Legacy Liability to Managed Closure: Performance-Based Characterization and Remediation

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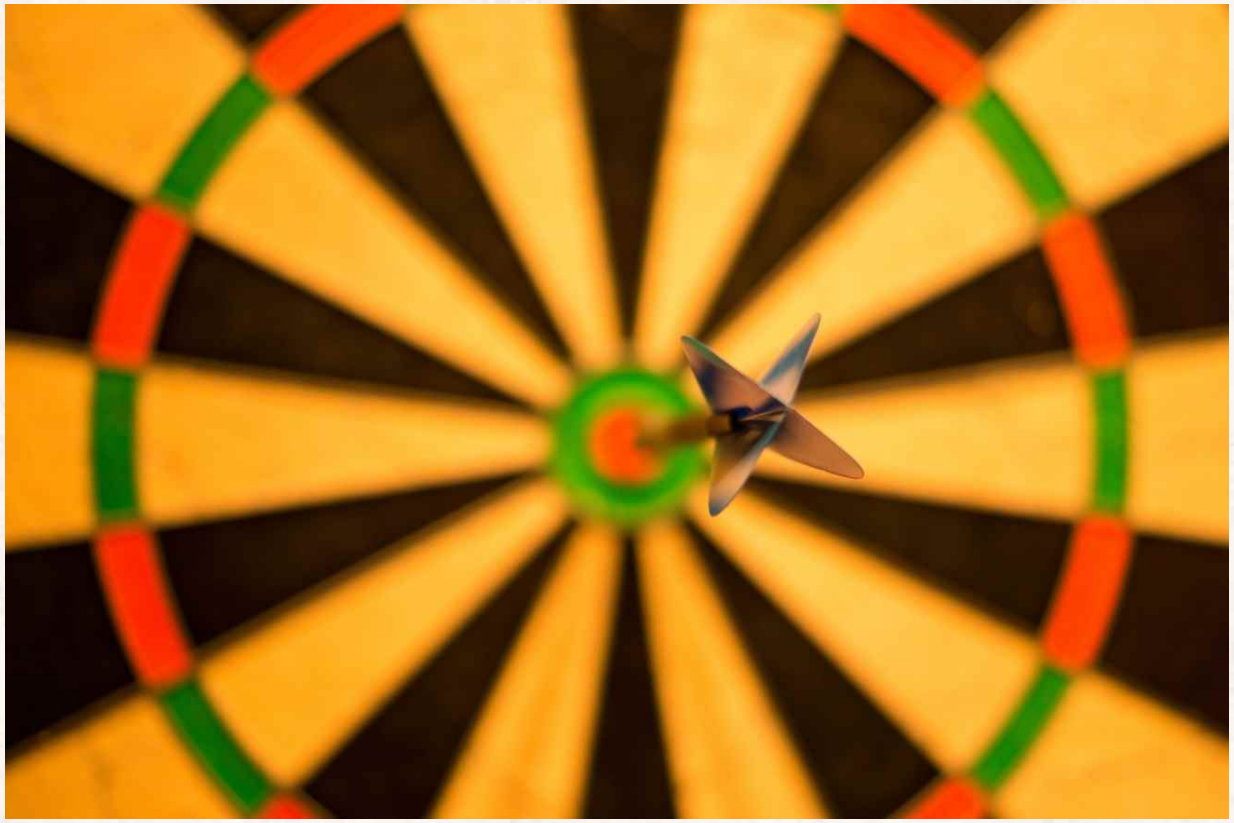
RPI GROUP

Site Background

- Former chemical plant in Western KY
- Multiple solvents:
  - Methylisolbutyl carbinol (MIBC)
  - Tetrachloroethene (PCE)
  - Hydrogen Peroxide
  - Acetone
  - Ethanol
  - Diesel Fuel

Remedial Objectives

1. Refine the existing CSM: accurately quantify total contaminant mass in soil and groundwater
2. Implement a multi-year remedial plan
3. Significant reductions = managed closure
4. Stop CVOCs from migrating onto off-site residential properties



Phased Remedial Approach

- Remedial Design Characterization: Data Gap Elimination (2011, 2012, & 2020), Soil Gas Survey (2012)
- Phase 1a: Off-Site BOS 100® Permeable Reactive Barrier (2013 and 2014)
- Phase 1b: Off-Site Shallow Soil Blending with ISCO (2013)
- Phase 2: CAT 100 Field Scale Pilot Study in Source (2016)
- Phase 3: CAT 100 PRB Extension (2018)
- Phase 4: CAT 100 1st Source Treatment Cell (2019)
- Phase 5: CAT 100 2nd Source Treatment Cell (2020)
- Phase 6: CAT 100 3rd Source Treatment Cells (2021)
- Optional Phase Future Consideration: Shallow Unsaturated Soil Blending with ISCO in Source

Original Projected Phases

Historical CSM

- Multiple releases
- Subsurface investigation began in 1991, CVOCs present
- PCE highest concentration and most widespread
- Combination of ex-situ and in-situ remediation methods selected

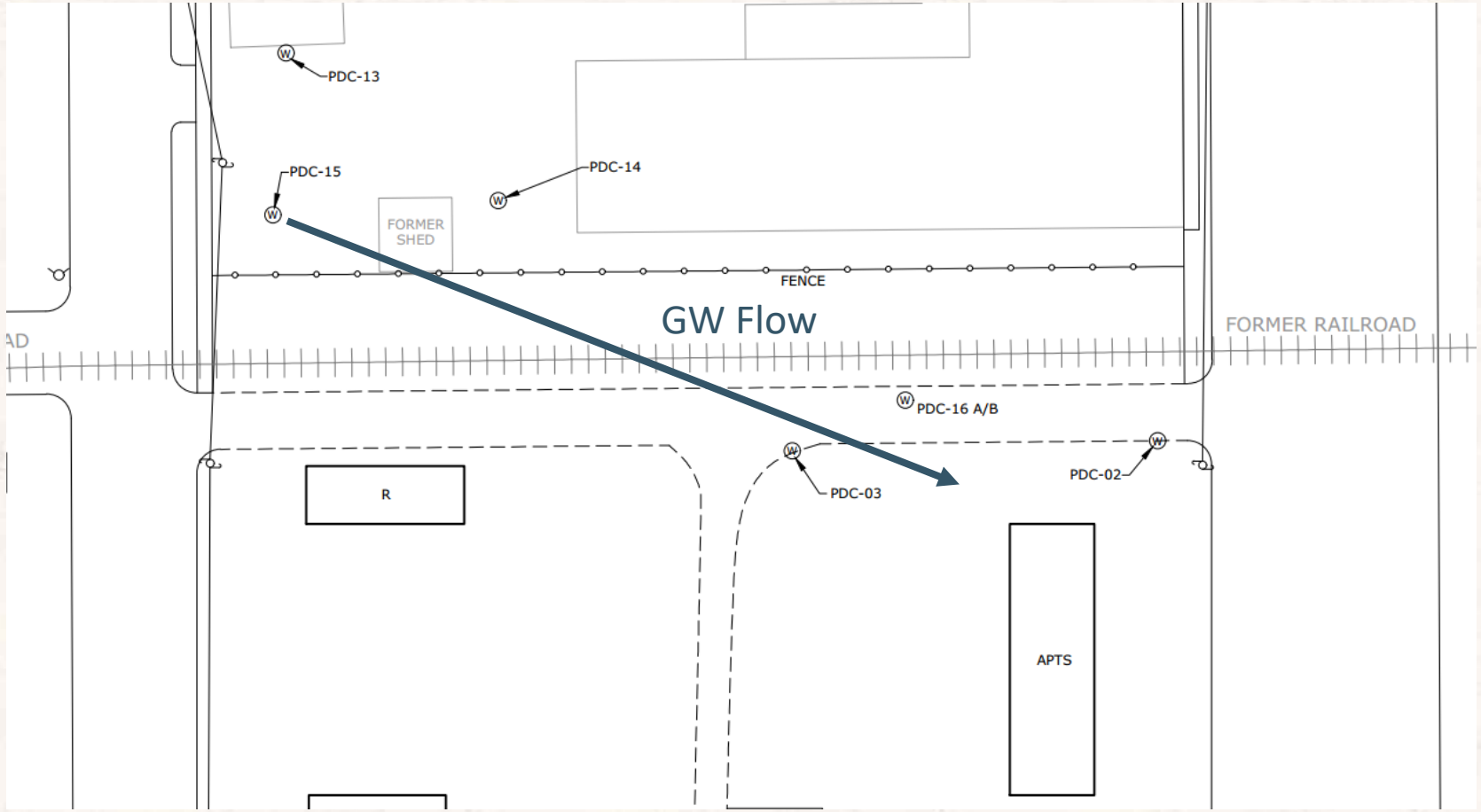
Historical CSM (cont.)

Source

- PCE 23,000 µg/L
- TCE 40,000 µg/L
- cis-DCE 258,000 µg/L
- VC 19,600 µg/L

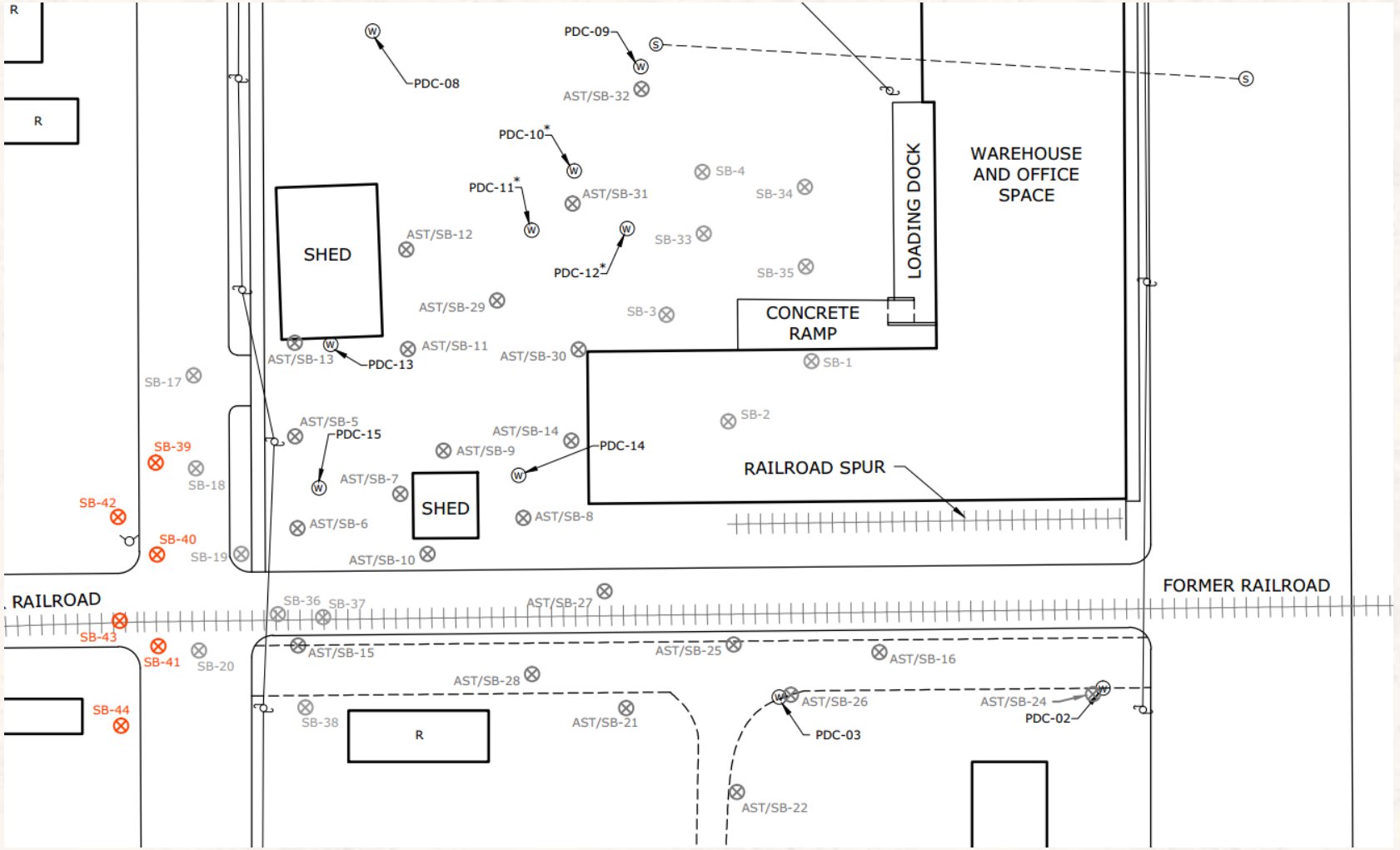
Distal Downgradient

- PCE 34,500 µg/L
- TCE 7,300 µg/L
- cis-DCE 3,630 µg/L



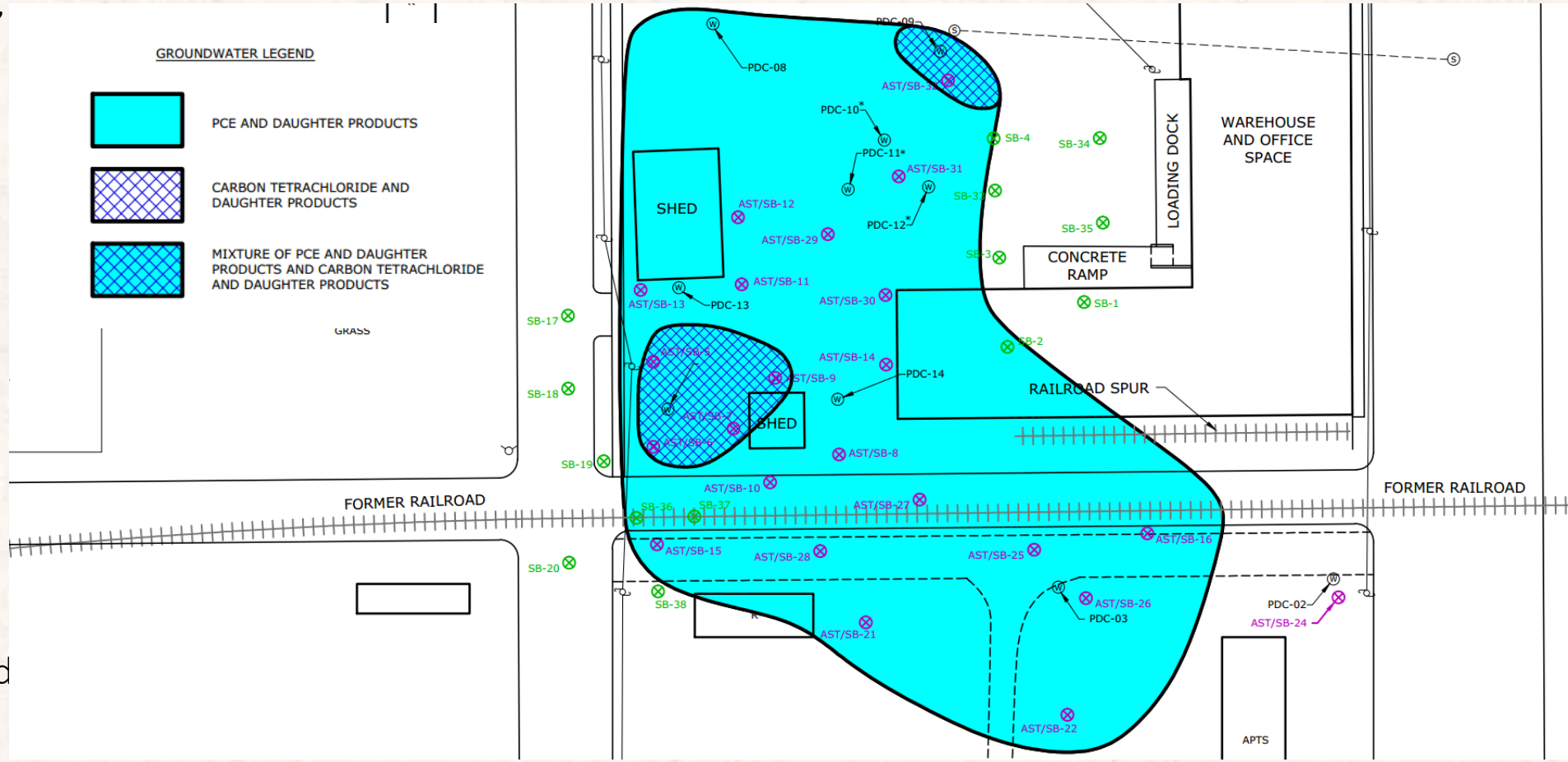
Initial Phase(s) 2011 thru 2013: Remedial Design Characterization (RDC)

- Forty-four (44) soil borings
- Nested wells at each soil boring location
  - Shallow and deep groundwater assessment
- Full monitoring network sampling



RDC Findings

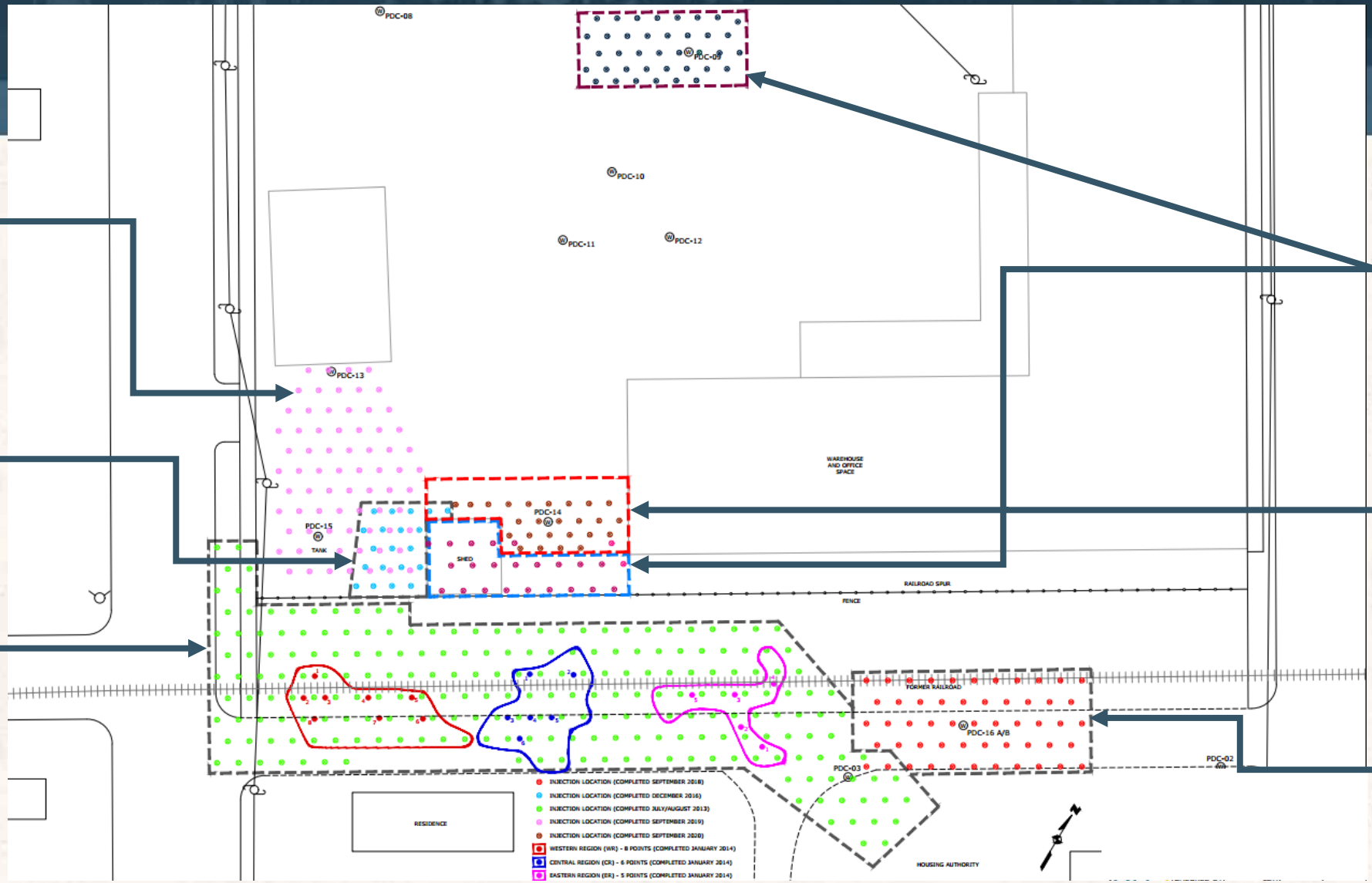
- Source: Saturated Soils (~20-40’ bgs)
  - PCE 2,700 mg/kg
  - TCE 40 mg/kg
  - cis-DCE 52 mg/kg
  - CT 42 mg/kg
  - MC 120 mg/kg
  - MIBK 220 mg/kg
- Geology: 0-40’ bgs low-permeability silts and clays, k = 1x10^{-7} cm/s
- 40’ -? Poorly sorted fine-grained sand, artesian groundwater



Phase 4: CAT 100 1st Source Treatment (2019)

Phase 2: CAT 100 Source Pilot Test (2016)

Phase 1: BOS 100 PRB and Shallow ISCO Soil Blend (2013/2014)



Phase 6: CAT 100 3rd Source Treatment (2021)

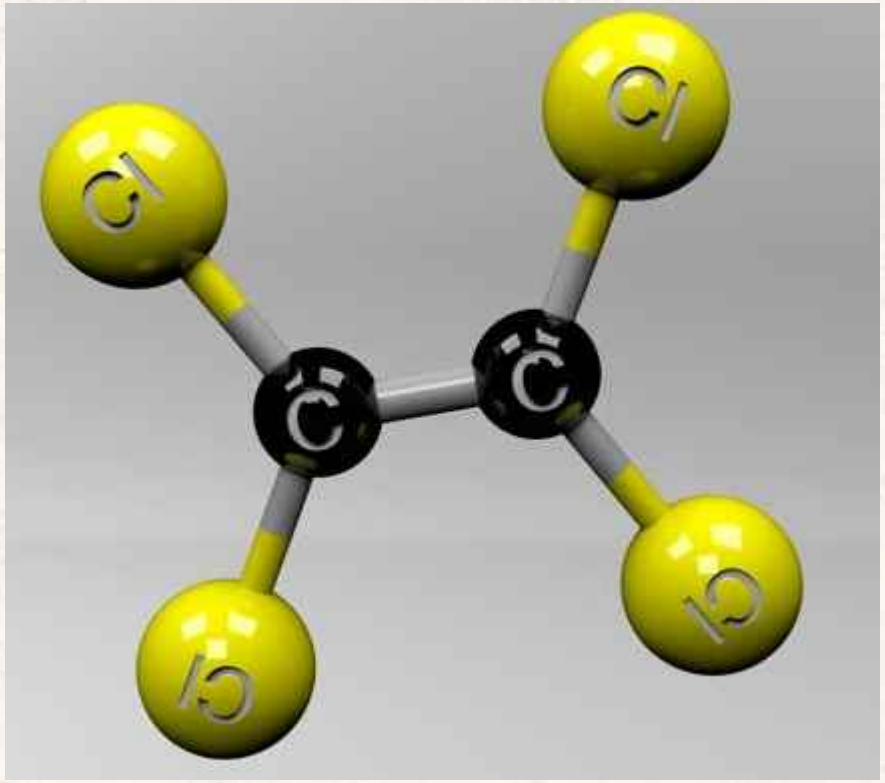
Phase 5: CAT 100 2nd Source Treatment (2020)

Phase 3: CAT 100 PRB Extension (2018)

Phase 1 Selected Technologies

BOS 100®

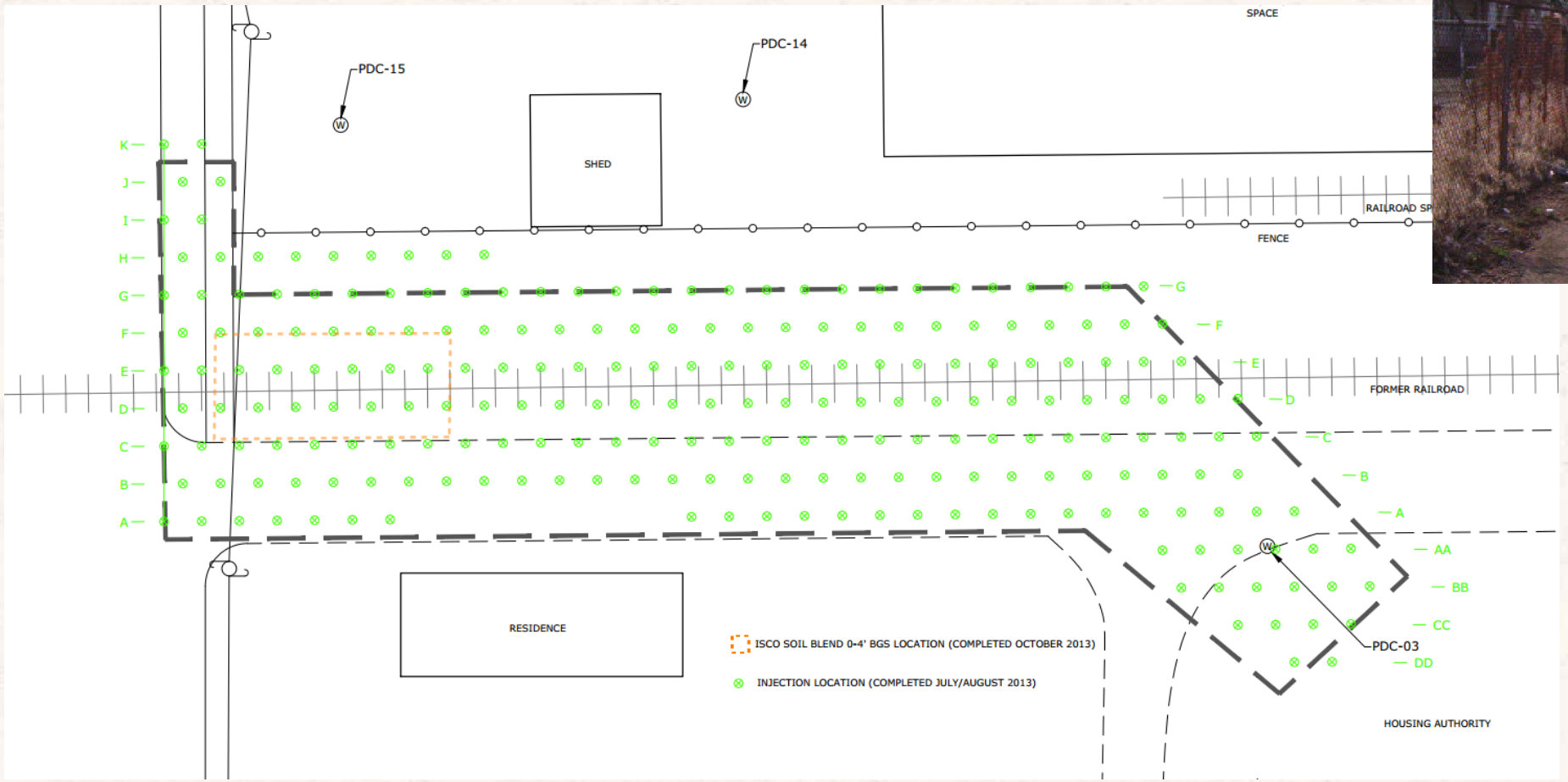
- Granular activated carbon impregnated with metallic iron
- Abiotic ß-Pathway Elimination
- Treatment of chlorinated solvents



Soil Blending

- Activated Persulfate

Phase 1: Off-Site PRB BOS 100® and Unsaturated Soil Blending (ISCO)

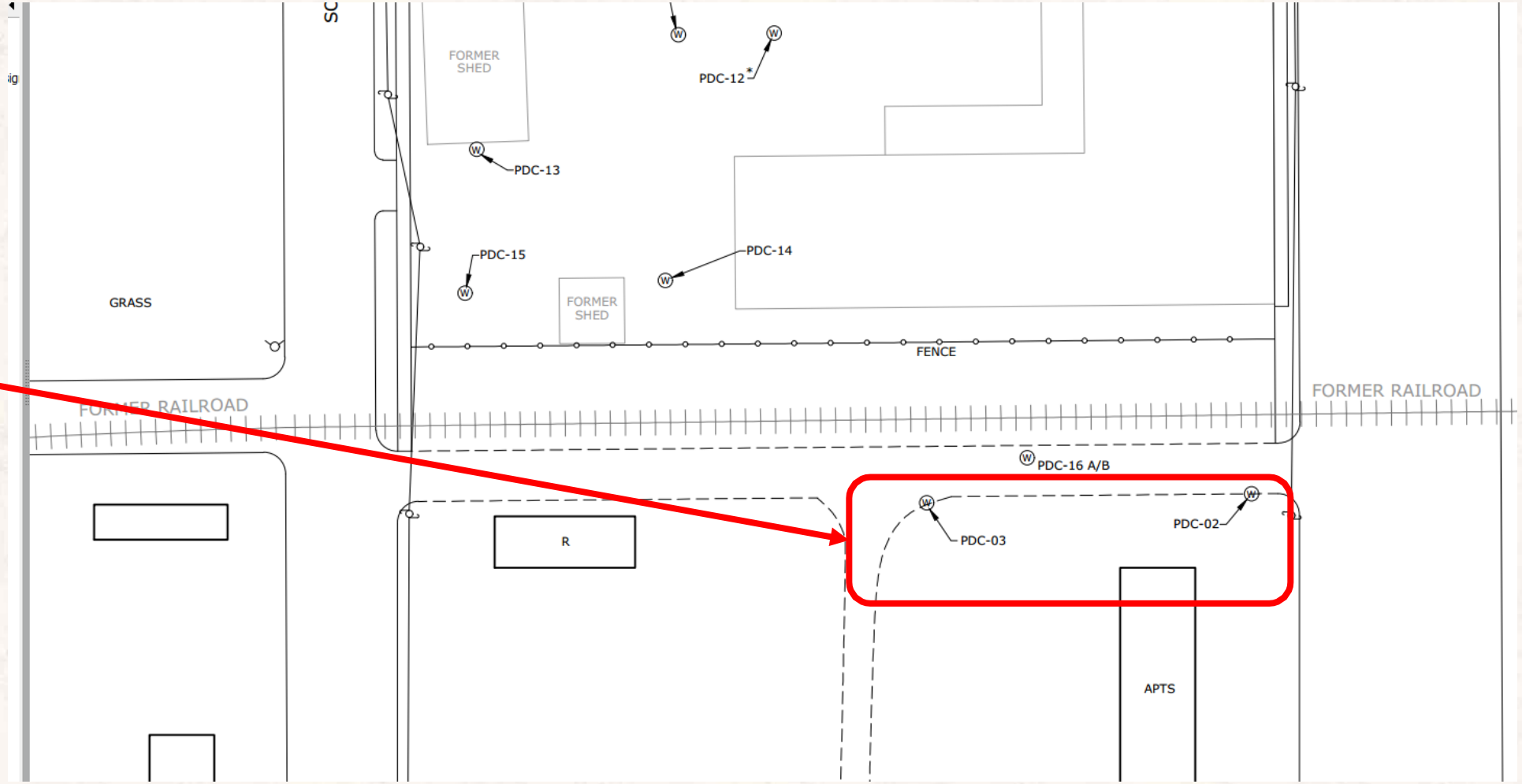


Phase 1: 180-day Post-Injection Results

Downgradient

% Reductions

- PCE ~84-99%
- TCE ~59-99%
- cis ~64-99%
- VC ~99%

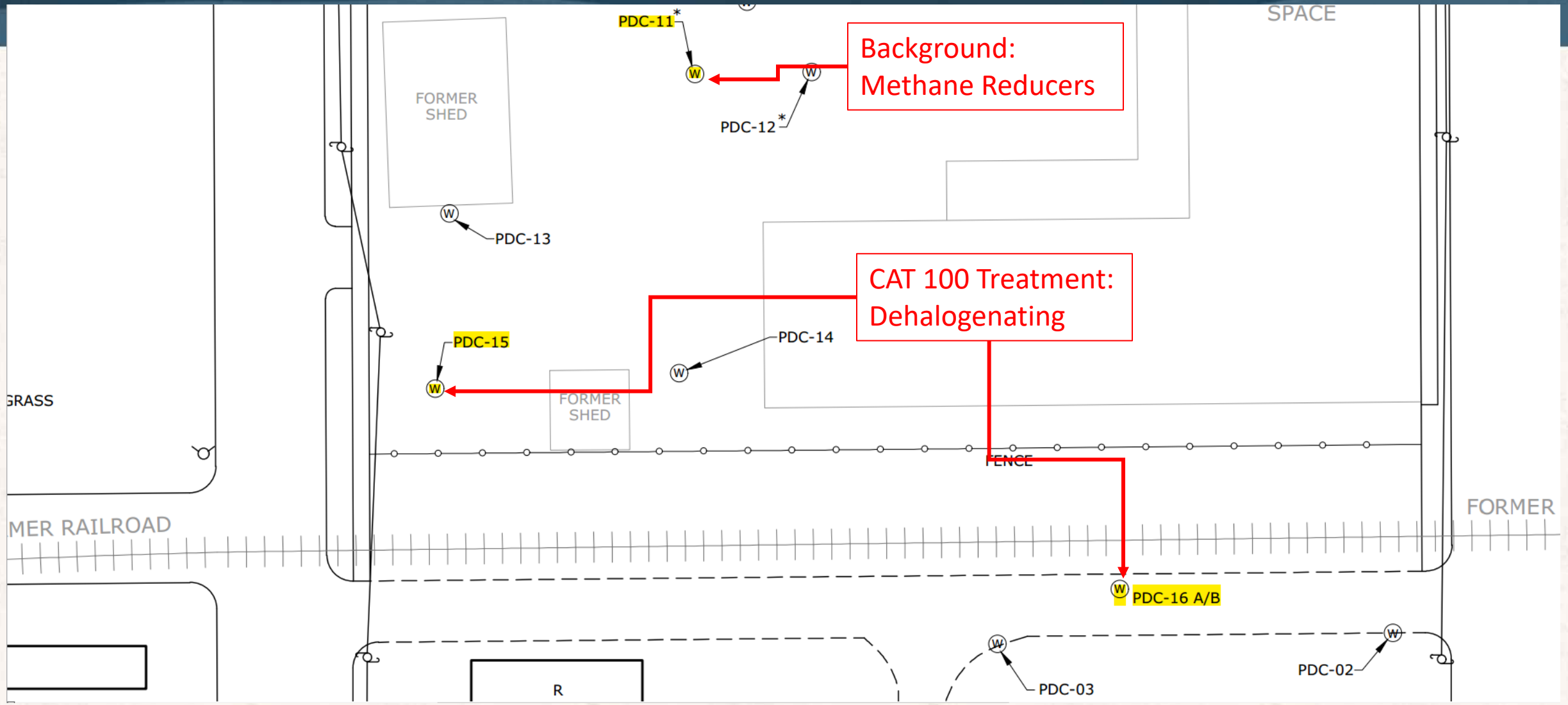


Innovations in Technology

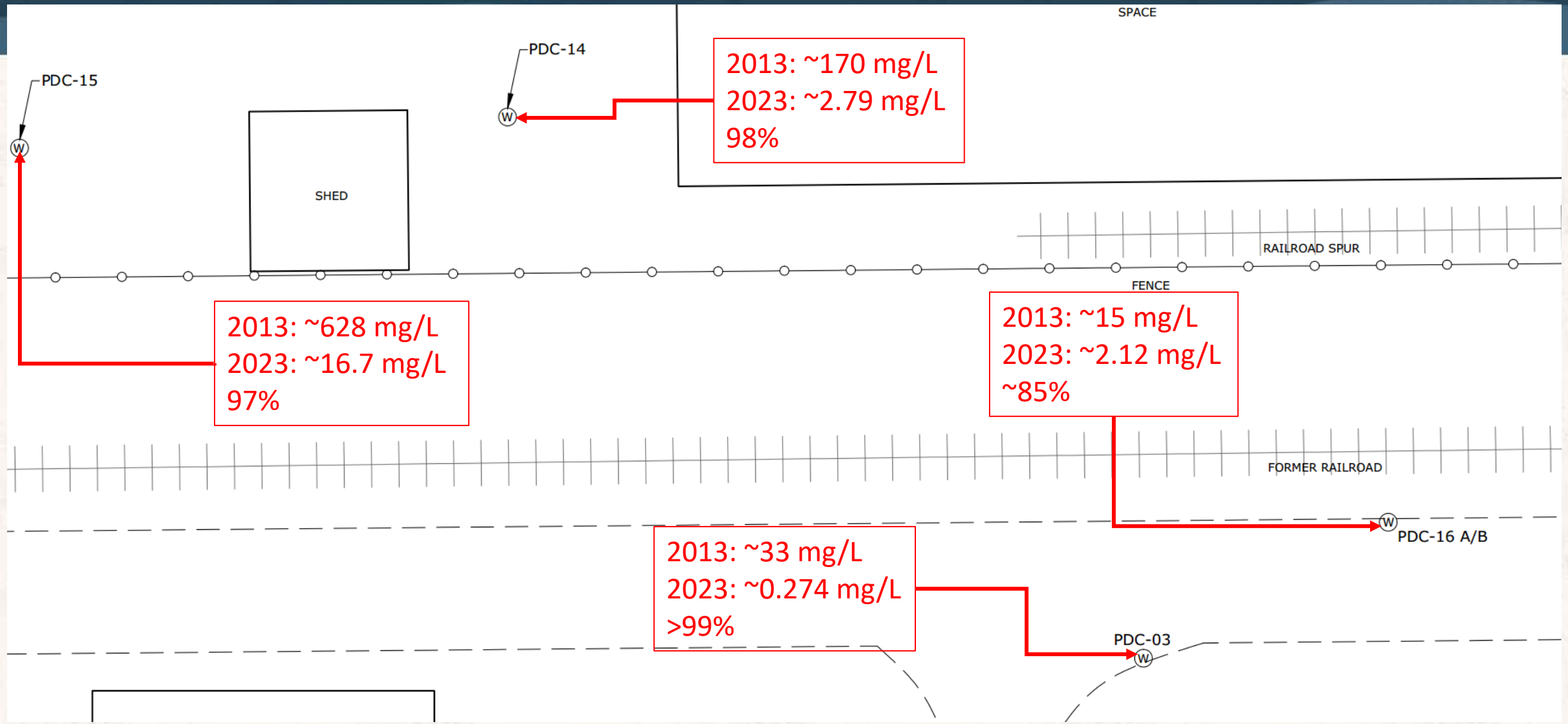
CAT 100

- Activated Carbon Impregnated with Metallic Iron (BOS 100®)
- Complex Carbohydrate
- Microorganisms
  - One Set Designed to Degrade COCs
  - Second Set Degrades the Carbohydrate
- Developed for High Concentration Scenarios (DNAPL)

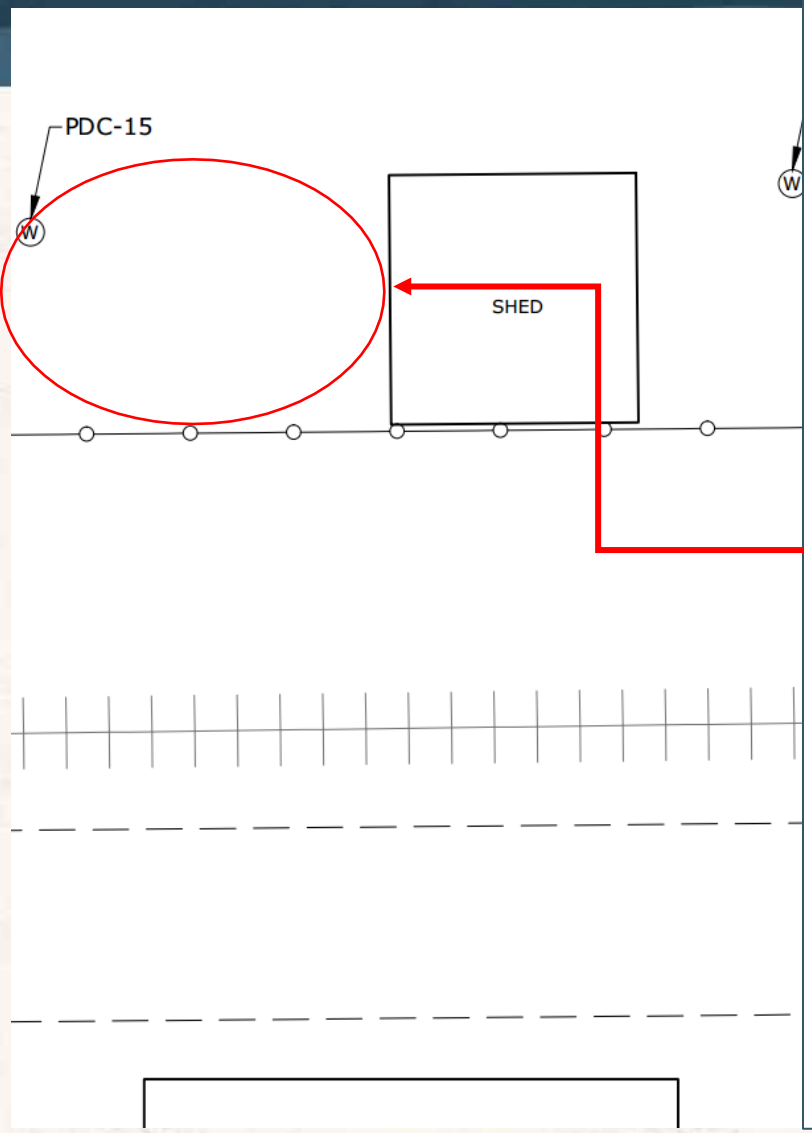
Microbial Diagnostics

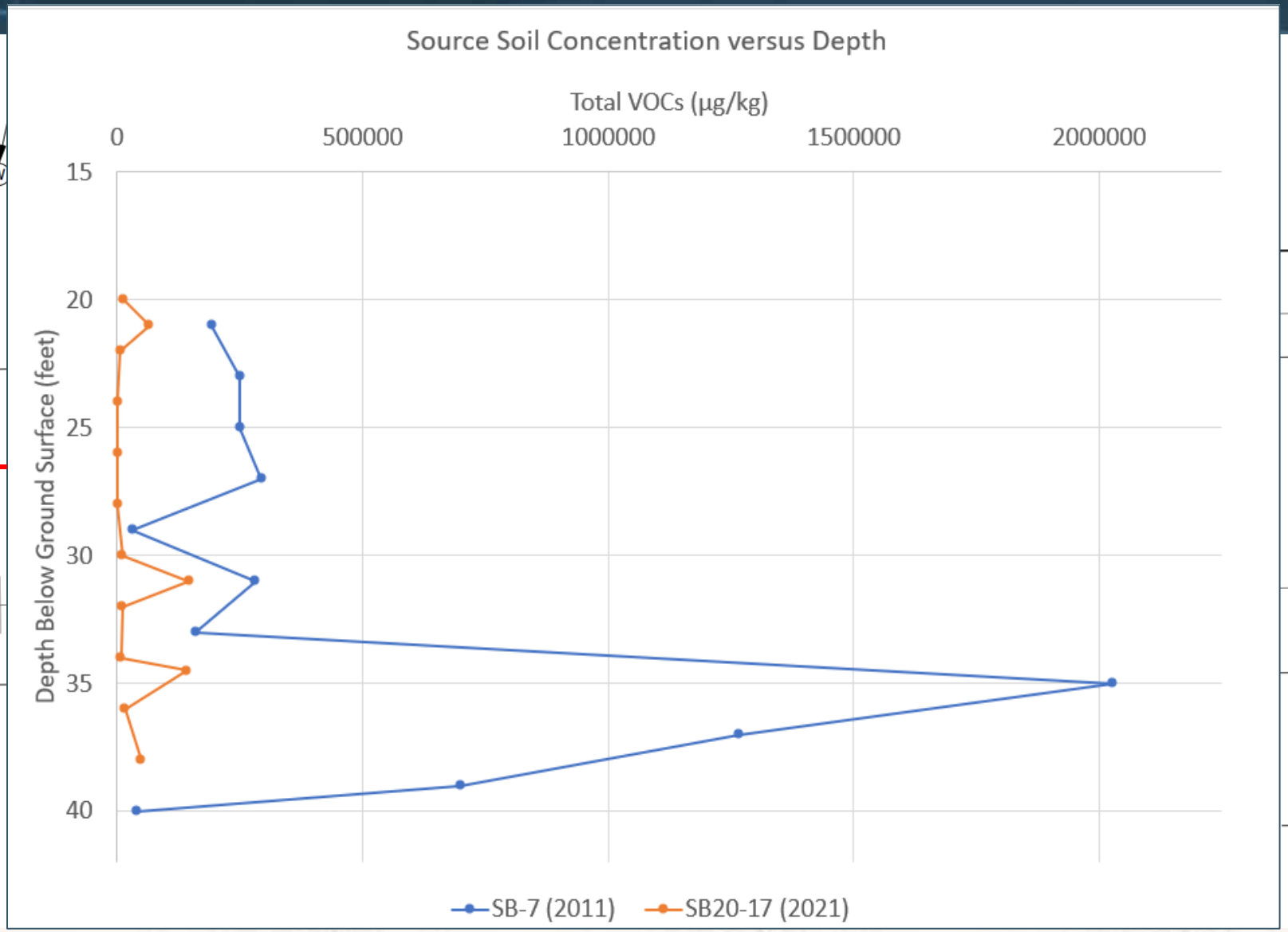


Performance as of September 2023 (Total CVOCs)

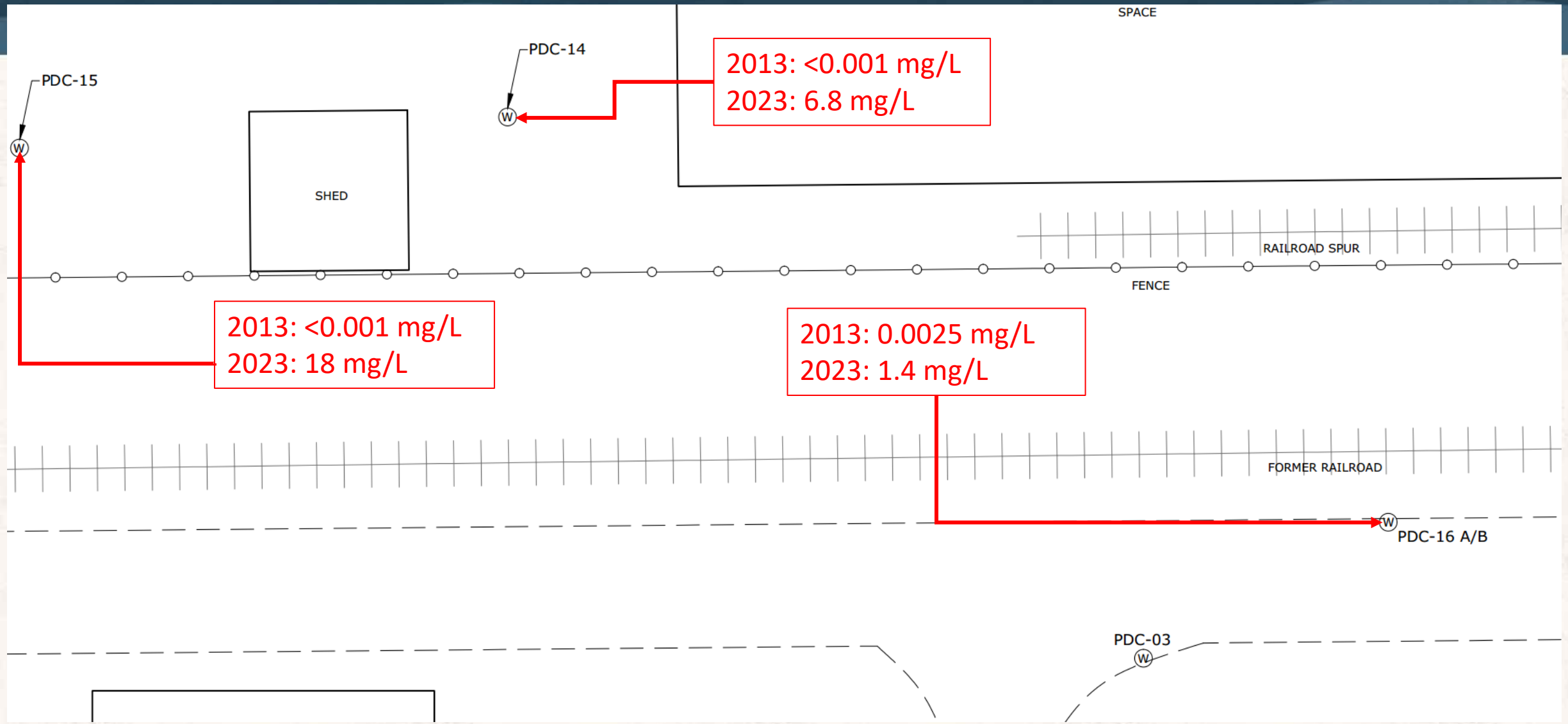


Performance as of November 2022 (Total VOCs)





Performance as of September 2023 (Ethylene)



Fiscal Consciousness

1. Remedial Design Characterization (RDC) – 3 Events ~$74k
2. ISCO Soil Blending - ~$38k
3. In-Situ Injection
    1. 6 Events ~$1.02M
    2. ~$170k/event or ~$128k/year (2013-2020)

Final Actions

1. On-site Structures Razed in Spring 2021 for Future Redevelopment
2. Final Source Treatment Completed in September 2021
3. Carbon Tetrachloride Alt. Source Treatment In-Situ Fall 2021
4. Managed Closure Granted 1Q2023

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