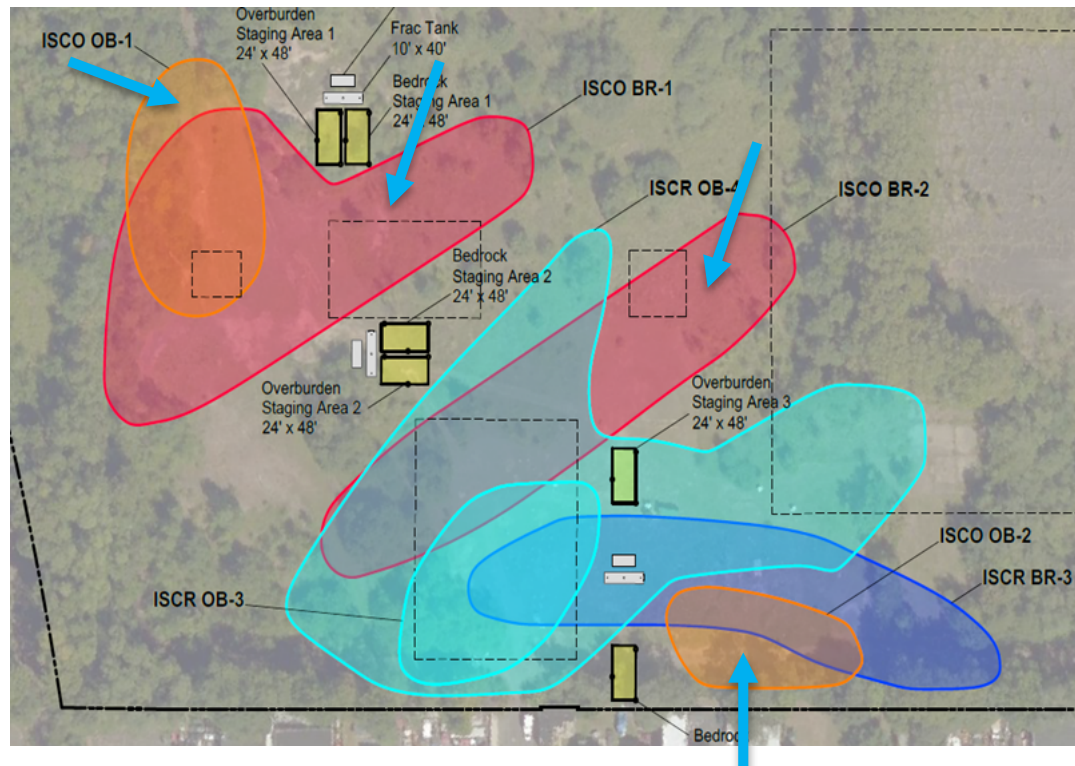
- Sequencing Remediation Activities
 - 2 – 3 injection crews for 6 months
 - ISOTEC on-site within 3 weeks after notice to proceed
 - Coordinate with construction activities (i.e. clearing and grubbing, earthwork, etc.)
 - Bedrock drilling occurred concurrently with overburden injection
- Optimize contaminant contact
 - Two DPT rigs on site
 - Closer injection spacing
 - Smaller injection intervals



HEINLEY

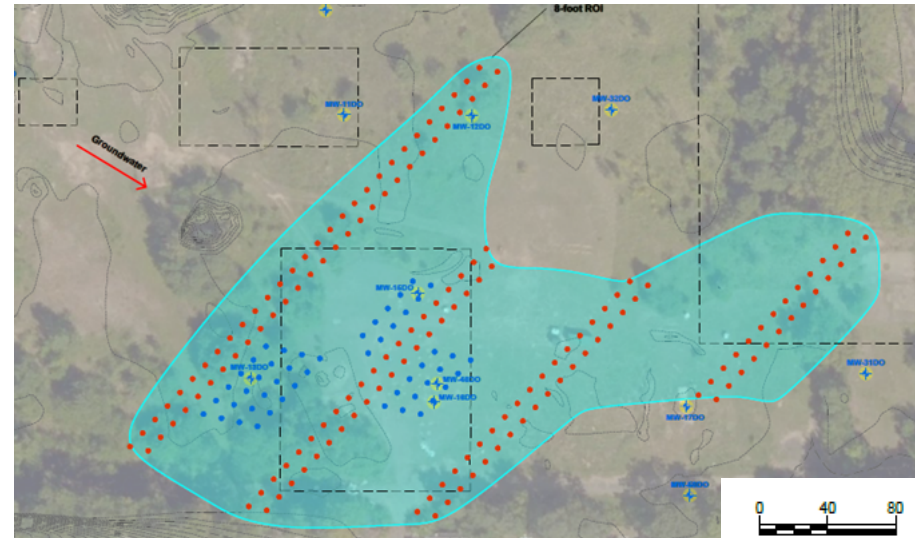
In-situ chemical oxidation

- 4 Treatment Areas
 - ISCO where TCE and 1,4-Dioxane above treatment targets
 - 2 Overburden treatment areas
 - 2 Bedrock treatment areas
- Combined oxidant approach
 - Modified Fenton's Reagent (stabilized H_2O_2 catalyzed by chelated Fe)
 - Enhance desorption, treatment for chlorinated ethanes
 - Activated Sodium Persulfate
 - Persistent oxidant (months)
- Low pressure injection
 - Overburden and bedrock



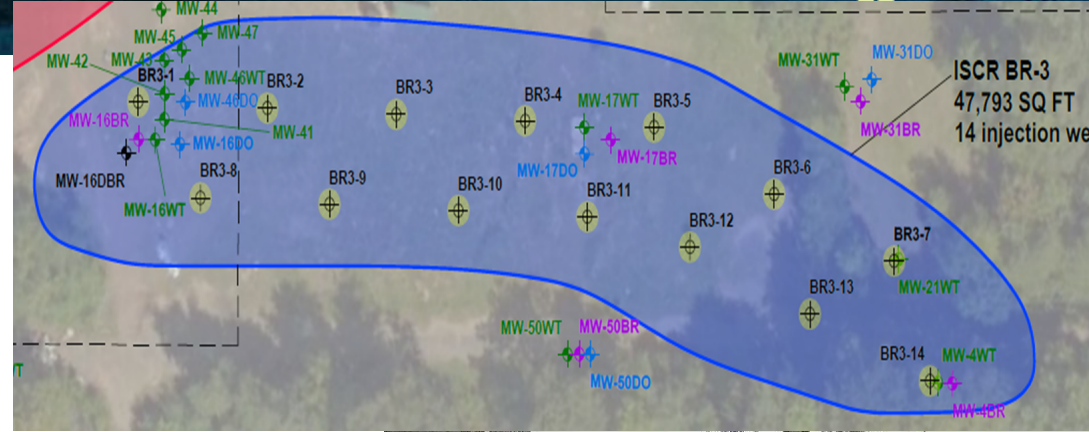
Enhanced In-Situ Dechlorination Overburden

- 2 Overburden areas of concern
- Multiple components
 - Small droplet EVO (SRS®-SD)
 - Sulfidated ZVI (SRS®-Z) – 4 micron
 - Bioaugmentation (DHC+DHB)
 - Nutrient blend (N, P) + sulfate (Nutrimax®)
- Injection points
 - Hot spot grids
 - Permeable reactive barriers (>1,100 LF)

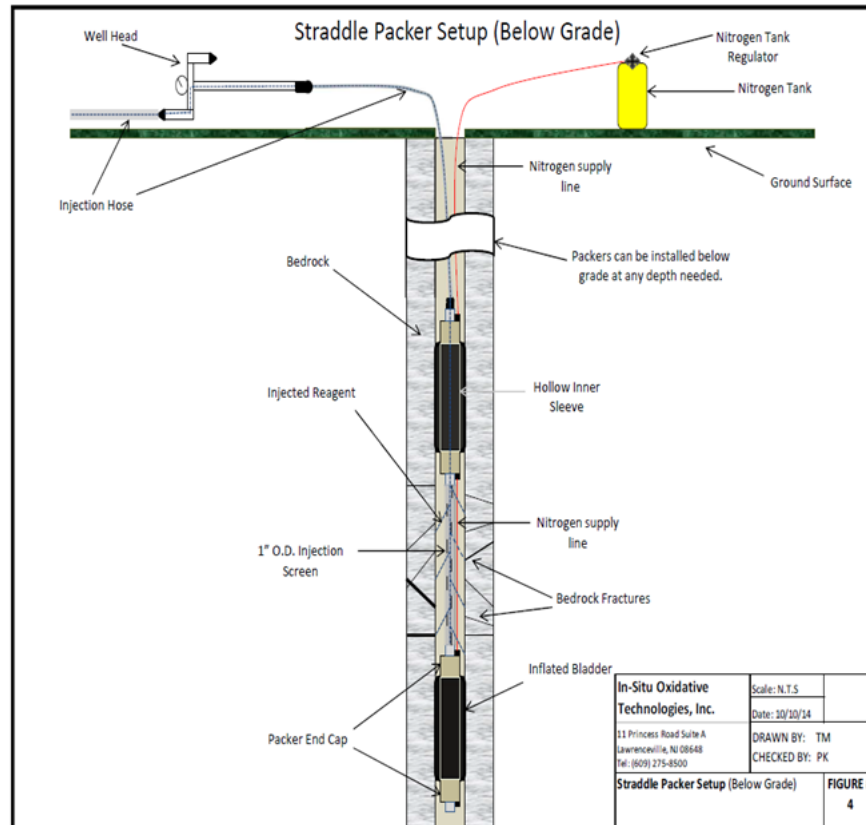
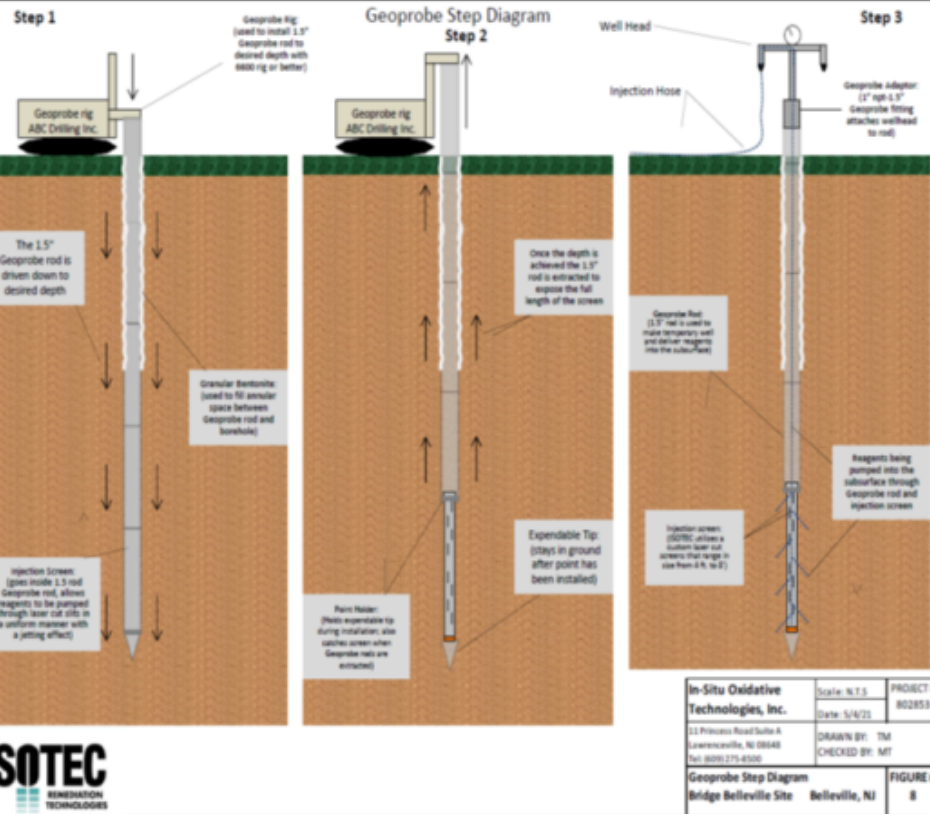


Enhanced In-Situ Dechlorination - Bedrock

- 1 Bedrock treatment area
- EISD focused for treating fractures
 - Large Droplet EVO
 - Sulfidated ZVI (SRS®-Z)
 - ~11% 4 micron
 - ~89% 44 micron
 - Bioaugmentation (DHC+DHB)
 - Nutrient blend (N, P) + sulfate (Nutrimax®)
- Open-Hole Bedrock Injection Wells
 - Straddle packers to target identified fractures



INJECTION METHODS

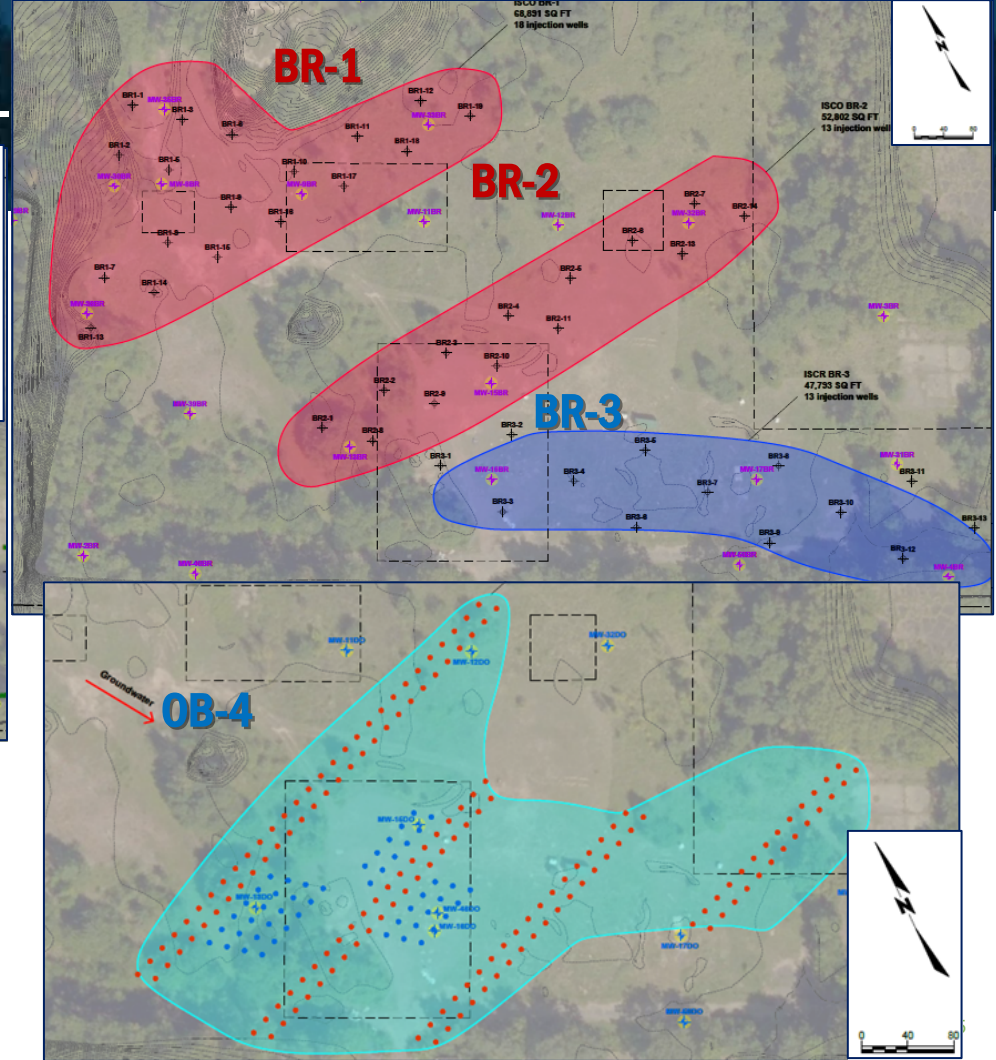
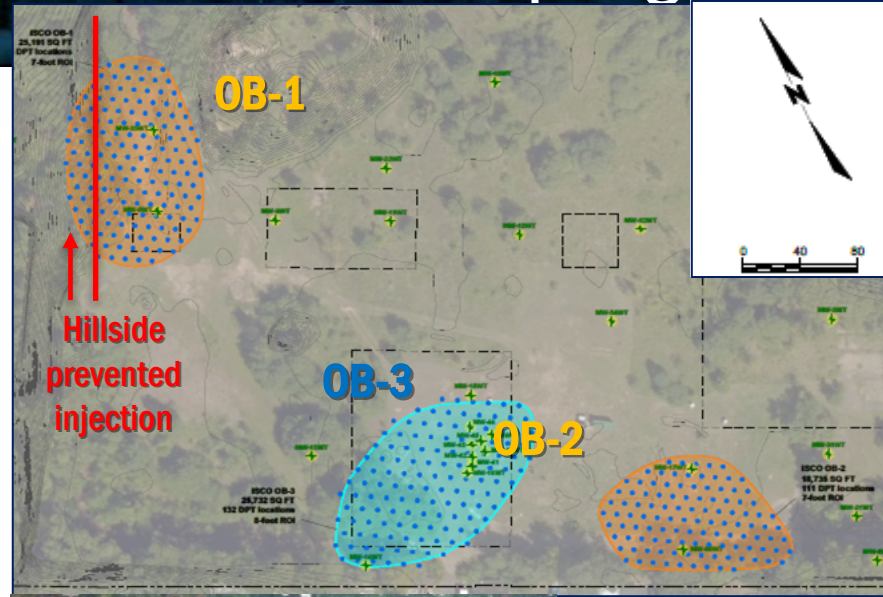


Remediation program – Phase 1

- Injection work completed within 180-day window under injection permit
- Remedial injections performed in parallel with construction activities
 - Clearing
 - Excavations
 - Ground improvement



Remediation program —



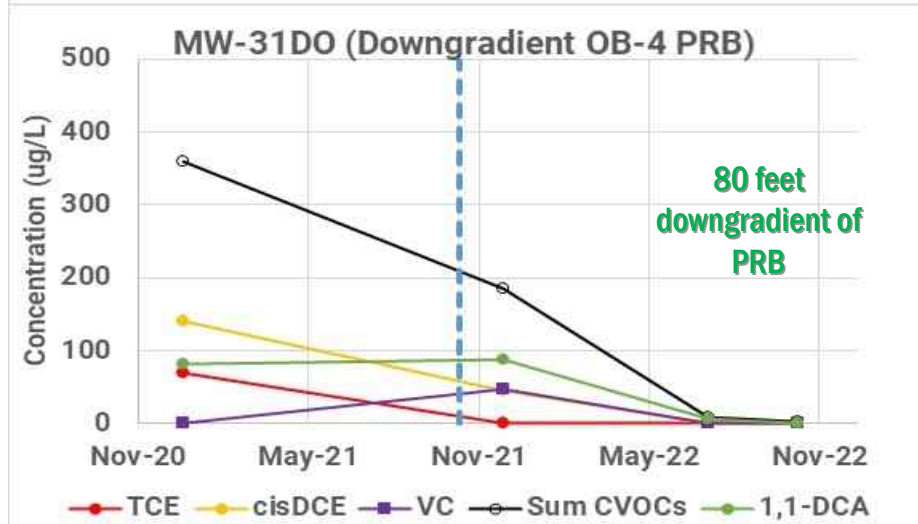
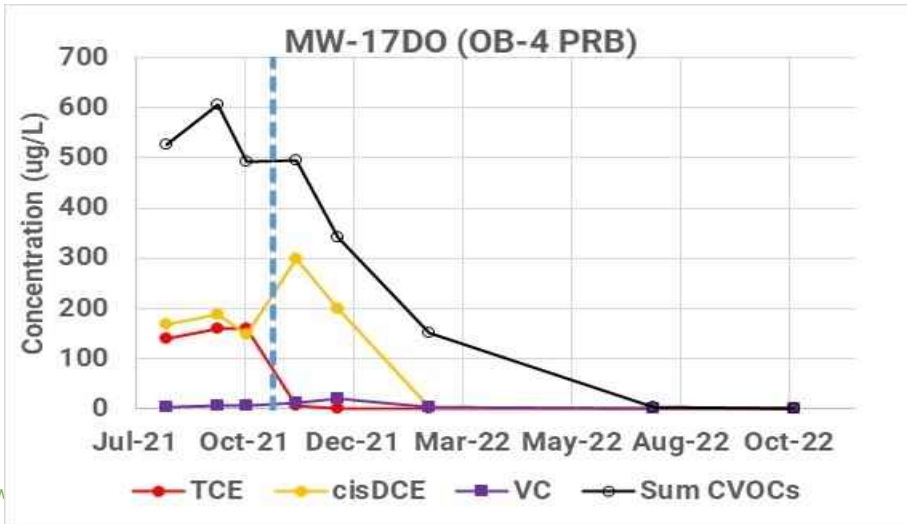
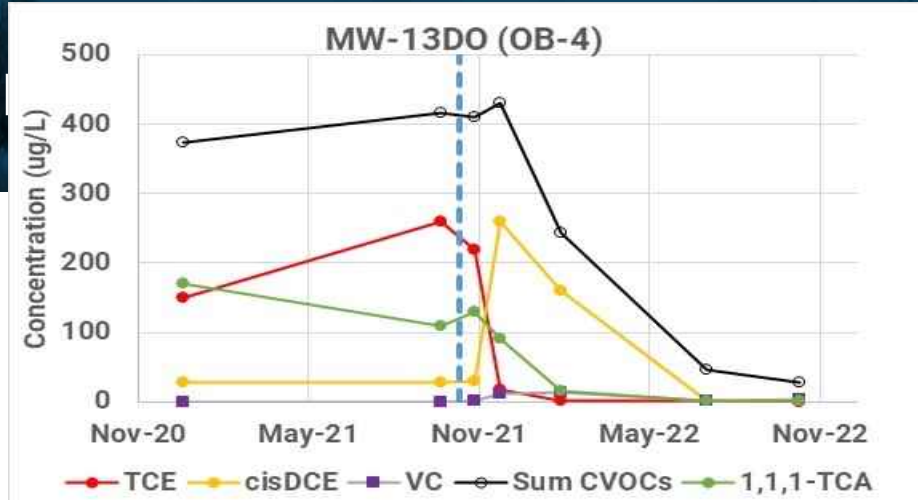
Remediation program – Follow-Up Remediation

- Spring 2022 – Follow-up ISCO in OB-1 before slab pour for new building
 - Highest concentrations
 - Upgradient impacts
- Fall 2023 – Focus on residual TCE & 1,4-Dioxane in upgradient bedrock
 - Additional open-hole bedrock injection wells on hilltop for upgradient treatment
 - Replacement open-hole bedrock injection wells for those abandoned during building construction
 - Limited overburden injection



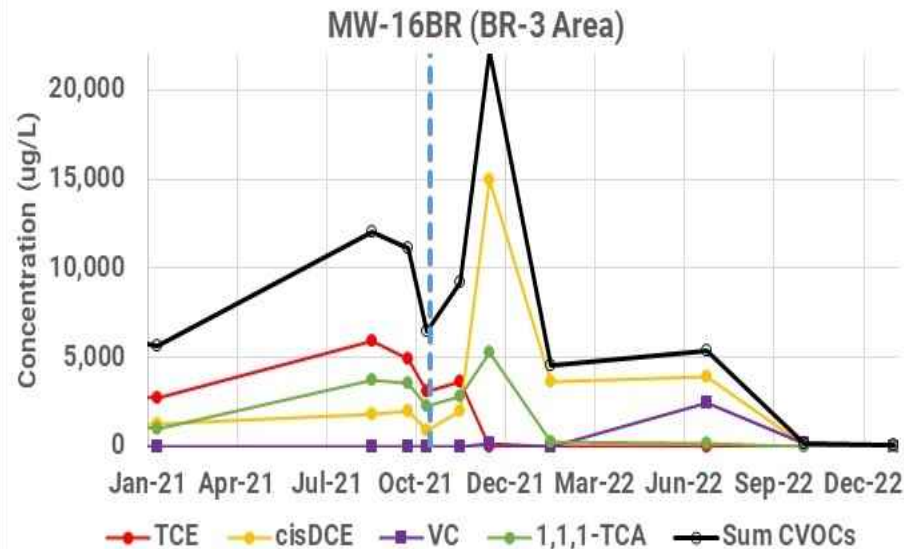
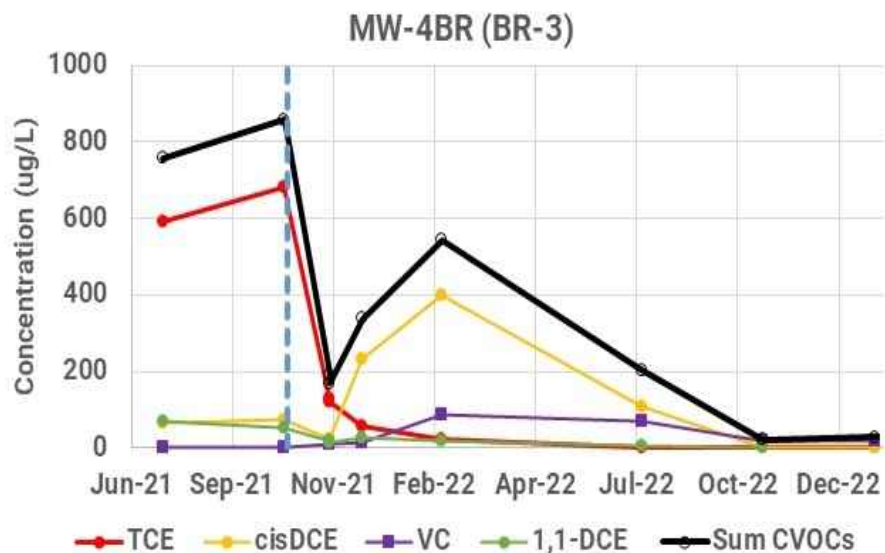
Results – EISD Overburden

- Site wide significant reduction in total CVOCs
- Biotic and Abiotic Dechlorination
 - Limited VC generation



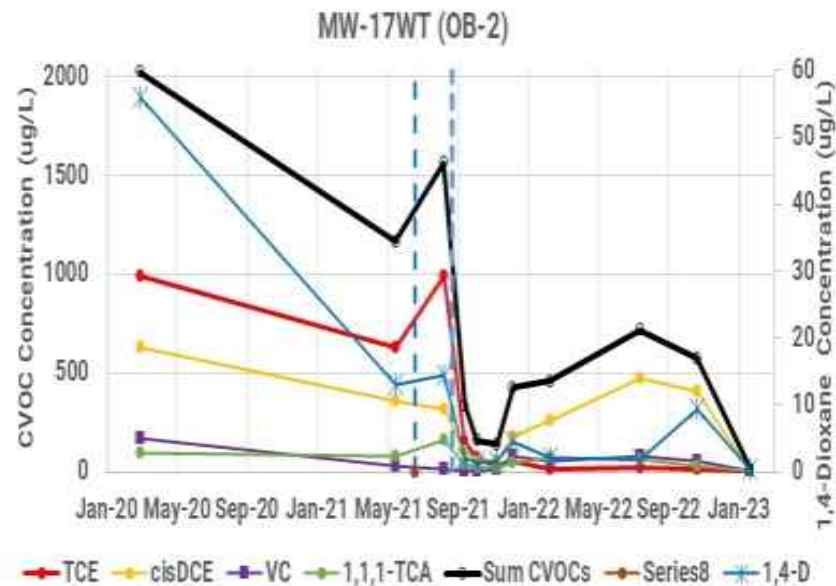
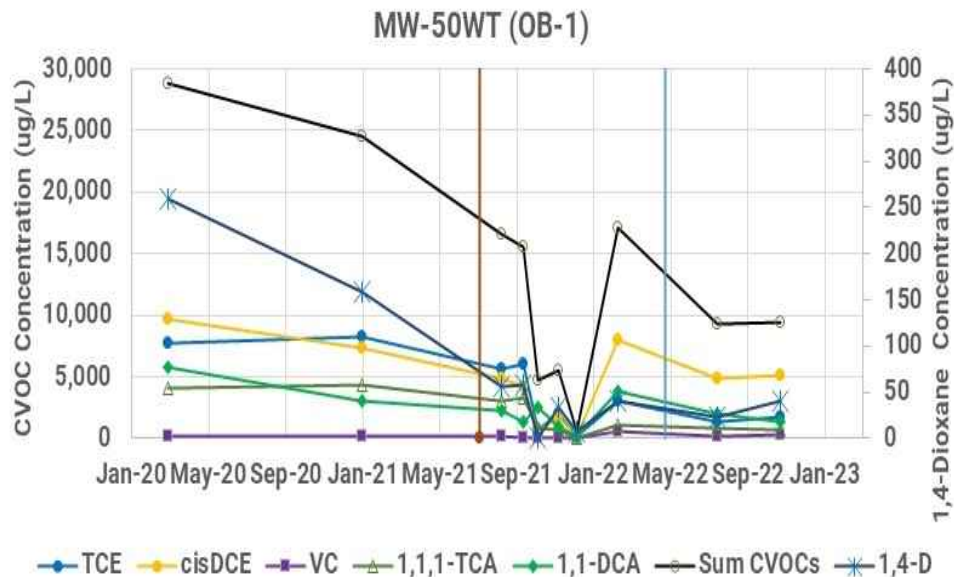
Results – EISD Bedrock

- 2 months post-injection
 - 4/4 monitoring wells – TOC > 20 mg/L & TCE reduced by >90%
- 15 months post-injection
 - 4/4 monitoring wells – 96% - 99% reduction in total CVOCs



Results – ISCO Overburden

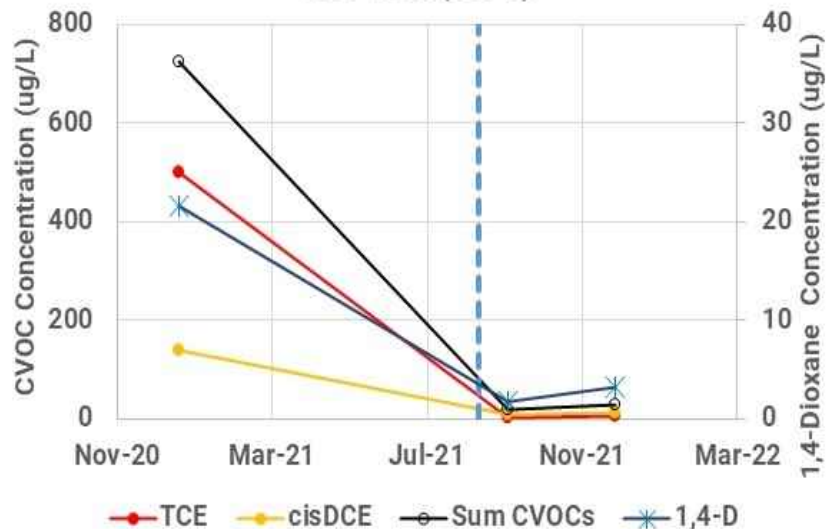
- OB-1 – upgradient contamination source leading to rebound
- OB-2 – 2 “rounds” of ISCO applied during initial mobilization



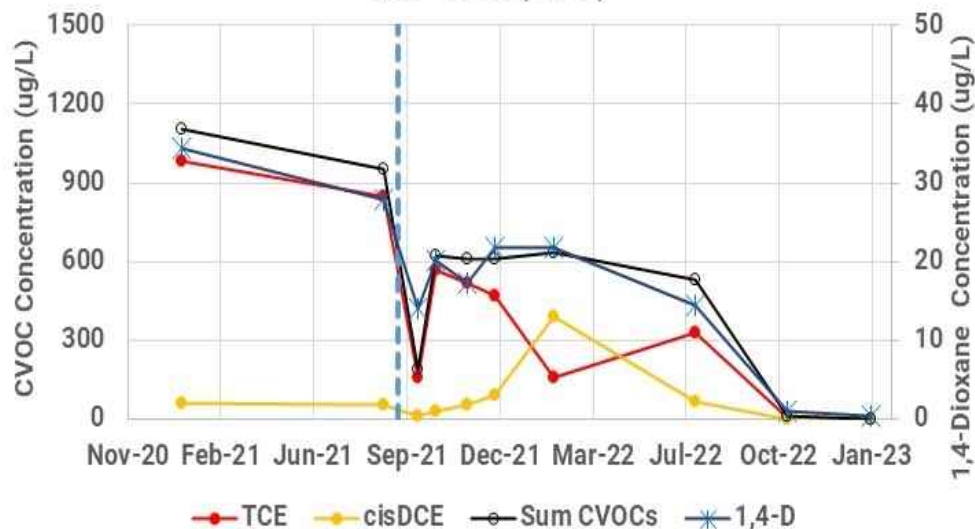
Results – ISCO Bedrock

- Decreases in CVOCs and 1,4-Dioxane
- Monitoring challenging when working at active construction sites

MW-9BR (BR-1)

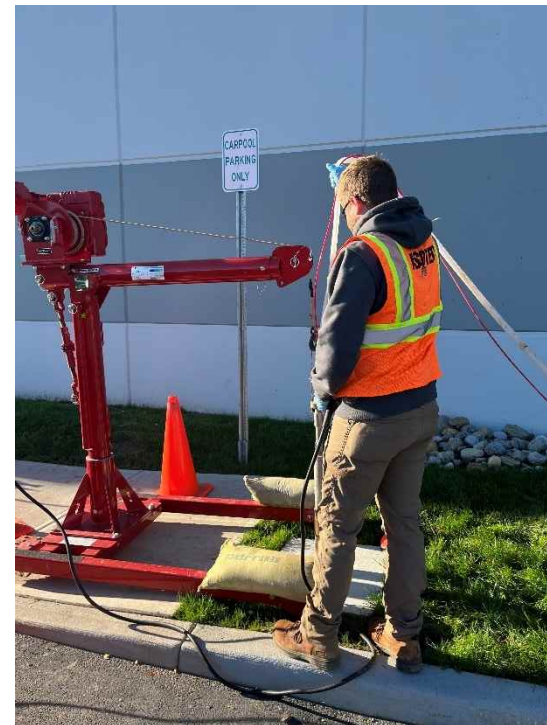


MW-13BR (BR-2)



Conclusions

- Fast-track remediation program
 - Combined remedy
 - Uncertainty from limited characterization
 - Contamination area and concentrations reduced site-wide
- Building has been built
 - Tenant in place = Jobs + Municipal Revenue
- Residual contamination
 - Lack of access to upgradient contamination
 - Next steps may include additional ISCO and/or PRBs



Co-author Acknowledgements



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Prasad Kakarla, P.E.



pkakarla@isotec-inc.com
(609) 275-8500 x111
www.isotec-inc.com



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Bedrock
Injections



Treatability
Laboratory



Activated Carbon Injectates
(BOS 100® & BOS 200®)



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(Headquarters)
Denver Area
Boston Area
Atlanta Area
San Diego
Connecticut