Combining Biotic and Abiotic Processes Post ISTT

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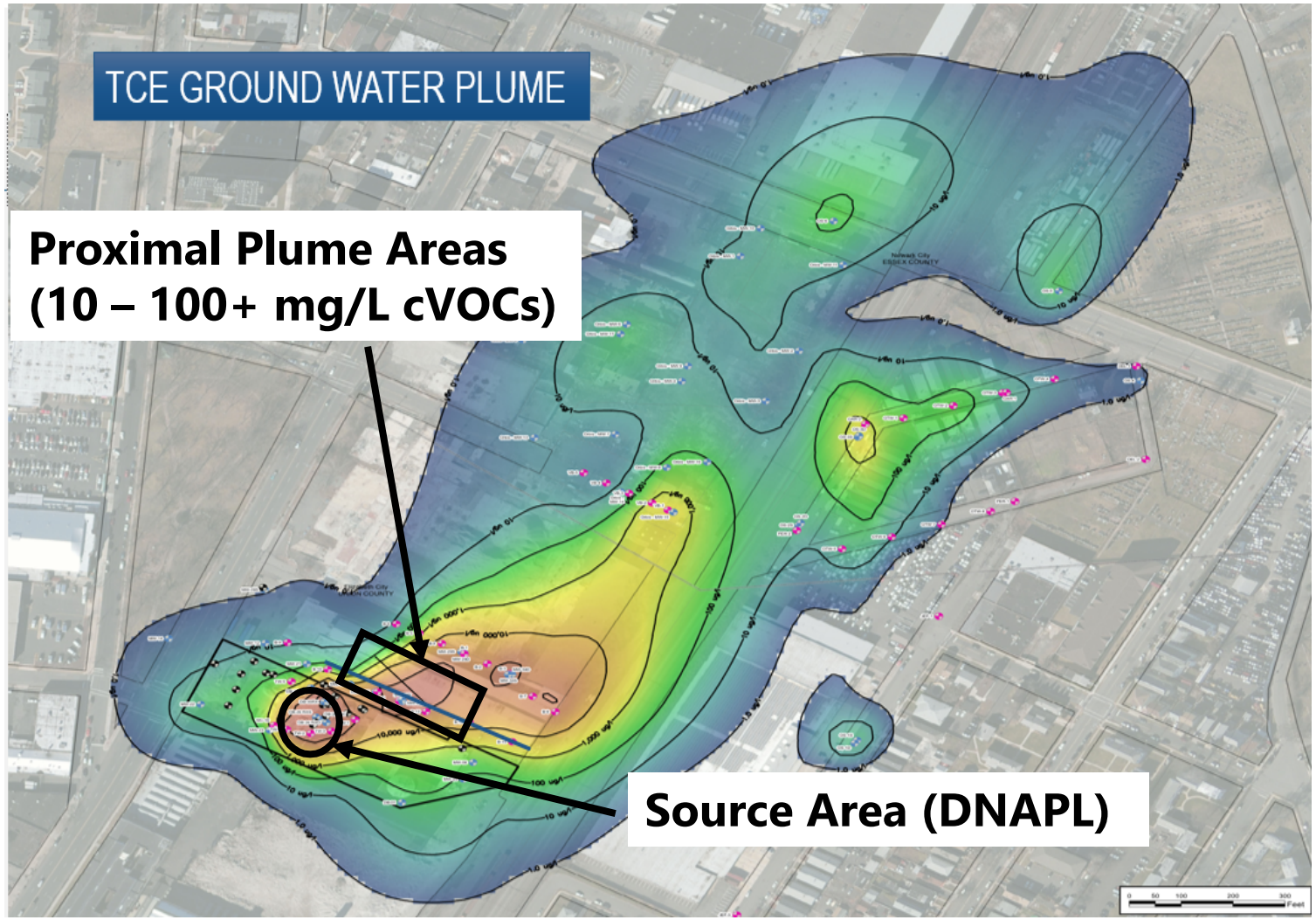
Woodard & Curran

Synergistic Remedies Increase Effectiveness

- In situ remediation approaches applied globally
- Combination remedies are new in situ remediation paradigm
- Enhance Strengths and Minimize Weaknesses
- Sequential and/or Spatial Combinations
- Combinations within a single remedy

Source & Plume Combination
Single Remedy Combination in Plume

TCE DNAPL Source and Plume



- Urban/Industrial Area
- Chlorinated ethenes
- ~1600 ft dissolved plume

COC	Soil (mg/kg)		Ground Water (µg/L)
	Unsaturated	Saturated	
1,2 DCE	525	493	163,000
PCE	13.2	2.26	8.3
TCE	7,510	23,600	963,000
VC	42	8.5	6,980

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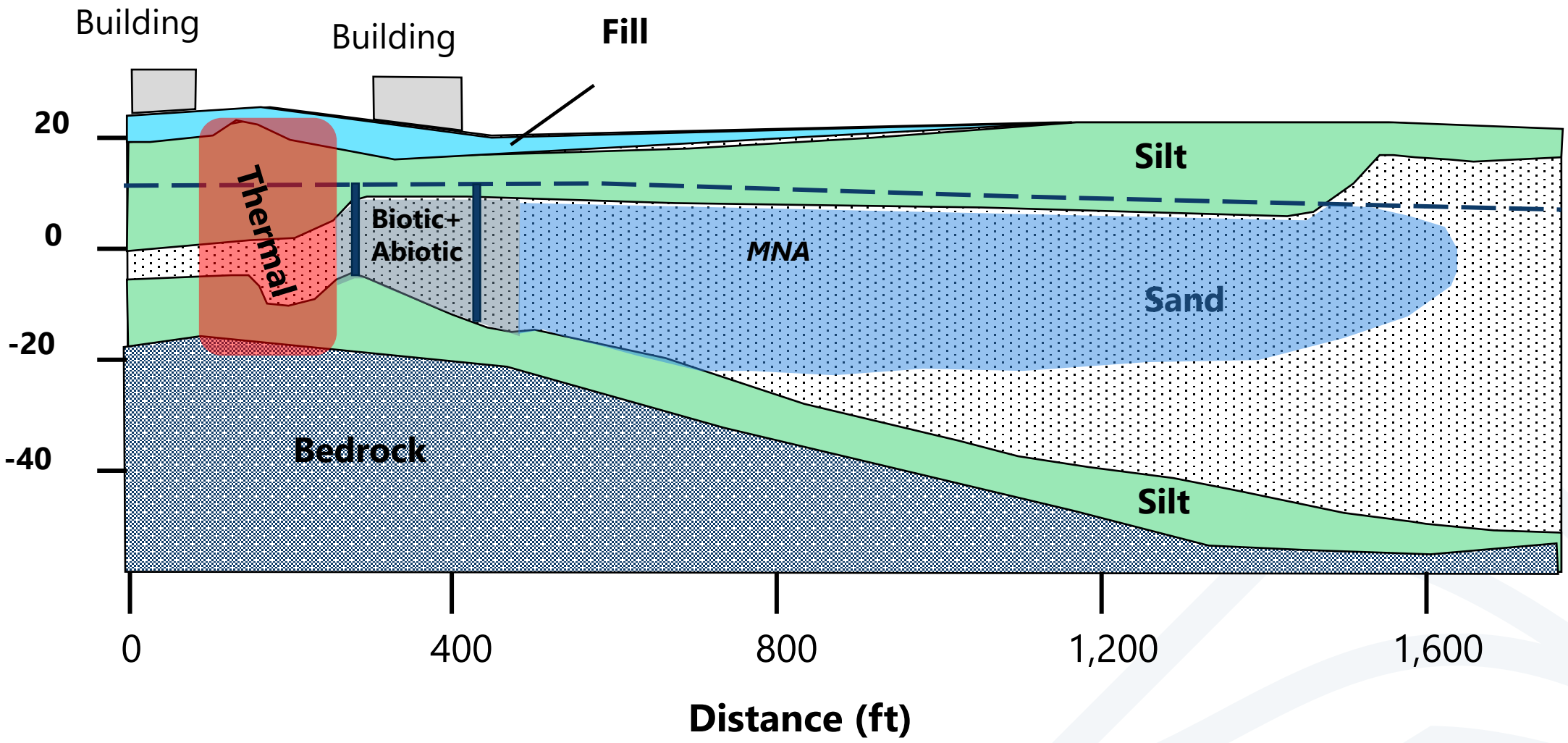
Leverage ISTT heat for enhanced remediation kinetics



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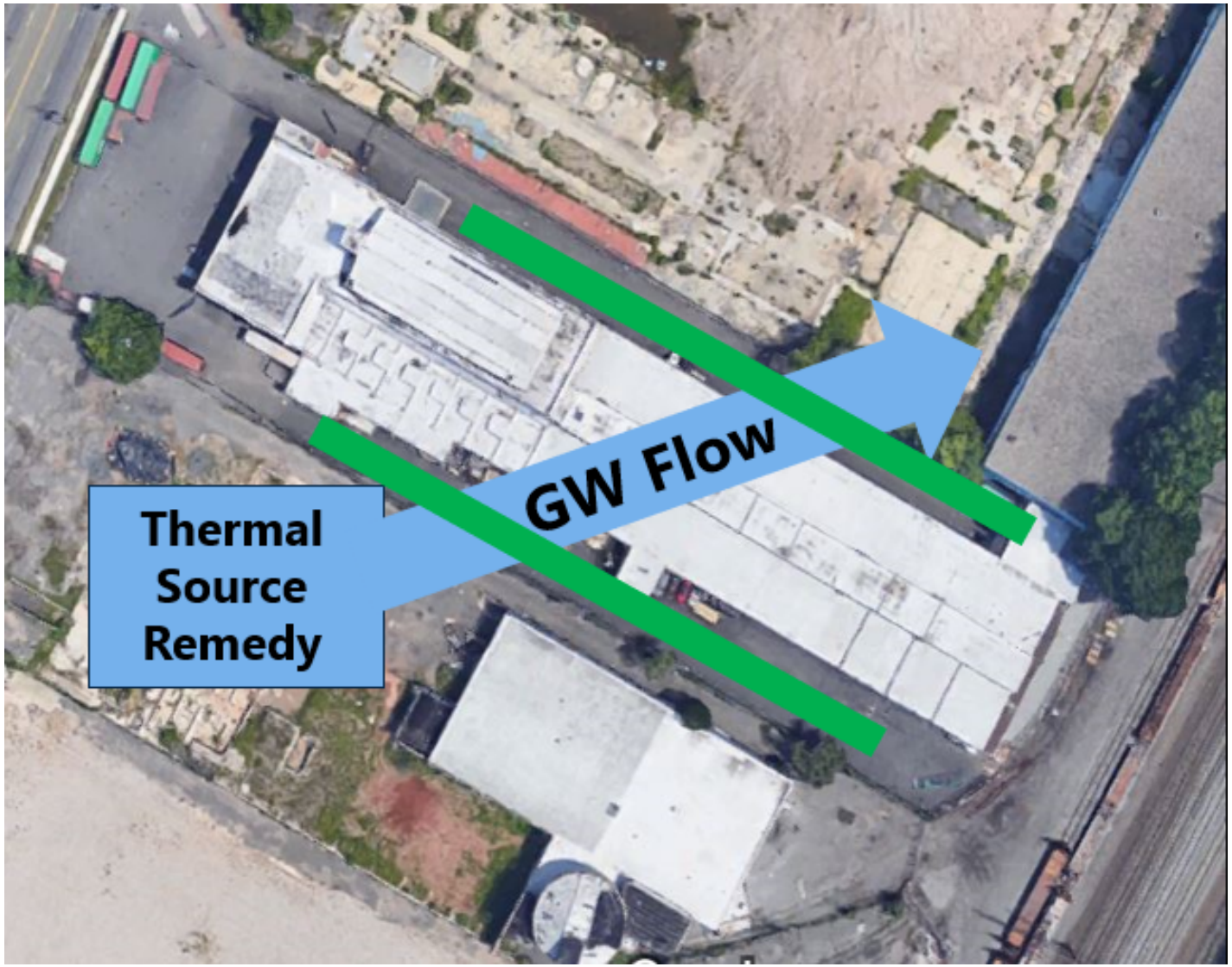
Warm water from ISTT affects downgradient conditions



- cVOC desorption
- Organic carbon release
- Microbial activity
- Abiotic degradation rates

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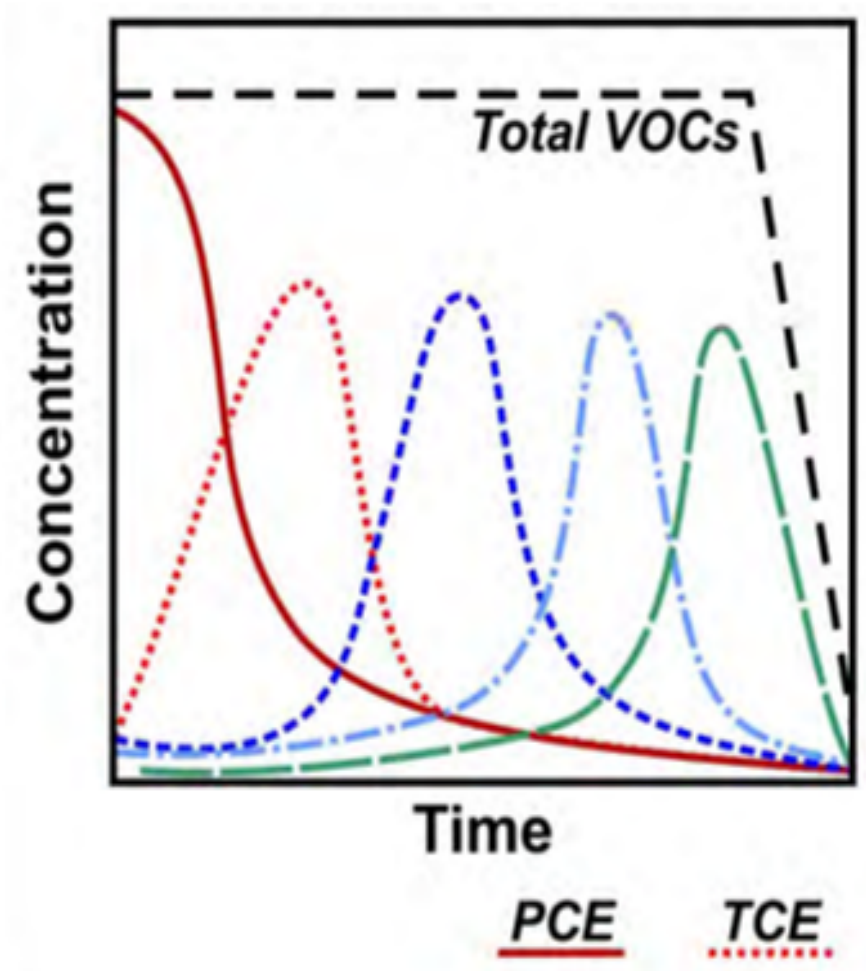
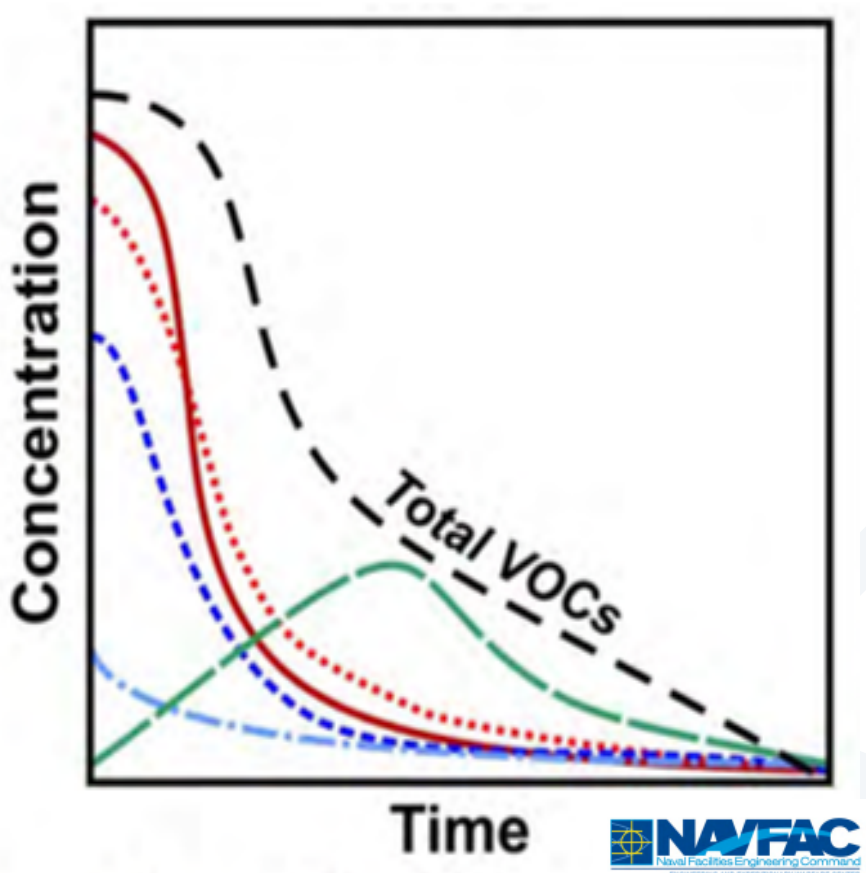
Combine biotic and abiotic processes

Biotic



Abiotic



NAVFAC Naval Facilities Engineering Command
ENGINEERING AND EXPEDITIONARY WARFARE CENTER

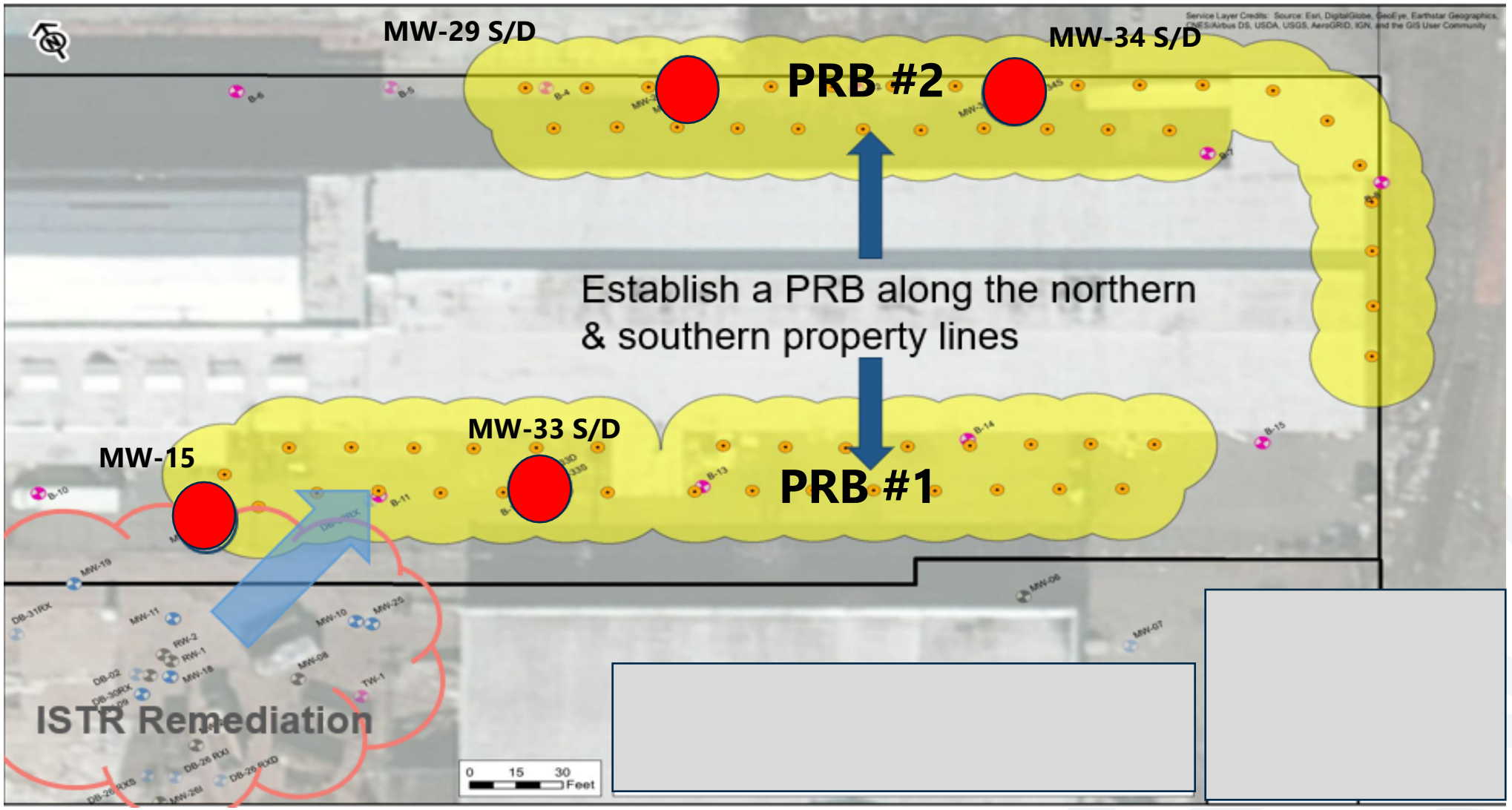
TECHNICAL REPORT
TR-NAVFAC EXWC-EV-1601

BIOGEOCHEMICAL TRANSFORMATION HANDBOOK

Utilized DPT equipment for reagent delivery

- Targeted transmissive sand zone, 14-57 ft below grade
- Direct-push injection
- 30% solids slurry
- 148,500 lbs Provect-IR (60% ZVI and 40% fermentable carbon)
- 325 injection intervals
- 57 borings

Installed reactive treatment zones



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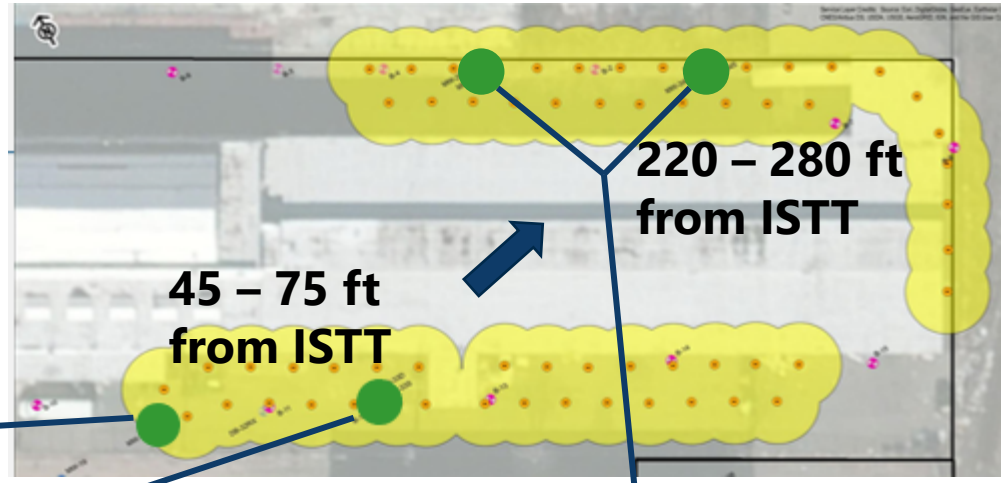
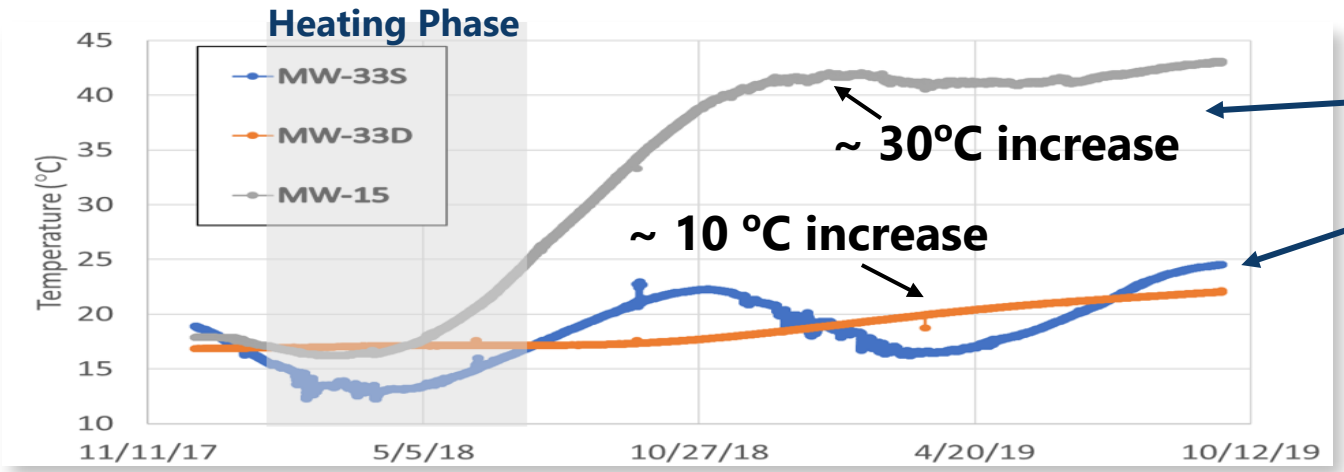
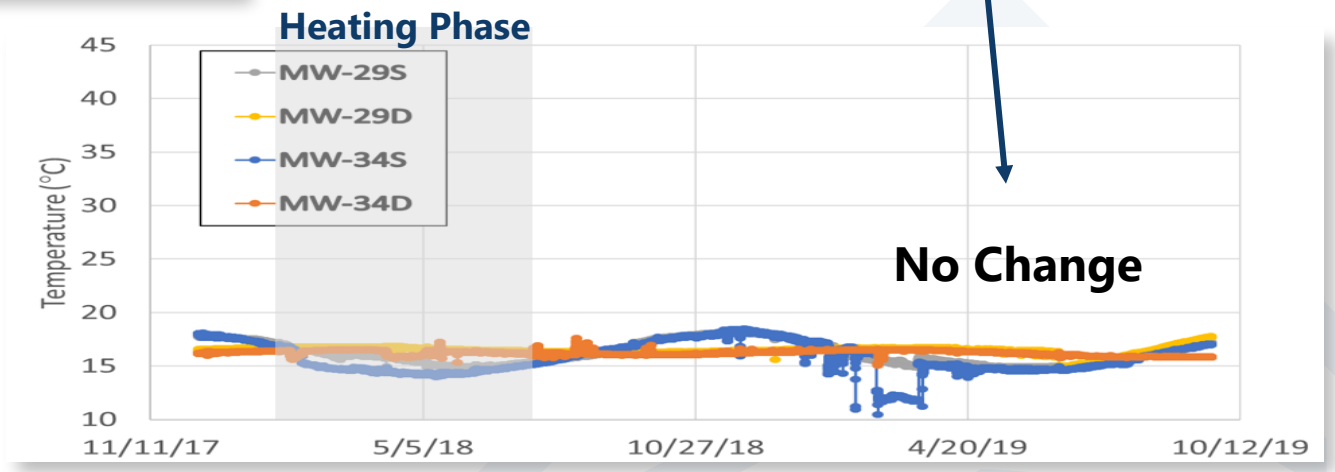
Temperature Results



Upgradient Zone



Downgradient Zone



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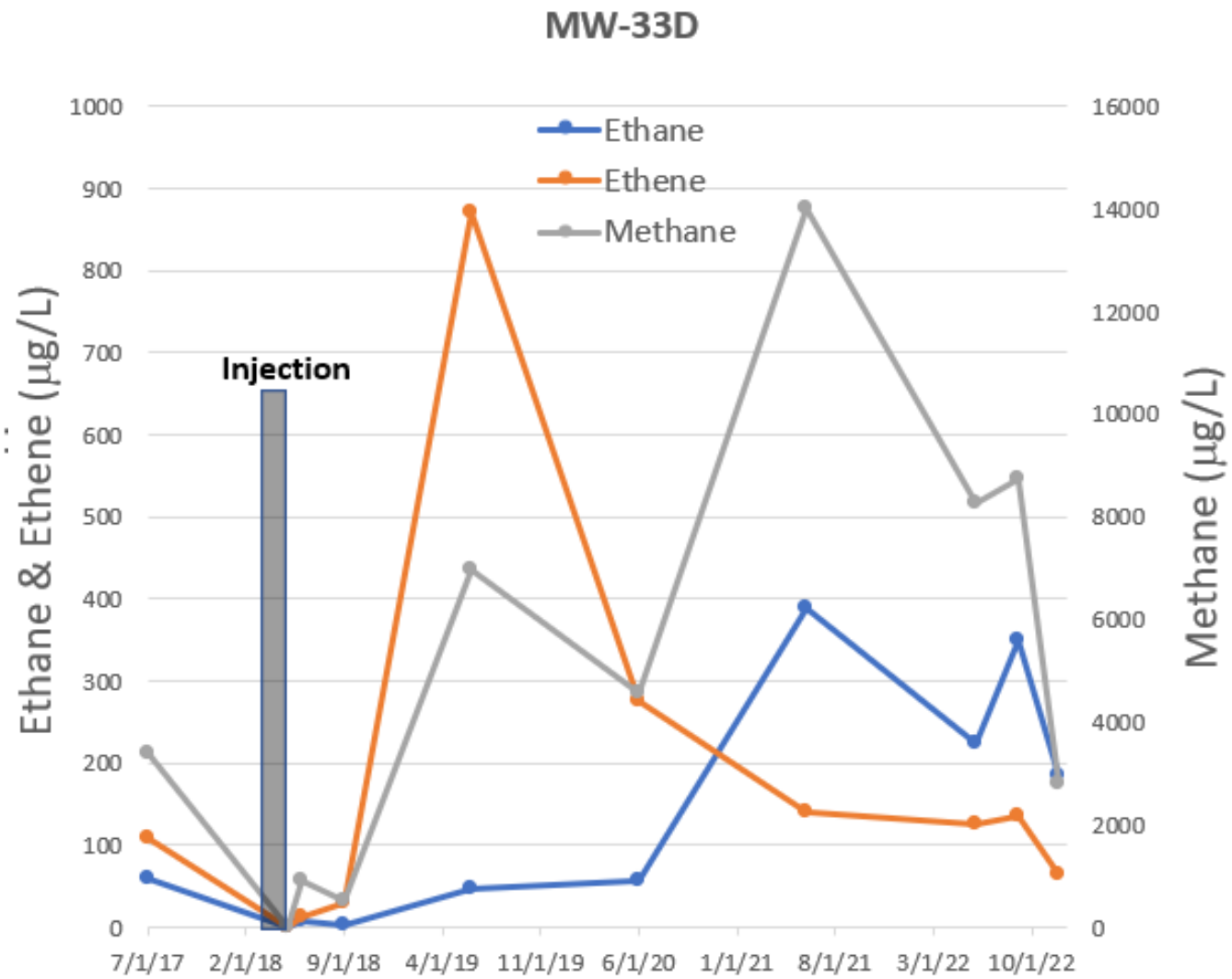
Biogeochemistry conducive for reductive dechlorination



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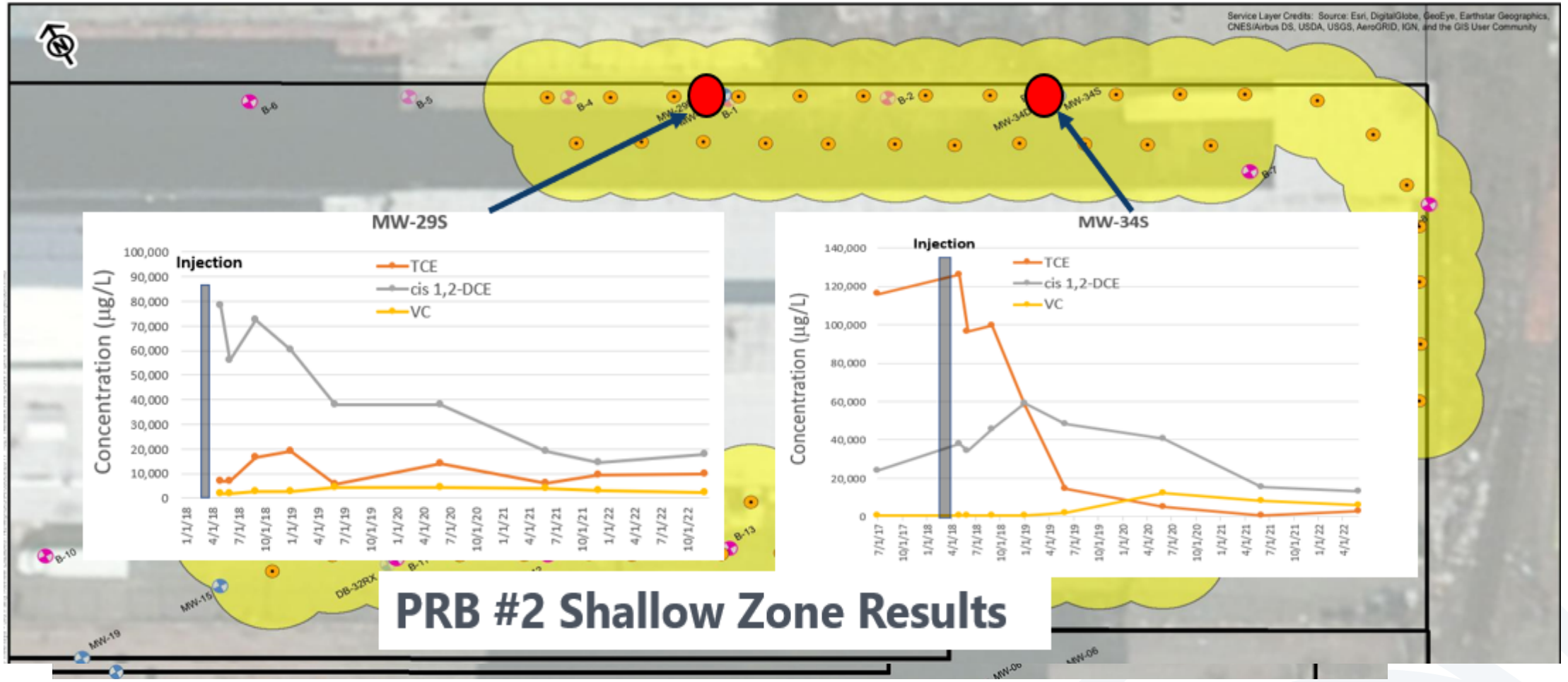
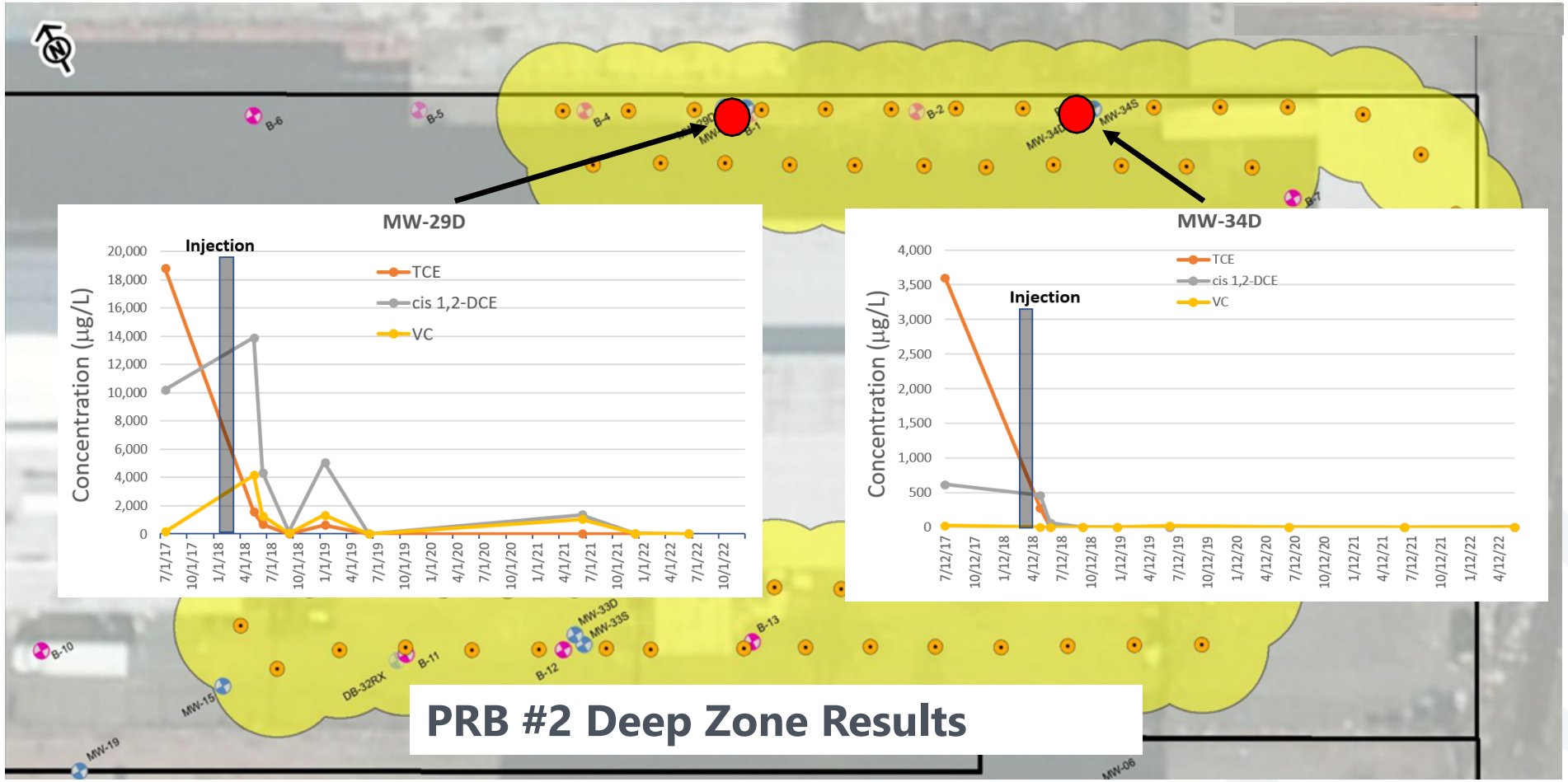
cVOC results PRBs #1 & # 2 shallow zone

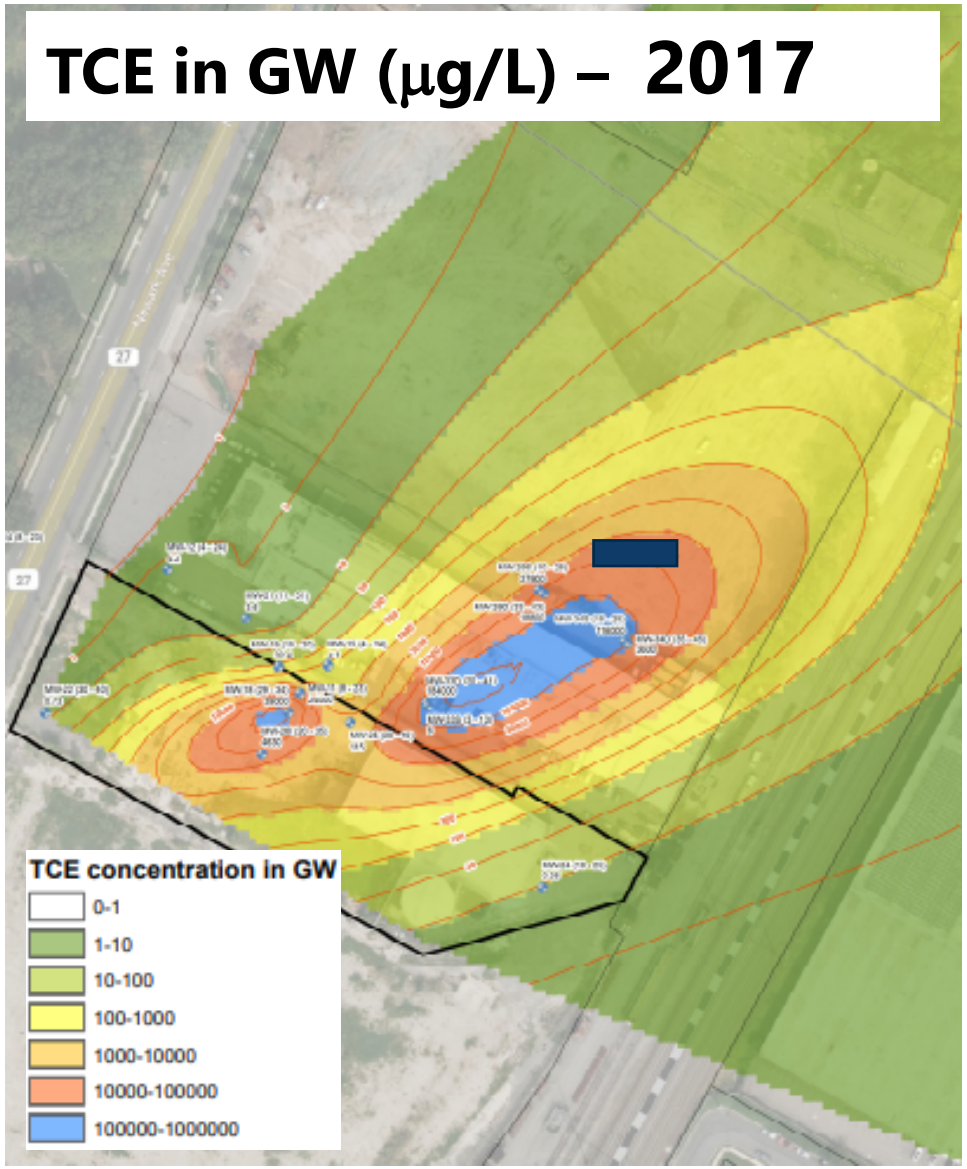


cVOC results PRBs #1 & 2 deep zone

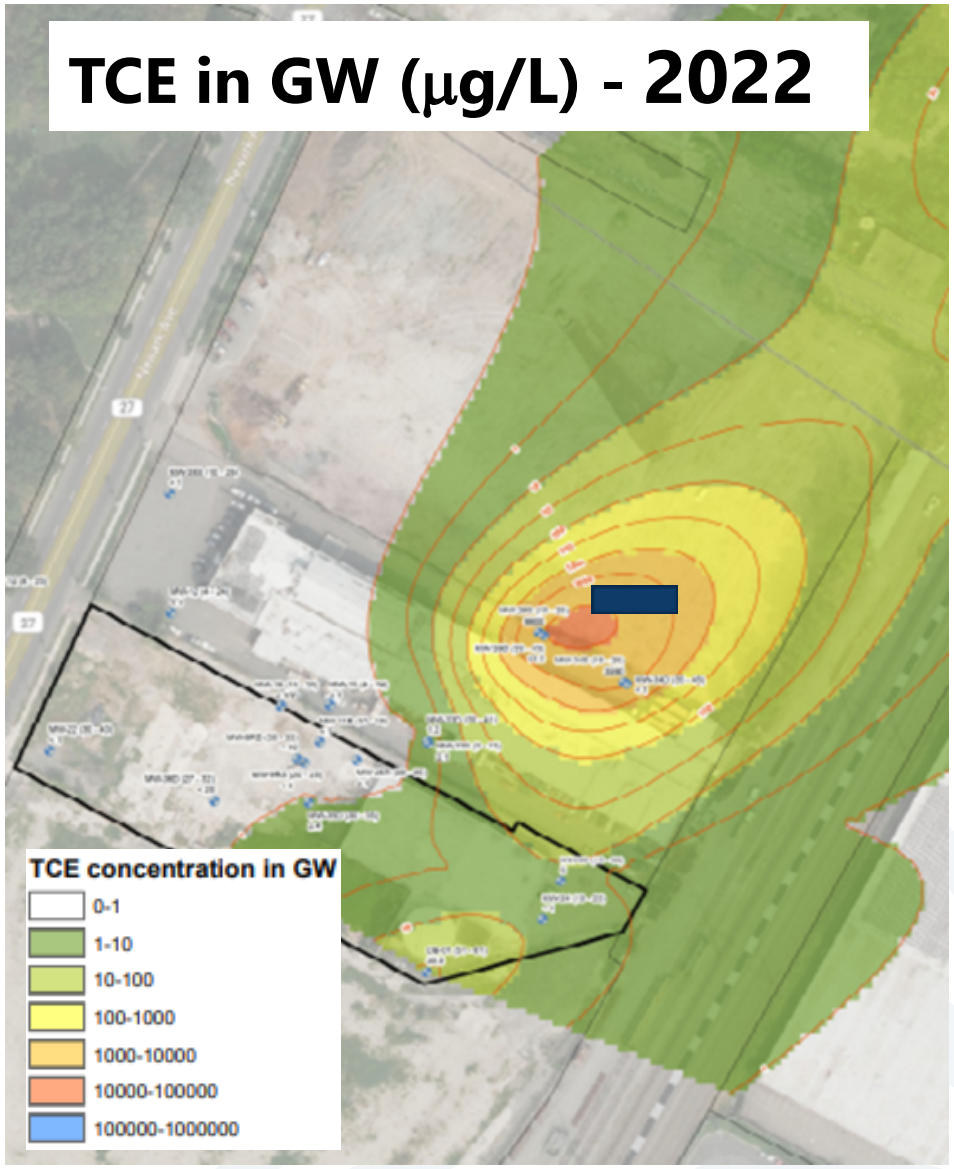


cVOC plume comparison

Baseline



~ 4 yrs. post injection



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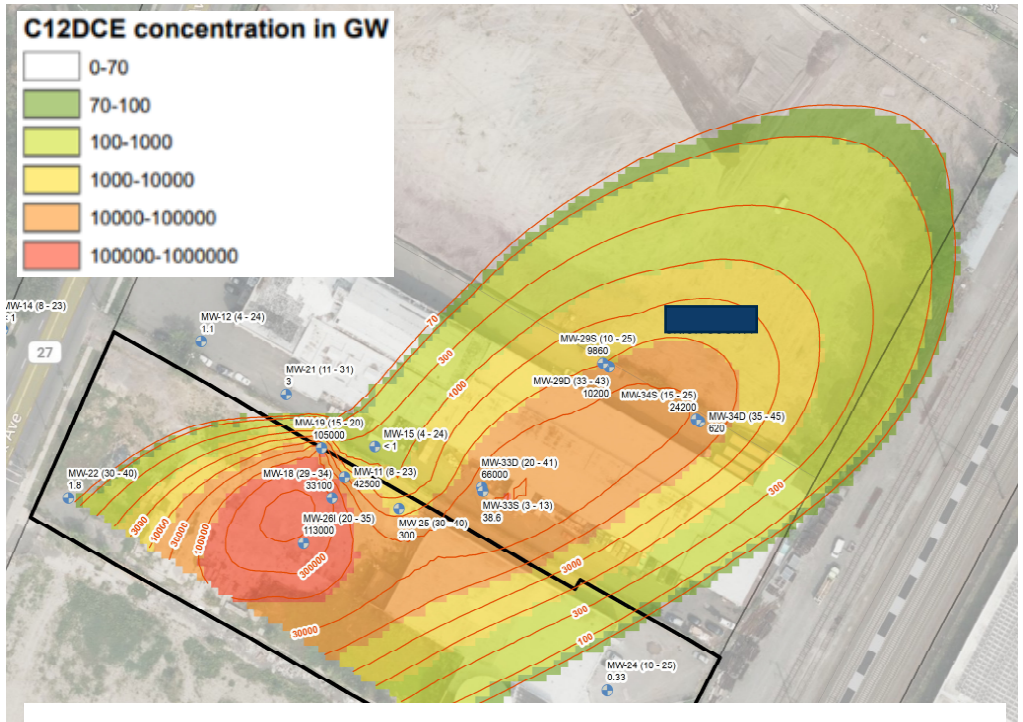
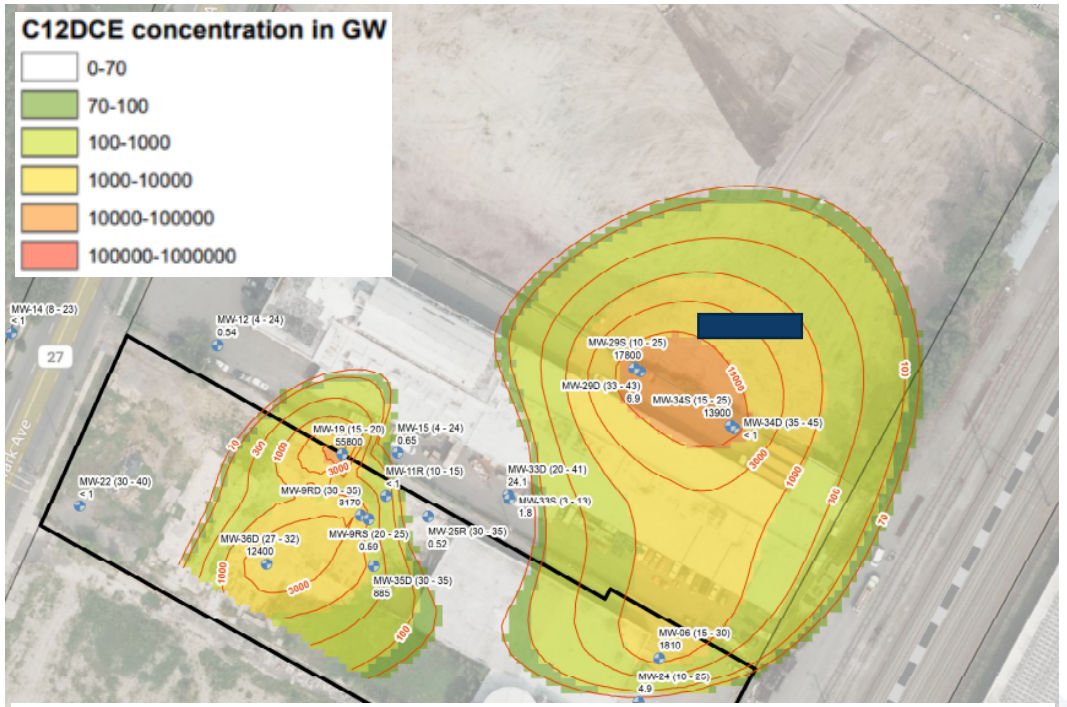


cis1,2-DCE in GW (µg/L) - 2017

~ 4 yrs. post injection



cis1,2-DCE in GW (mg/L) - 2022

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Combined, Synergistic Approach is Effective

Measured temperature increases downgradient

Source area GW temps @ 60°C after +1yr; Currently @ 21°C

Heat migration slower than expected

Effective biotic and abiotic degradation

Favorable biogeochemical conditions

10x to 100,000x cVOC reductions

Continuing to evaluate GW semi-annually

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Thank you!

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