

SMART *Remediation*

*Chlorinated Solvent Daughter Product Management
and Expedited Remediation*



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CHLORINATED SOLVENT DAUGHTER PRODUCT MANAGEMENT AND EXPEDITED REMEDIATION

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Daughter Product Generation/Remediation

- Chlorinated volatile organic compounds (CVOCs) are common contaminants that tend to persist in the subsurface
- Daughter products are generated where an electron donor is introduced or where sufficient natural organic carbon is present in the aquifer
- For sites where either perchloroethylene (PCE) or trichloroethylene (TCE) is the parent compound, the degradation products are primarily cis-1,2-dichloroethylene (DCE) and/or vinyl chloride (VC)
- For source areas, significant daughter product concentrations can be generated and can persist for extended periods of time, even decades

Why Do They Persist?

- There are many reasons why daughter products do not degrade naturally or post-enhanced reductive dechlorination (ERD) remediation:
 - Geochemistry
 - Microbiology
 - Lack of sufficient organic carbon
 - Distribution of remedial amendment
 - Incomplete CSM
 - Poor design/capture

Let's Dig Into Some Project Examples

- All sites to be discussed:
 - Source area treatment (no PRBs)
 - Unconsolidated soil
 - Shallow (<15 m) DPT slurry injection
 - Pre-injection high density sampling was performed
 - Most had some level of microbiological assessment work performed
 - Abiotic degradation PRB downgradient of treatment area(s) => Important

Technology Highlights

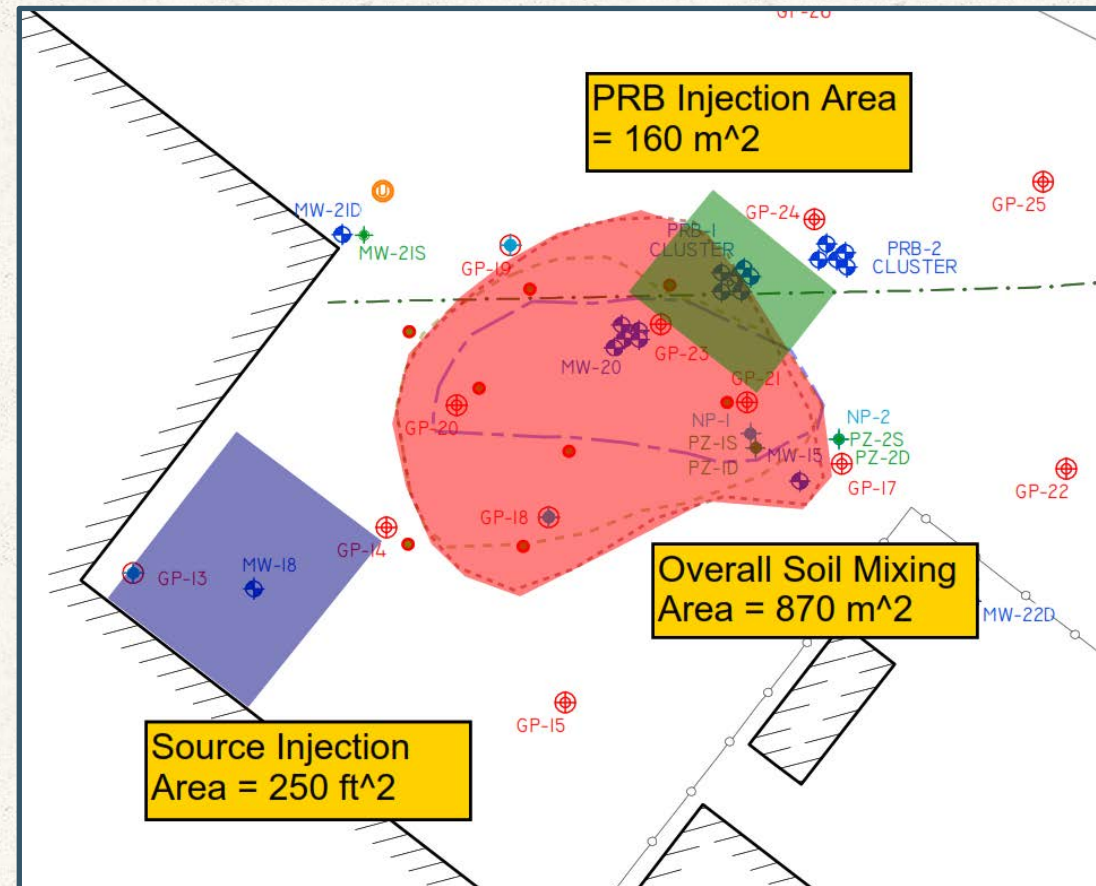
- Key Elements
 - Granular activated carbon (GAC) impregnated with metallic iron (abiotic degradation)
 - Electron donor – food grade starch or chitin
 - One set of microorganisms designed to degrade CVOCs
 - Second set of microorganisms designed to break down the electron donor
 - Nutrients (yeast extract or pea fiber)
 - Quantities of “ingredients” are tailored for each project site

Project Sites We Are Going to Review

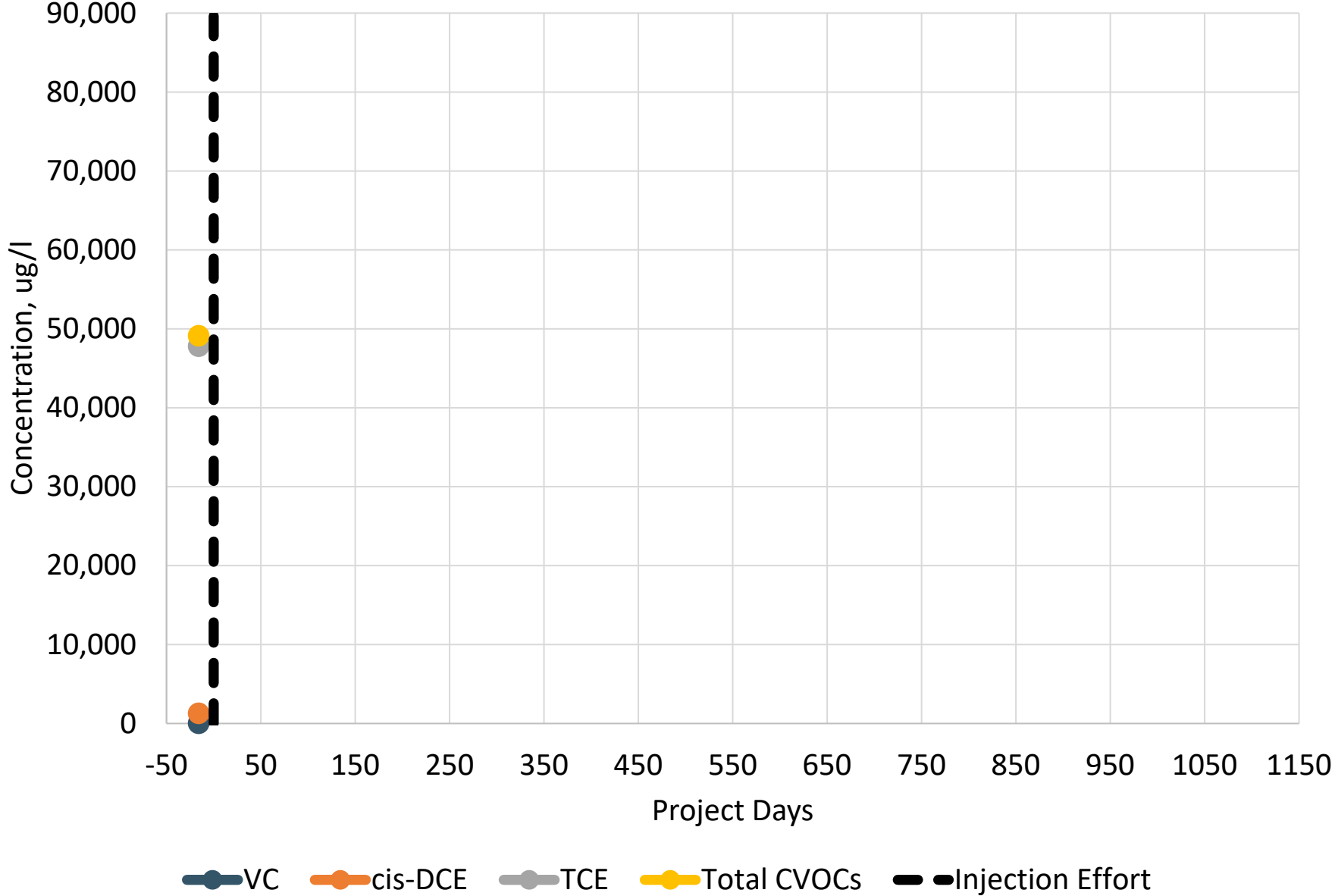
- #1. Elevated parent compounds relative to daughter concentrations
 - Sites with no natural dechlorination or ERD
- #2. Elevated daughter concentrations relative to parent
 - Sites with natural degradation or ERD performed
- #3. Site with significant saturated soil mass
 - This highlights the importance of the high density sampling

Site #1 - Source Area Application

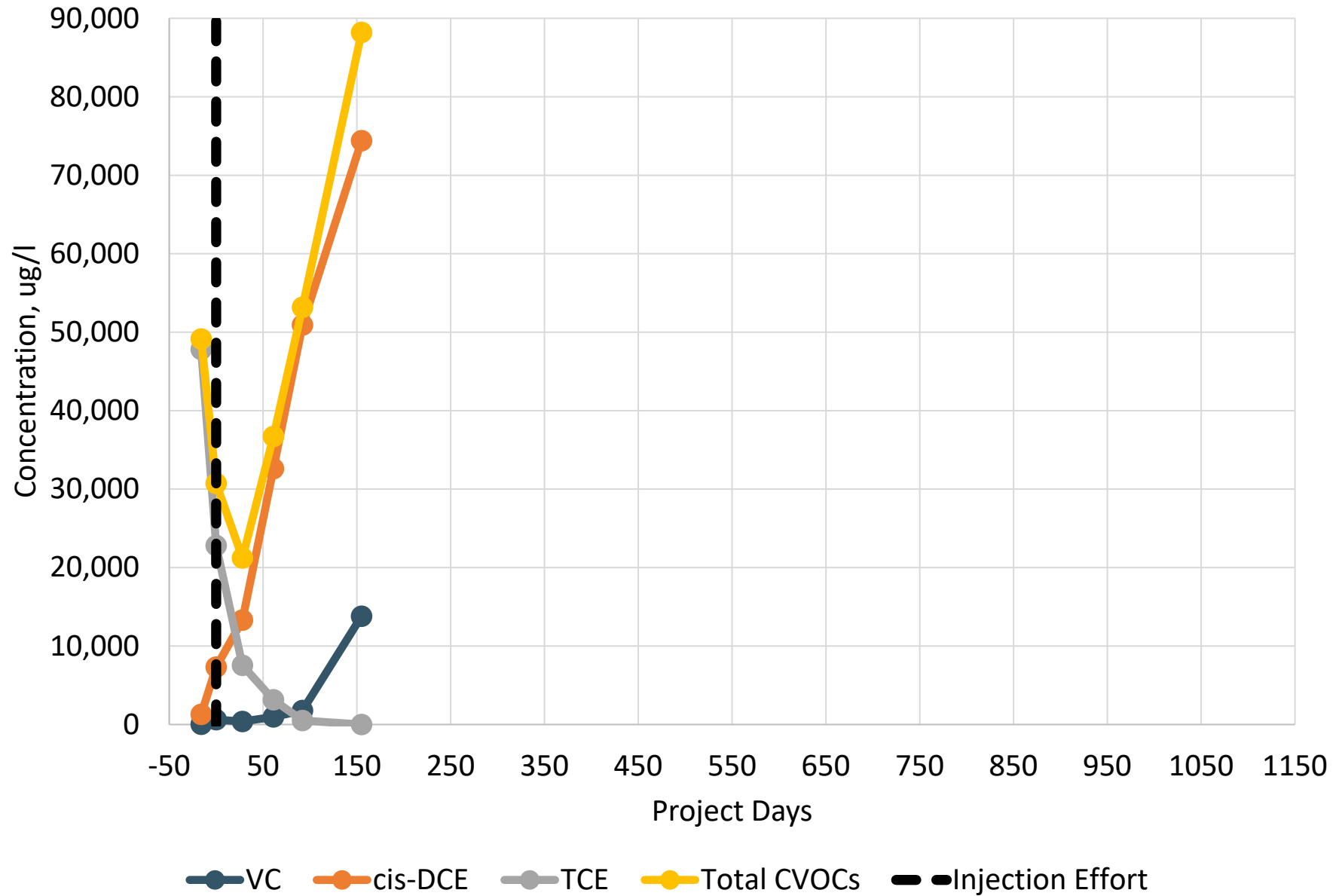
- Example of site with mostly parent compounds at baseline
- April 2020 Installation
- 3,000 kg of product was applied in a 250 m² area from a depth of 2.5 m to 9 m bgs.
- 69 points on 1.8 m centers
- Part of a combined remedy (ISCO and abiotic technology also applied)



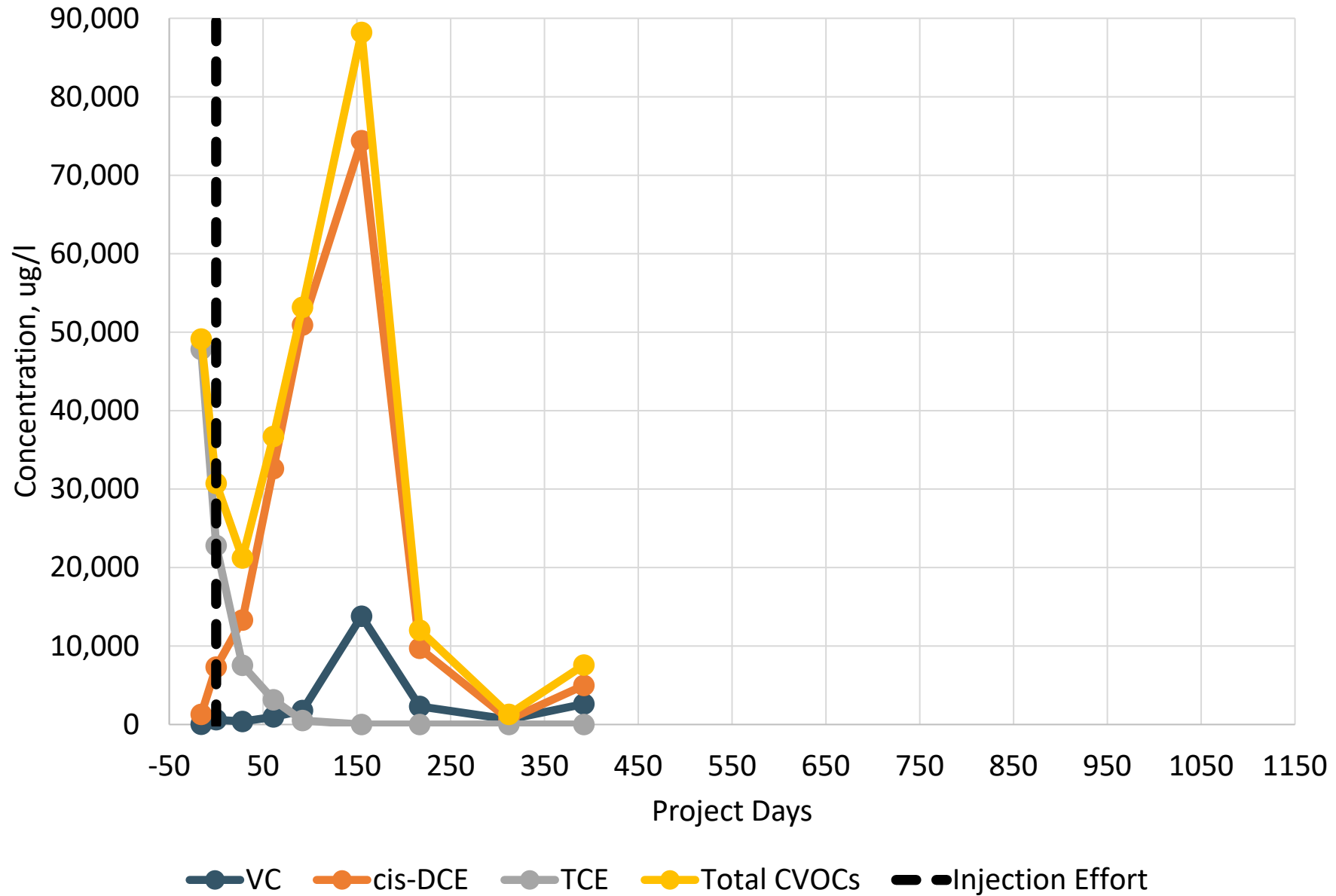
Source Area Concentrations v. Time (Baseline)



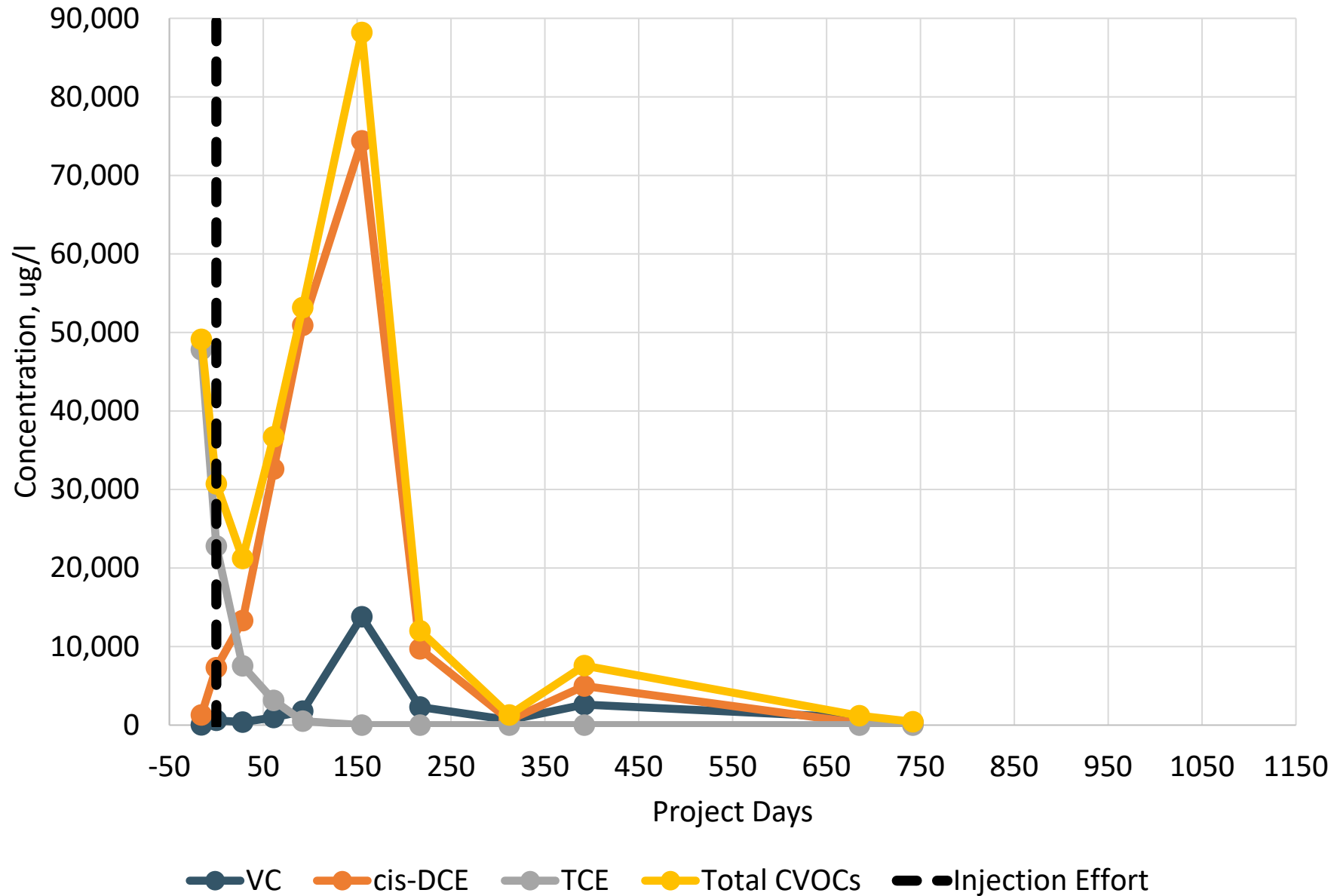
Source Area Concentrations v. Time (~0.5 Yr)



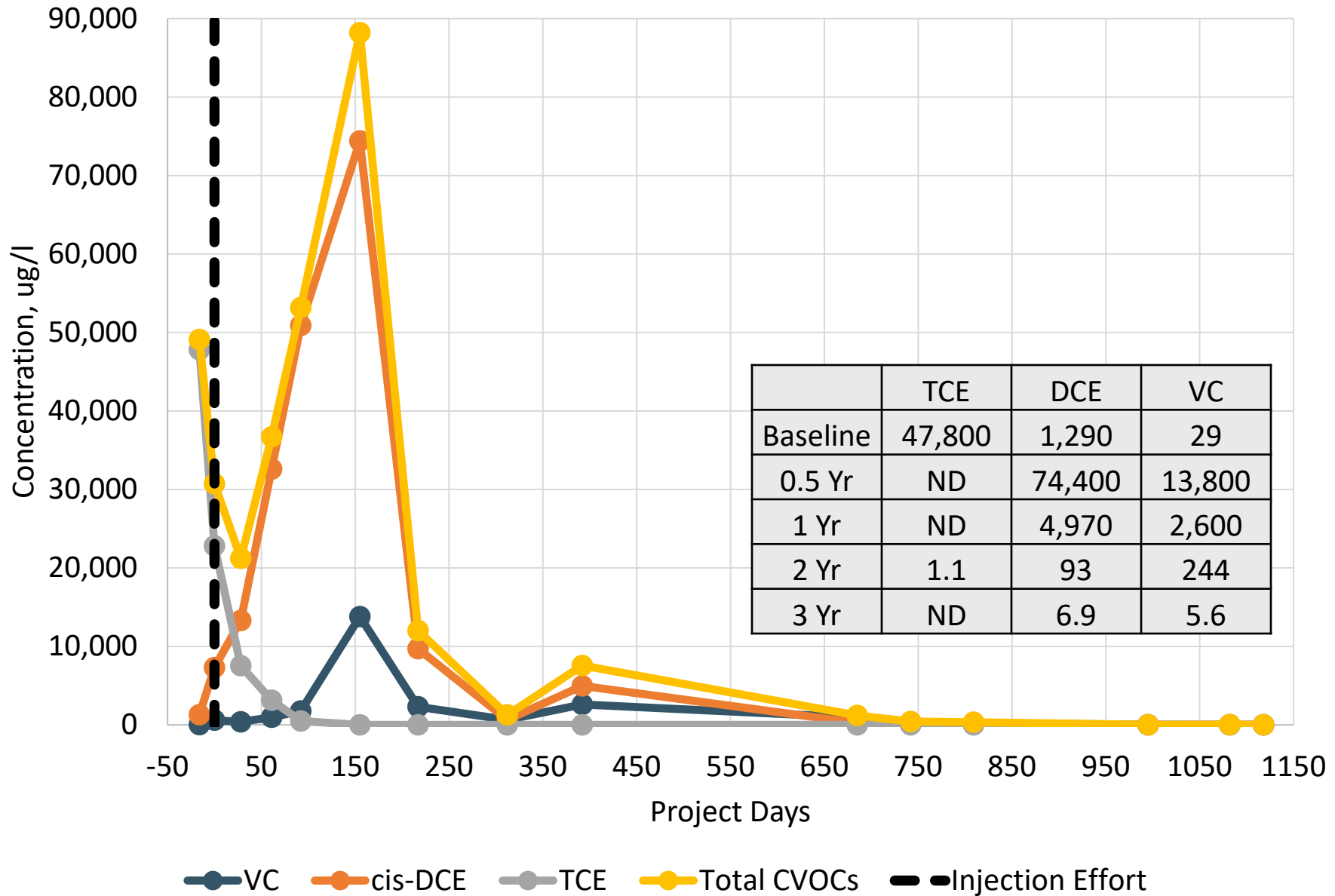
Source Area Concentrations v. Time (~1 Yr)



Source Area Concentrations v. Time (~ 2 Yr)



Source Area Concentrations v. Time (~3 Yr)

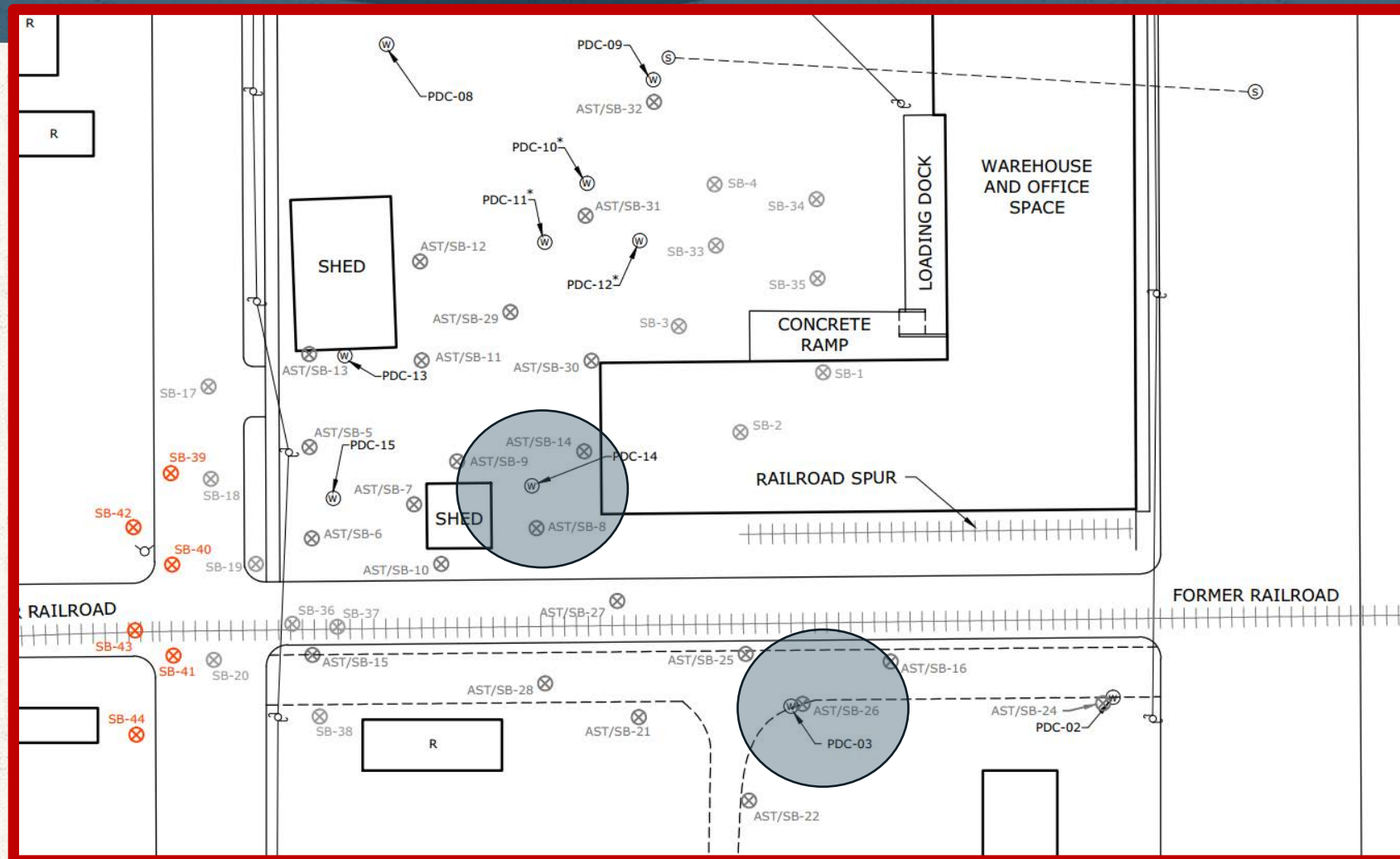


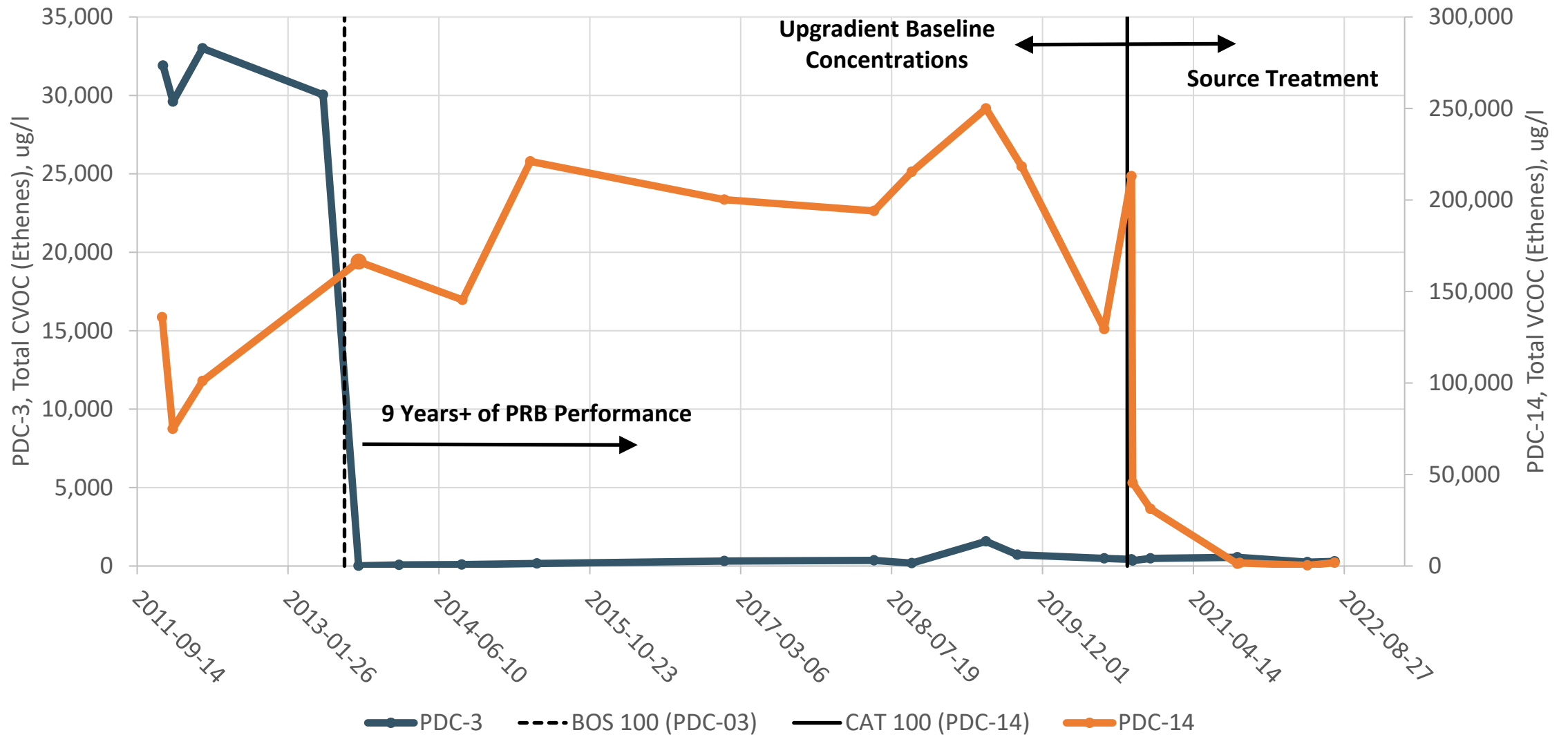
Site #2 – Source Area Application

- Example of site with elevated daughter products at baseline
- Part of multiyear phased approach (ISCO and abiotic technology also applied)
- September 2020 Application

Remedial Design Characterization (RDC), 2011 thru 2013

- Forty-four (44) soil borings
- Nested wells at each soil boring location
 - Shallow and deep groundwater assessment
- Full monitoring network sampling
- Samples run pro bono at our lab in Denver



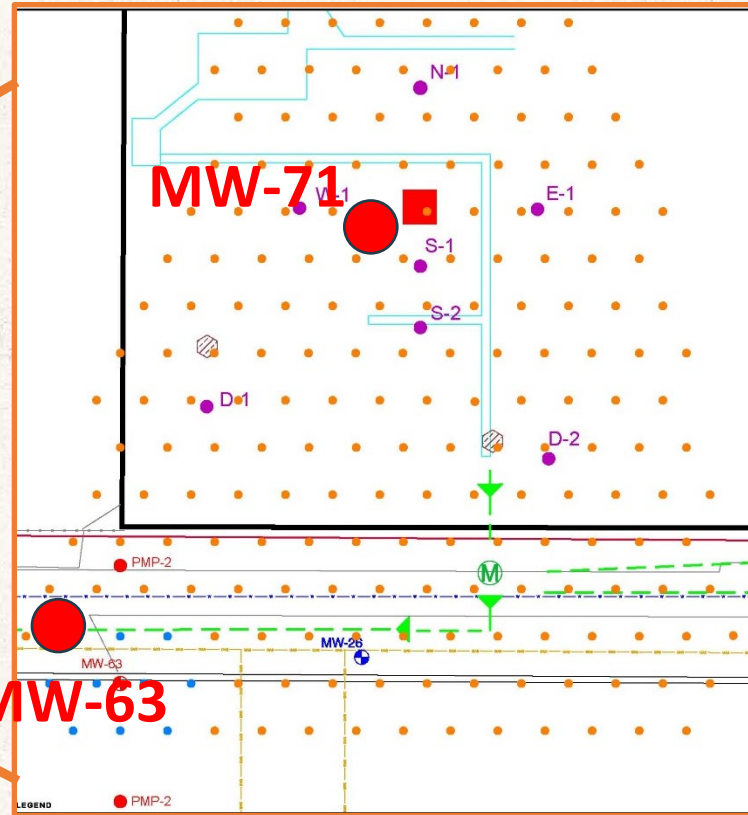
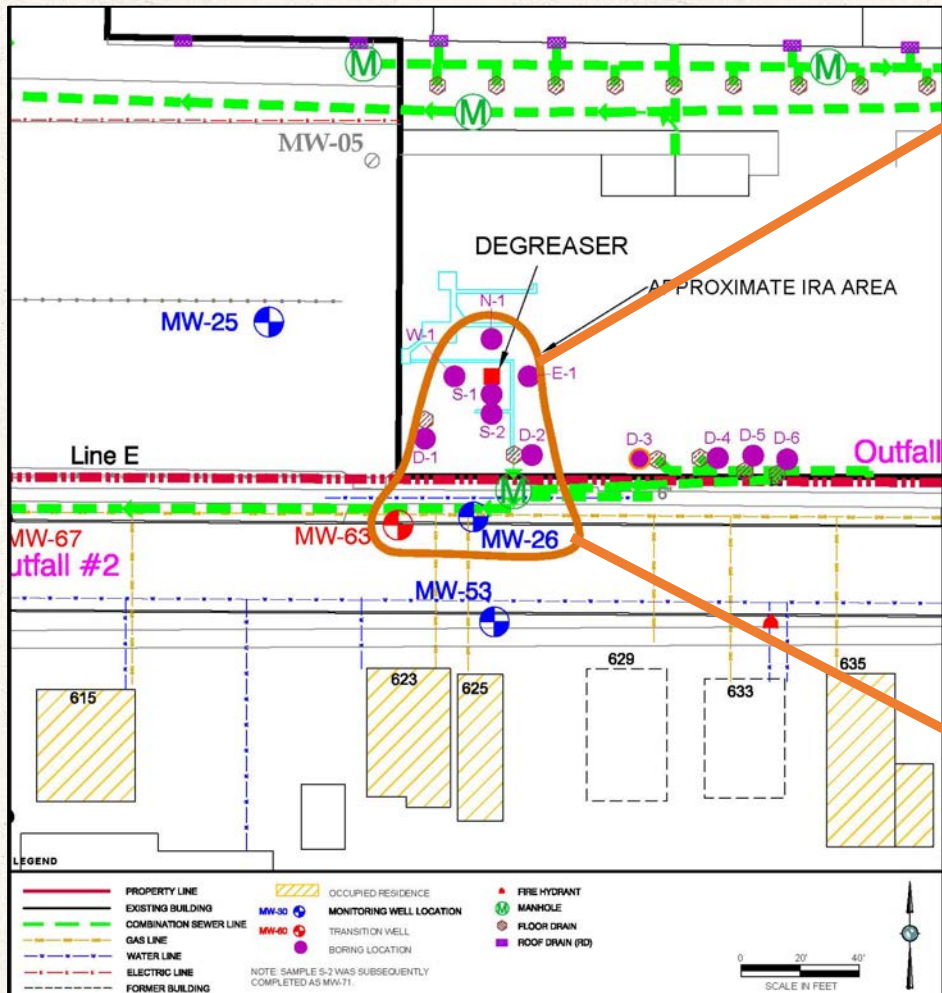


	PCE	TCE	DCE	VC
Baseline	30,800	27,500	144,000	10,700
1 Yr	ND	ND	653	540
2 Yr	ND	ND	123	231

Site #3 – Source Area Application

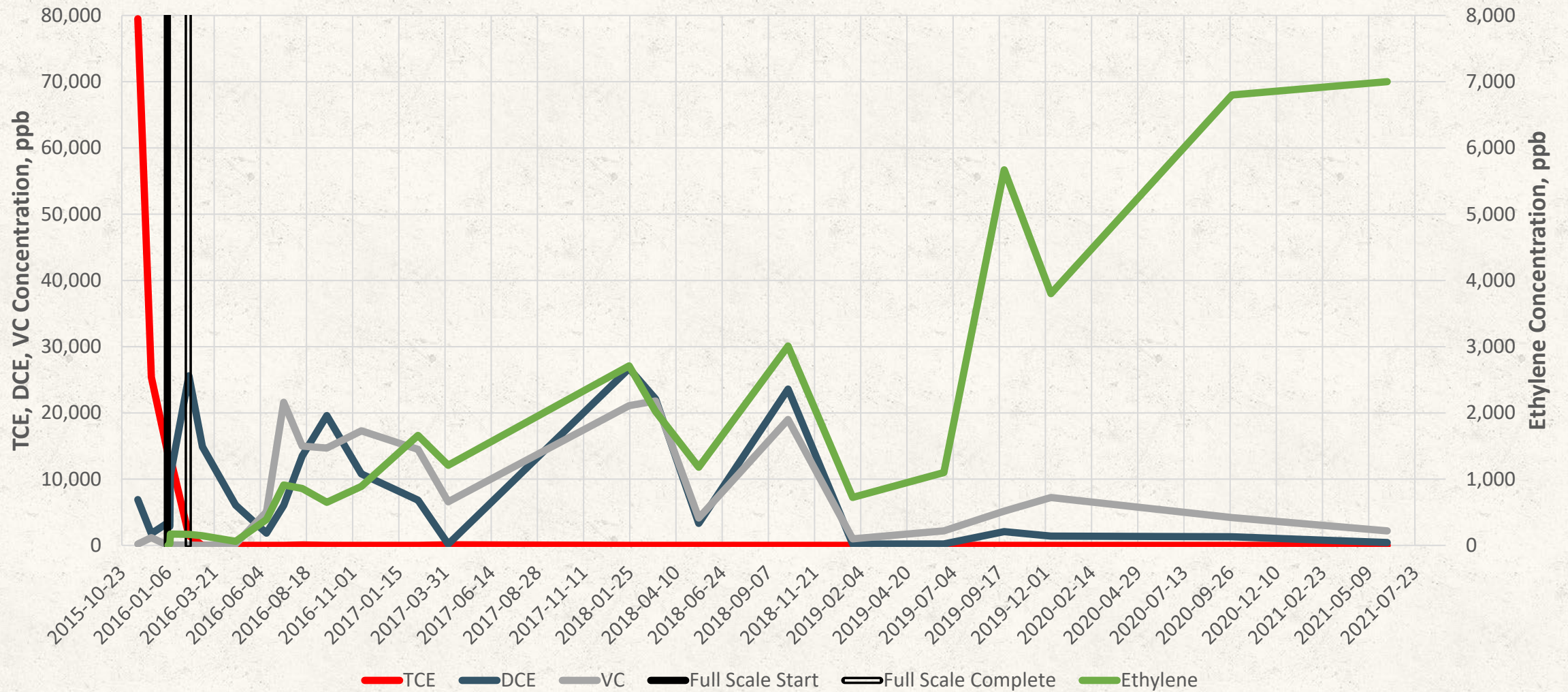
- Example of site with elevated parent products at baseline and significant daughter product saturated soil mass from previous ERD application
- Part of multiyear phased approach
- First Quarter 2016 Application

Site Map

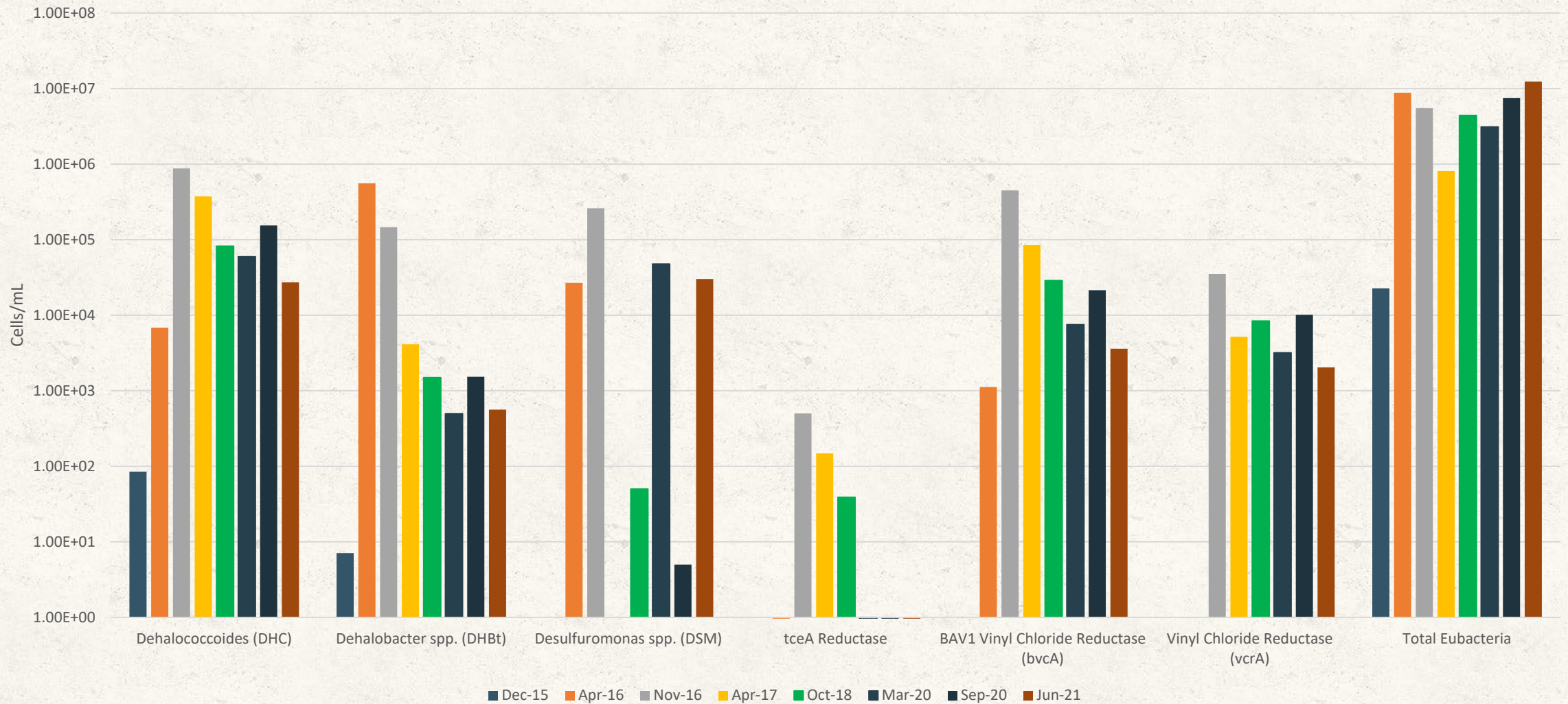


- ~540 m²
- 5,100 kg of product installed in 215 injection points in January & February 2016

MW-71 – Degreaser Source Area




MW-71 Biological Signature



Summary

- Success starts with the RDC and accurate CSM
 - Guides dosing and expectations
- Application of synergistic technologies can expeditiously manage daughter products generated naturally or via ERD
- In most instances, an abiotic PRB should be installed for downgradient control of daughter products



Thank you for your time!

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