

Management and Treatment of Contaminants in Low Permeability Zones Using PlumeStop®

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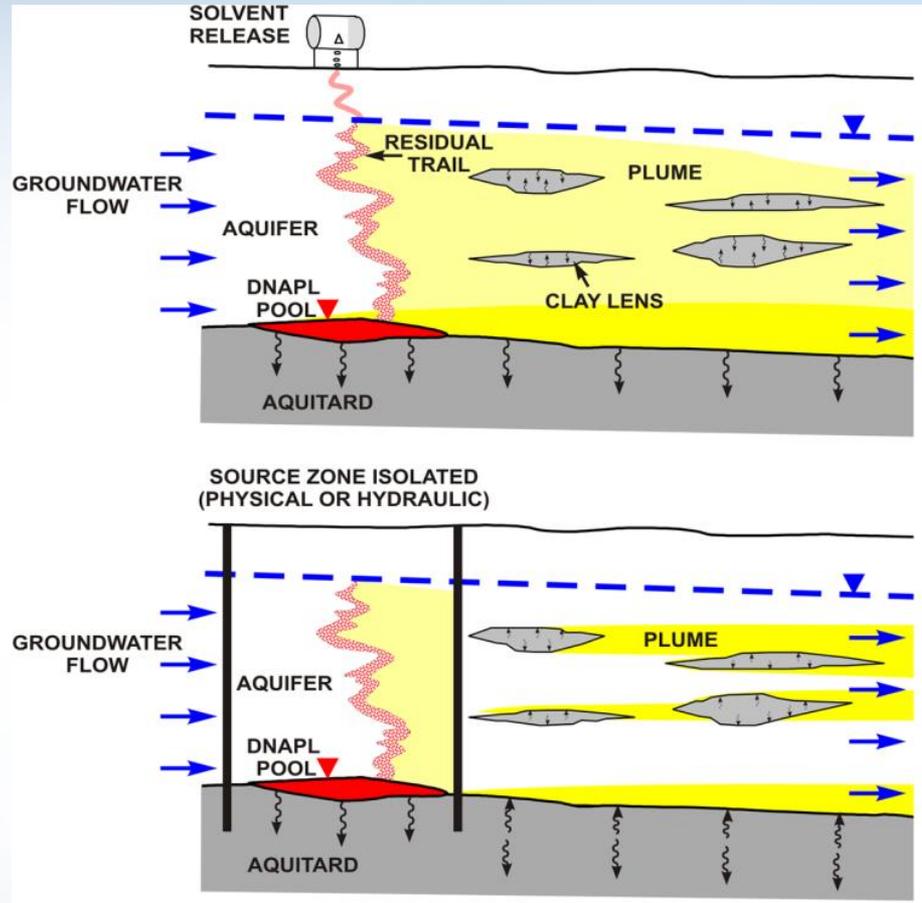
Presentation Contents

- Study Motivation: Back diffusion & plumes
- Laboratory tank study:
 - Setup
 - Flushing & Treatment Results
 - Effluent data
 - Soil VOCs
 - Microbial qPCR data

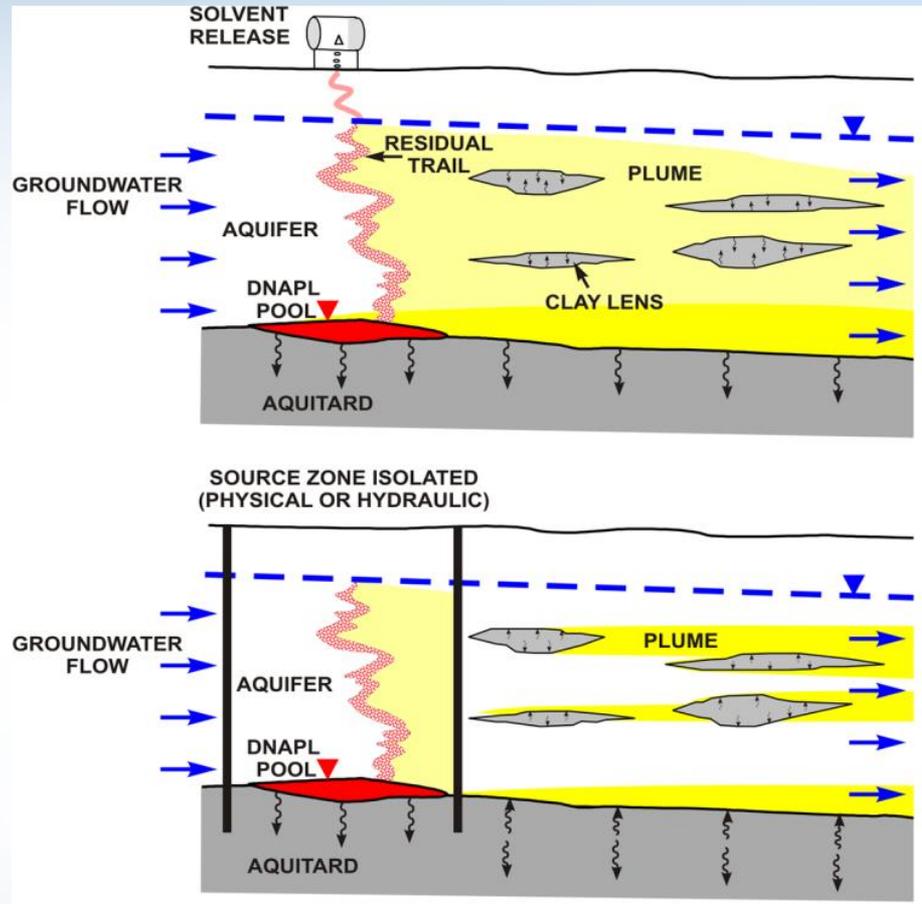
Motivation for This Work

Determine the efficacy of PlumeStop Colloidal Activated Carbon for managing dissolved chlorinated ethenes diffusing from low permeability (k) soils

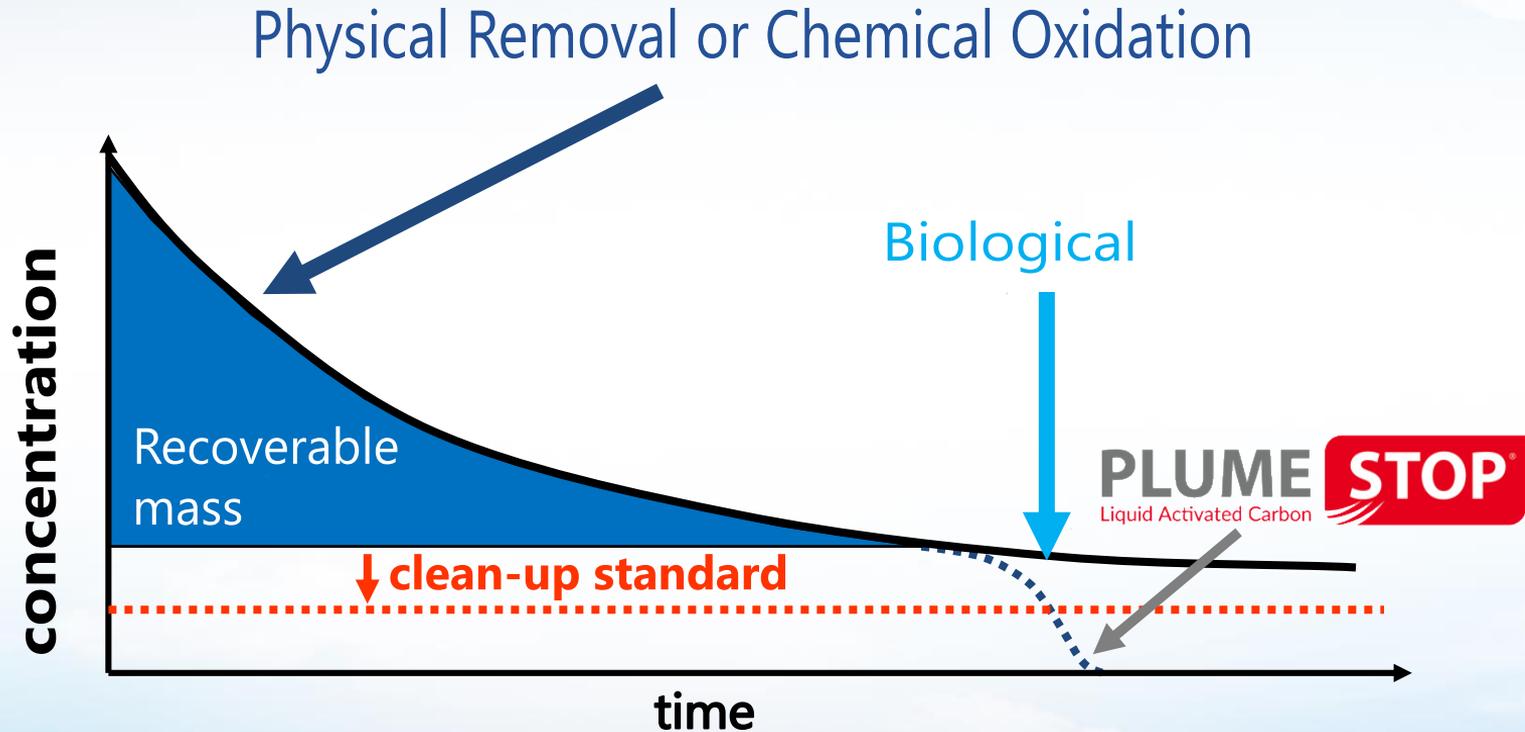
The Problem: Persistent contamination observed in plumes can be the result of back-diffusion and desorption from low k zones



The Challenge: These zones are diffusion dominated, and are thus very difficult to remediate



Treatment with Back Diffusion



Experimental Setup

Experimental Setup

- Four identical 0.5m x 1.0m x 2.54cm tanks
- 5-cm thick, alternating high and low k zones
- Low k:
 - Silt from F.E. Warren AFB, WY
 - $K \sim 1 \times 10^{-4}$ cm/sec
 - Foc $\sim 0.3\%$
- High k:
 - 80% M. Sand, 20% sandy loam
 - $K \sim 1-5 \times 10^{-2}$ cm/sec



Experimental Setup (cont.)

- Flushed with TCE saturated water for 36 days
- Followed by clean water flushing
- Flow was upwards in tanks



TCE Exchanger & Sampling



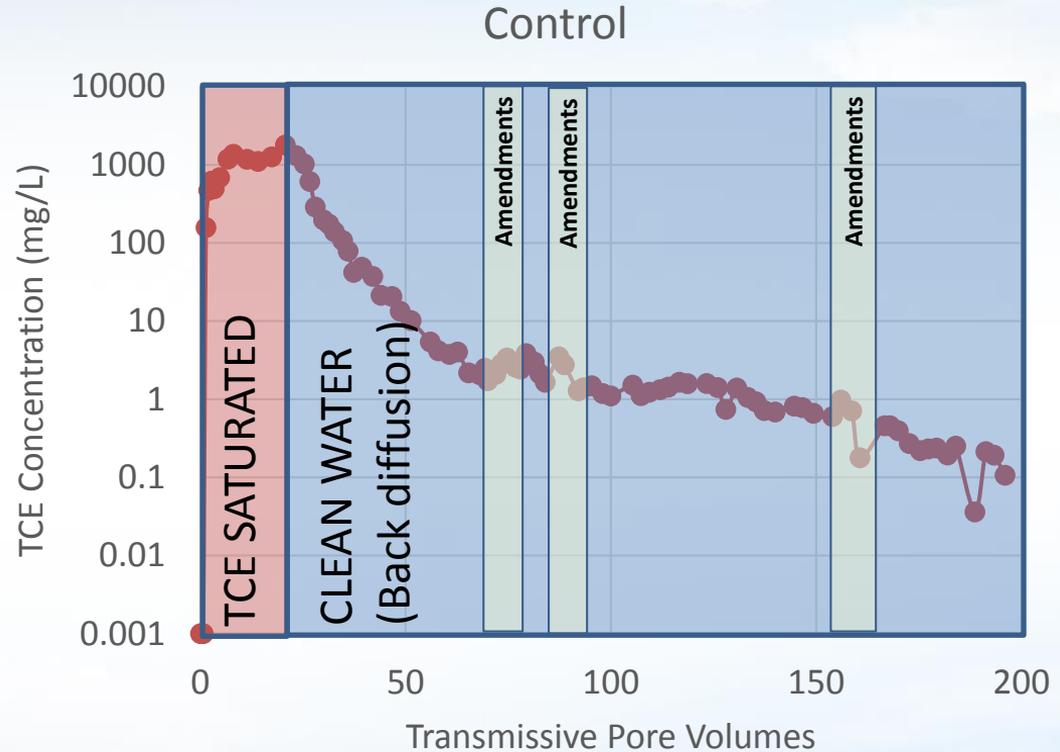
TCE exchanger column
for delivery of TCE to
tanks

Effluent samples collected
throughout experiment for
VOCs



Experimental Design & Timeline

1. "TCE Spill"
 - a. TCE saturated water flushed through tanks (~24 PVs)
2. Flushing / back diffusion:
 - a. Influent switched to clean water until effluent TCE <4 mg/L
3. Treatments Begin



Treatments

Tank 1 Control

Tank 2 PlumeStop only

Tank 3 ERD Treatment

- DHC, Lactate (DHC-L)

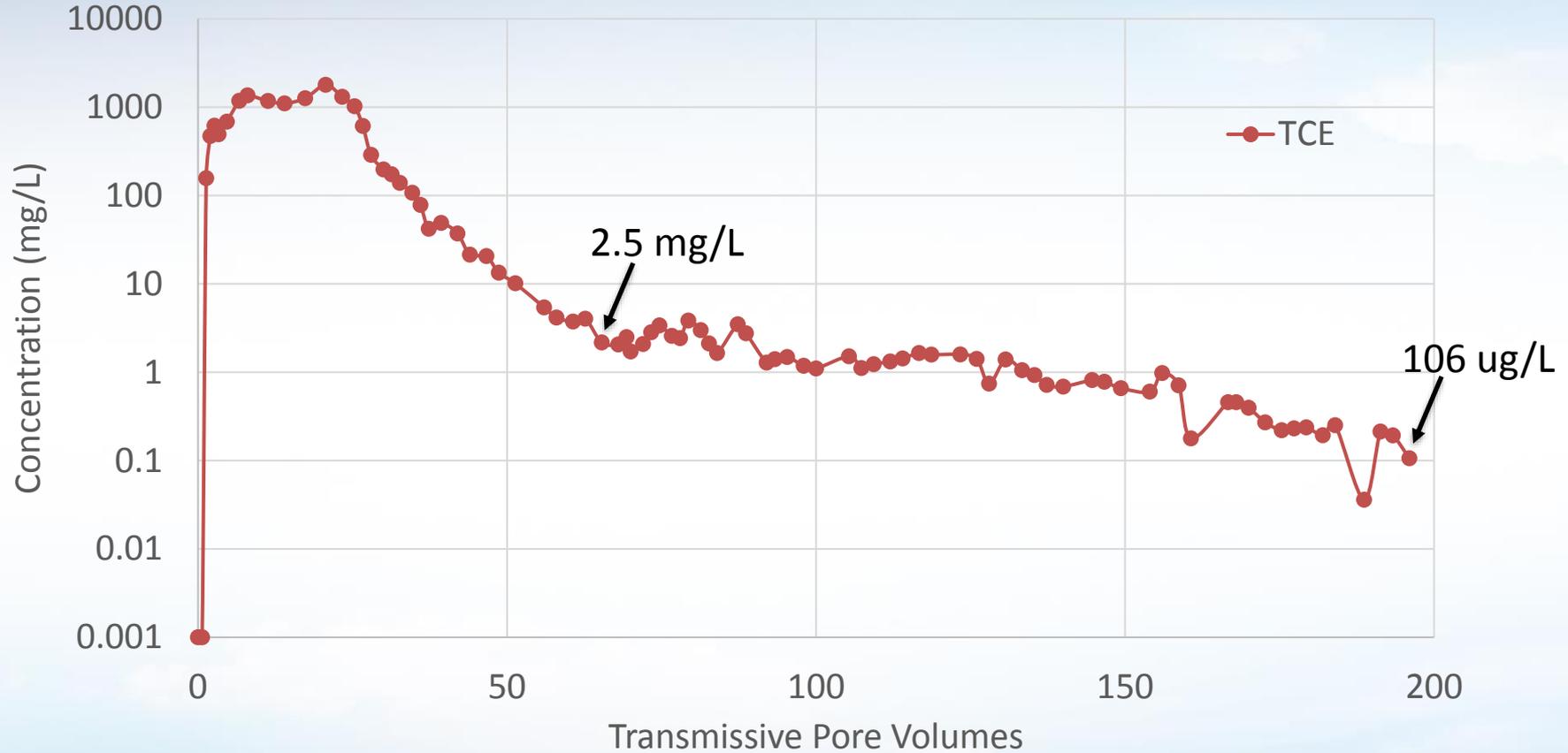
Tank 4 PlumeStop + ERD

- PlumeStop, DHC, lactate (PS-DHC-L)

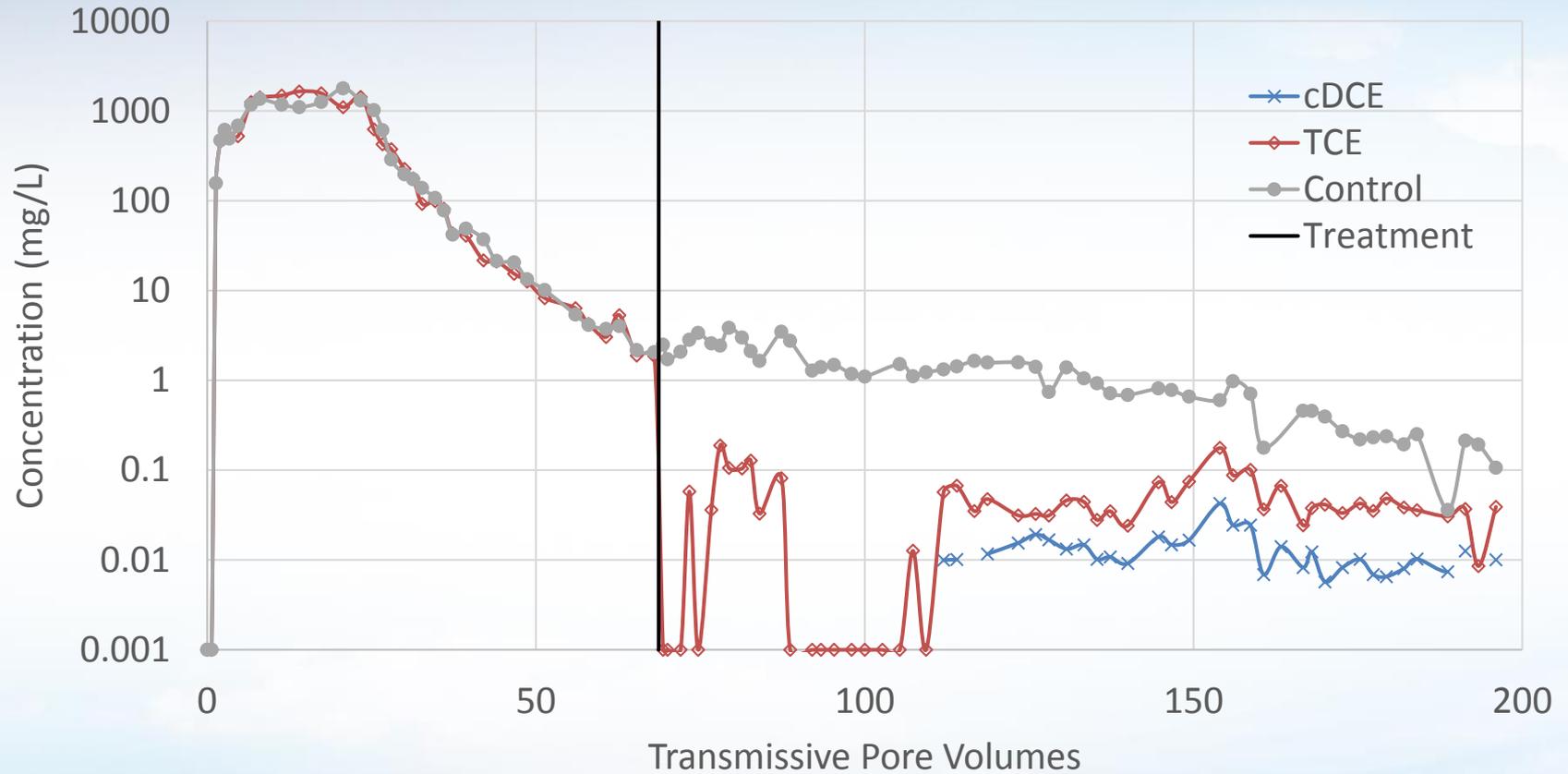


Effluent VOC Results

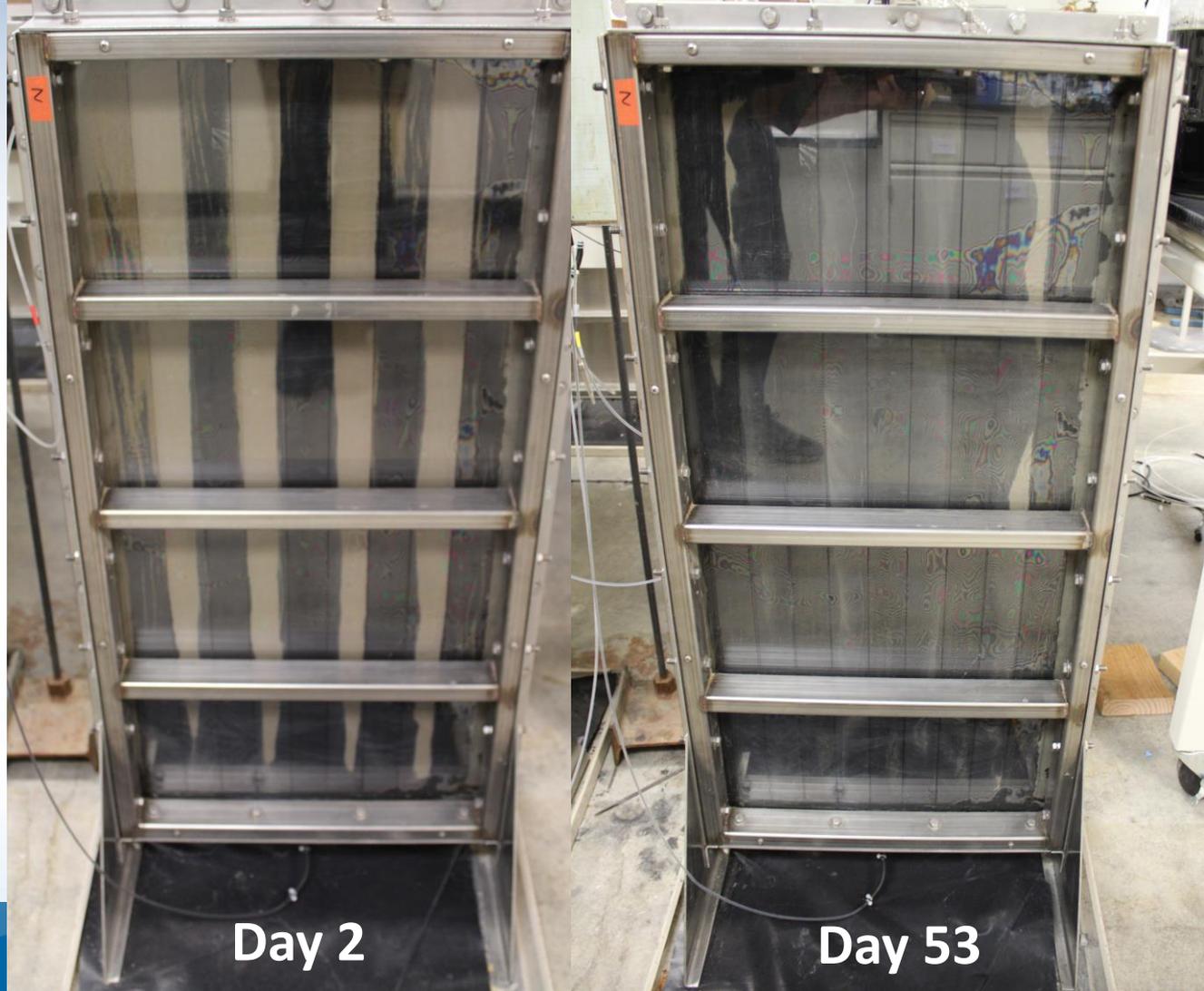
Control – No Treatment



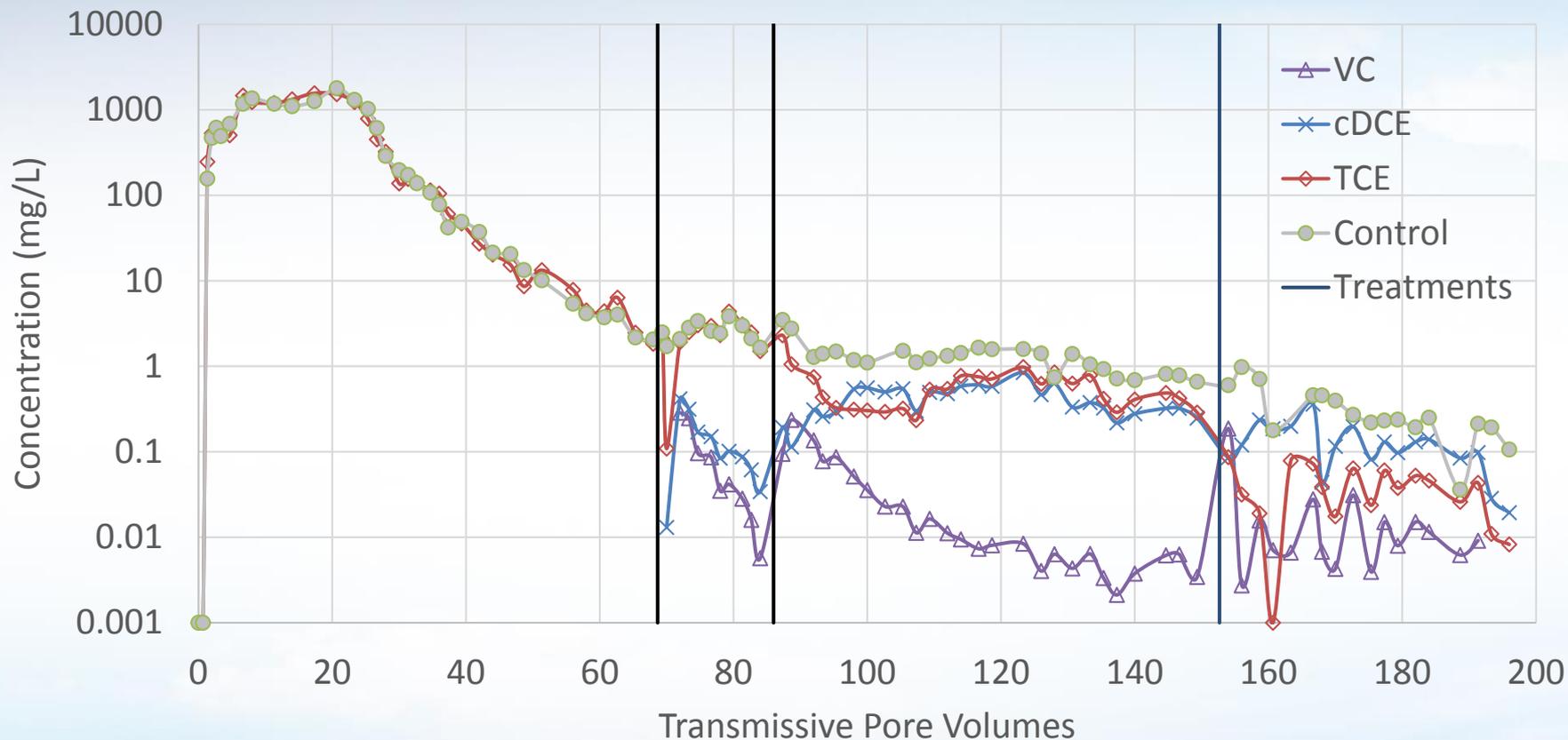
Tank 2 - PlumeStop Only



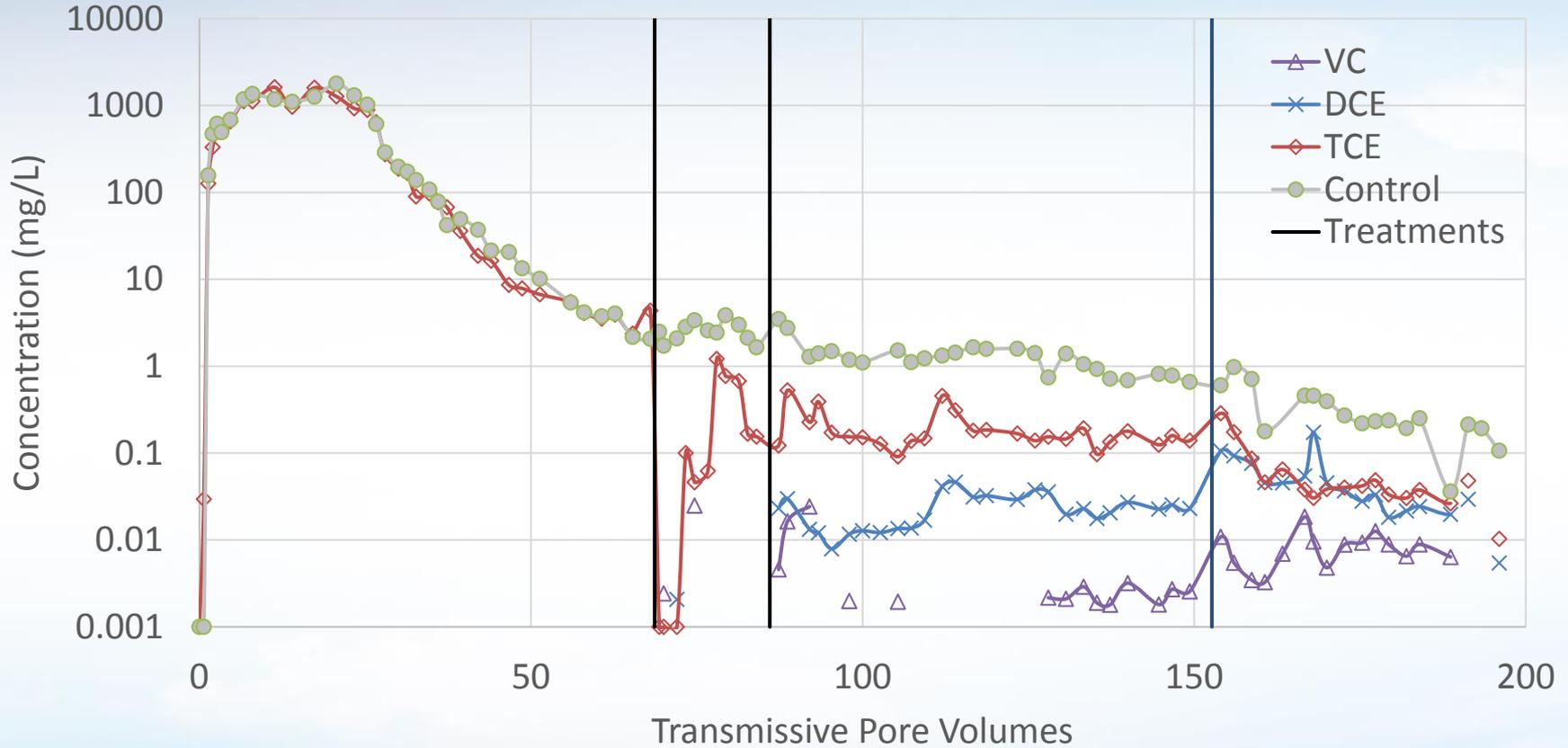
PlumeStop
Transport:
PlumeStop only



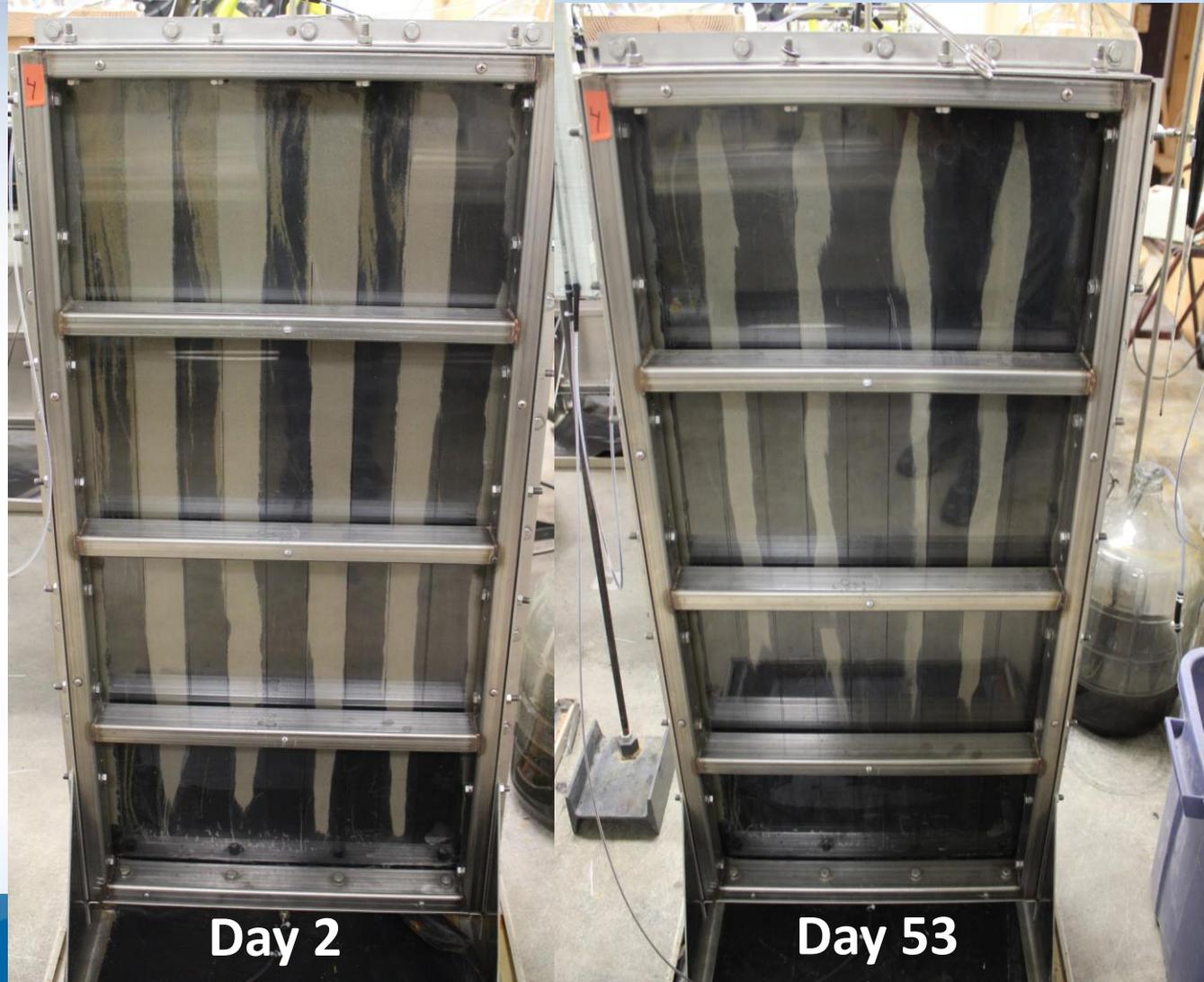
Tank 3 – DHC & Lactate



Tank 4 – PlumeStop, DHC, Lactate



PlumeStop
Transport:
PlumeStop,
DHC, Lactate

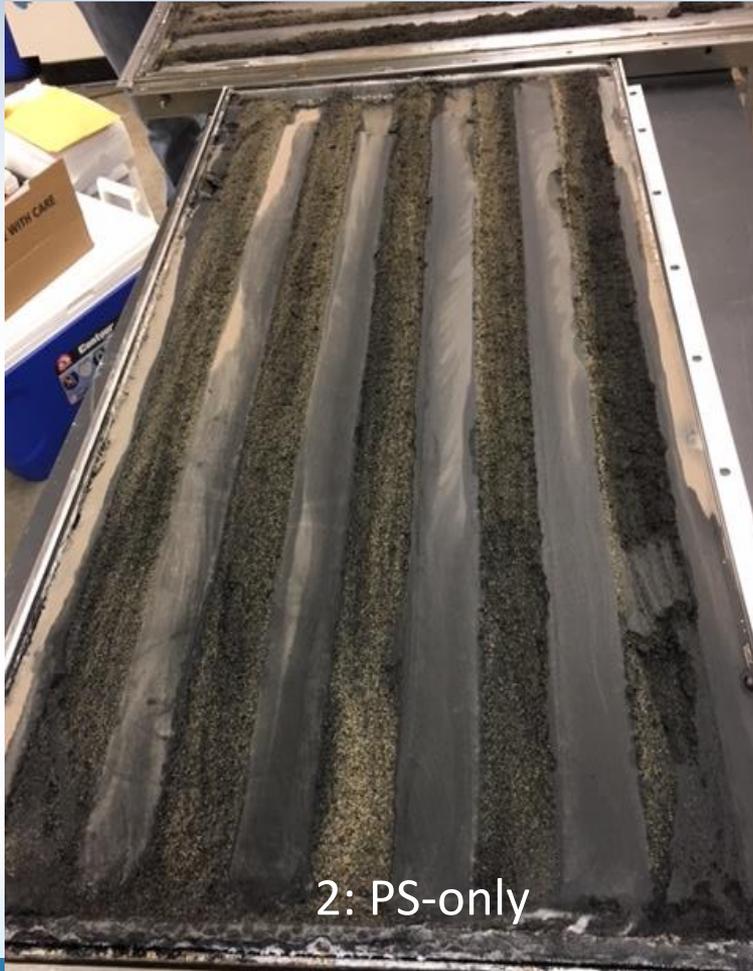


Day 2

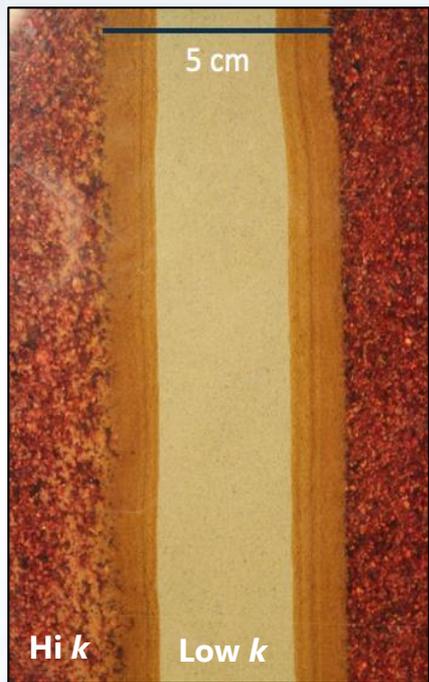
Day 53

PlumeStop Transport: End of Study

Meaningful
migration into
low k zones



PlumeStop Flushing– Comparison to Permanganate



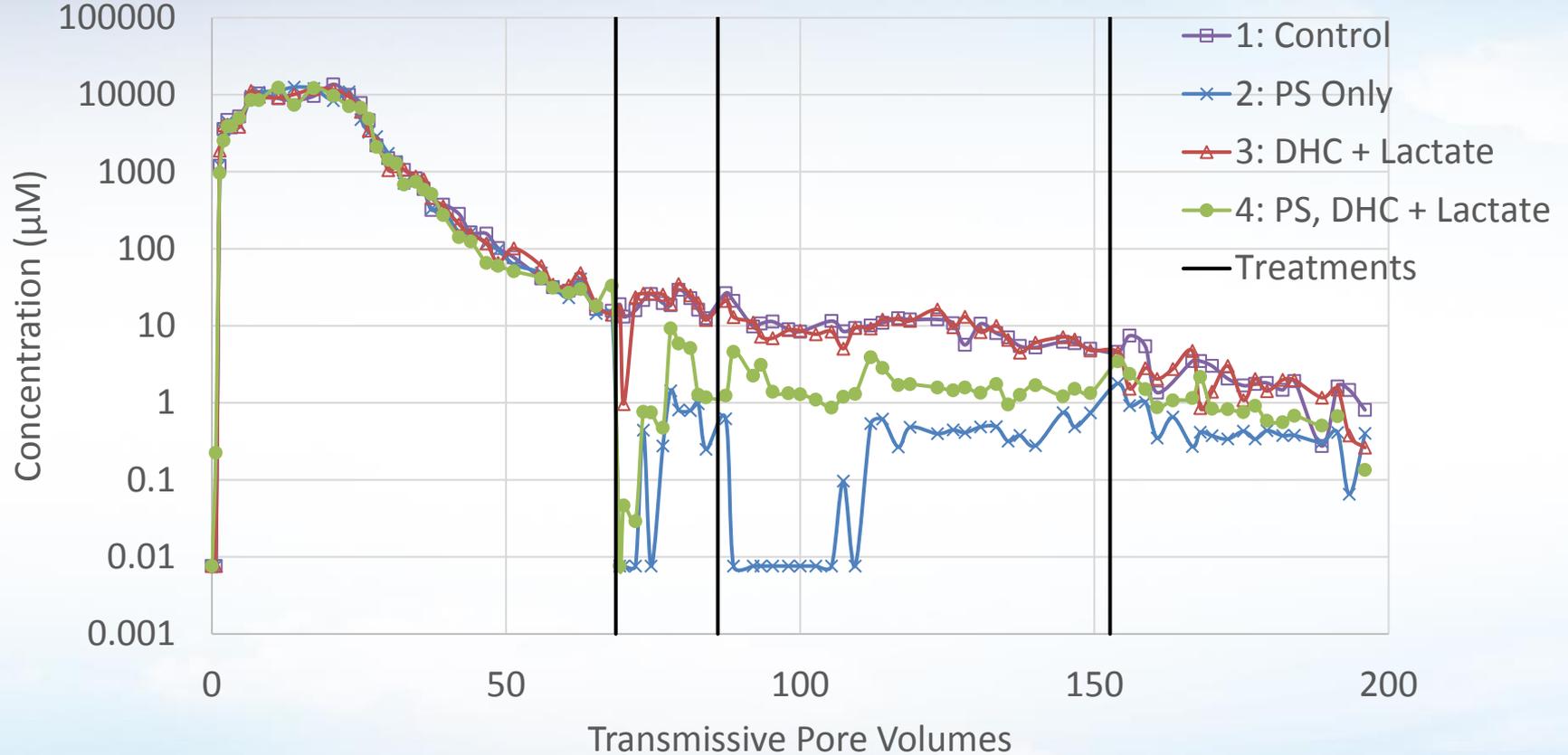
Permanganate Treatment¹



PlumeStop Treatment

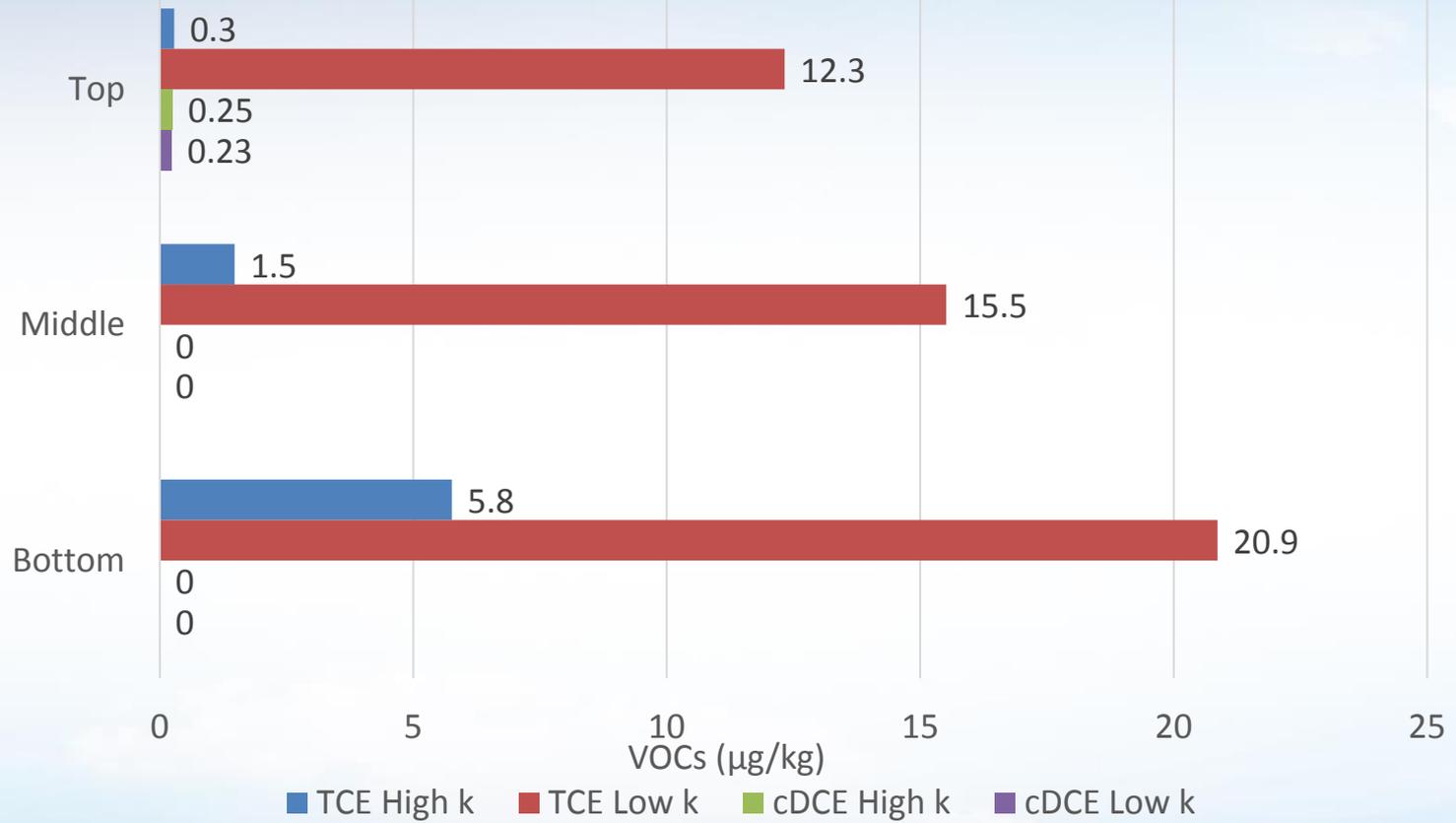
¹ K. Saller, T. Sale. 2013. *Management of Contaminants Stored In Low Permeability Zones*, SERDP Project ER-1740.

All Tanks - Total Effluent VOCs

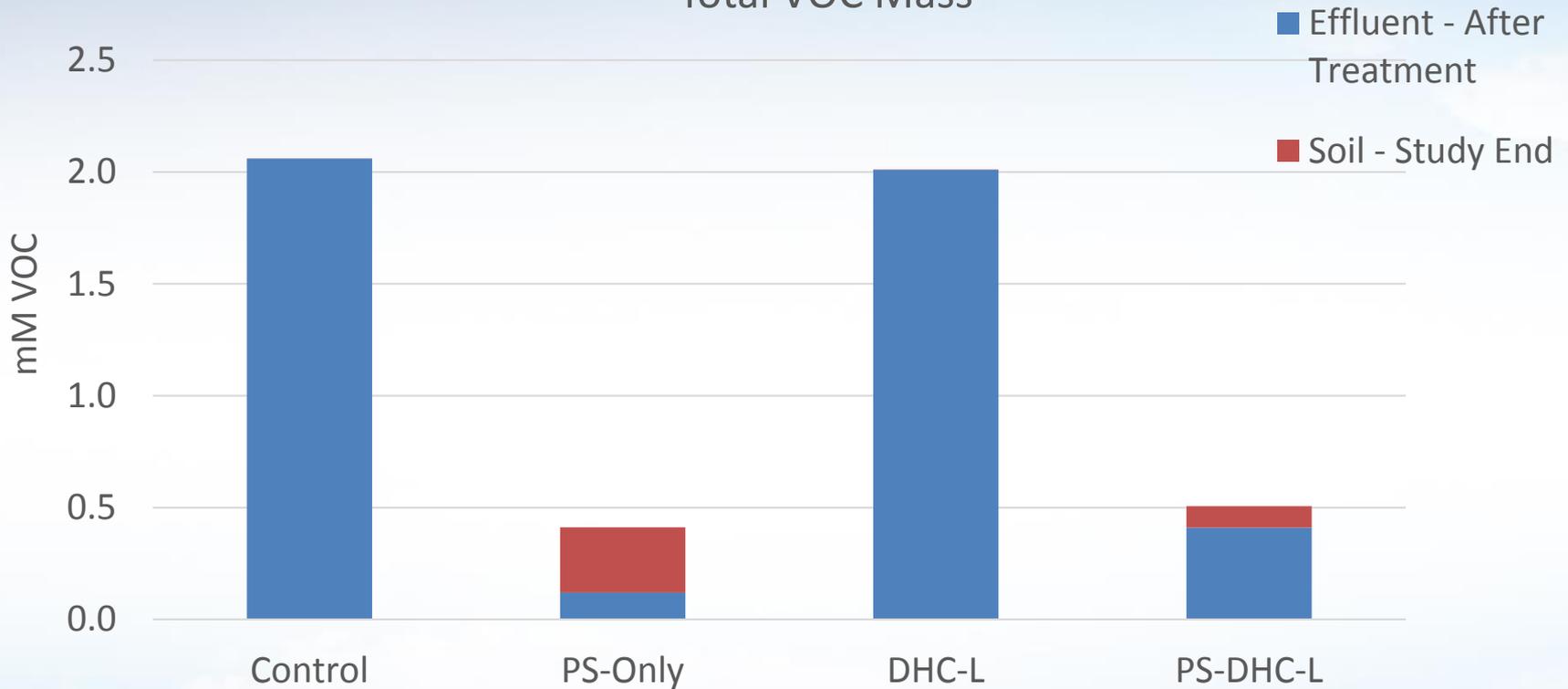


Total VOC Mass

Control – Soil VOCs



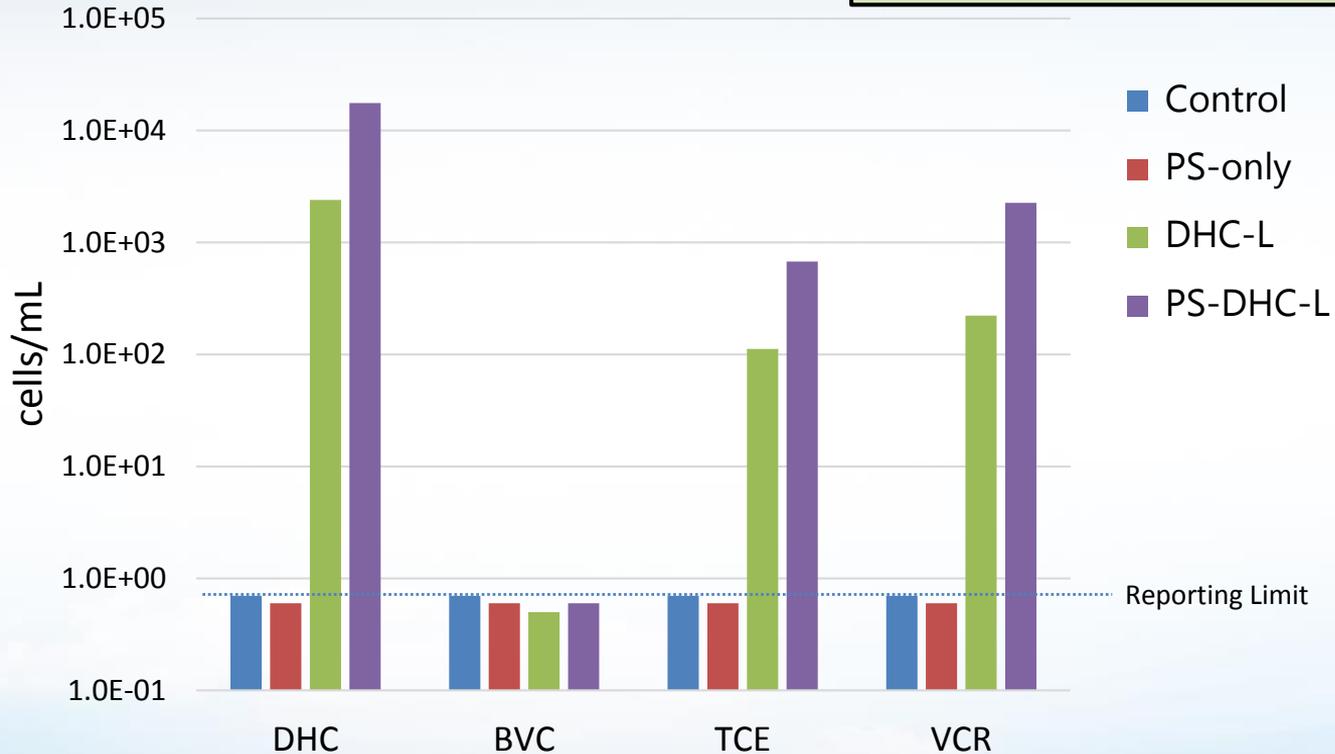
Total VOC Mass



Water/Soil Microbial Results

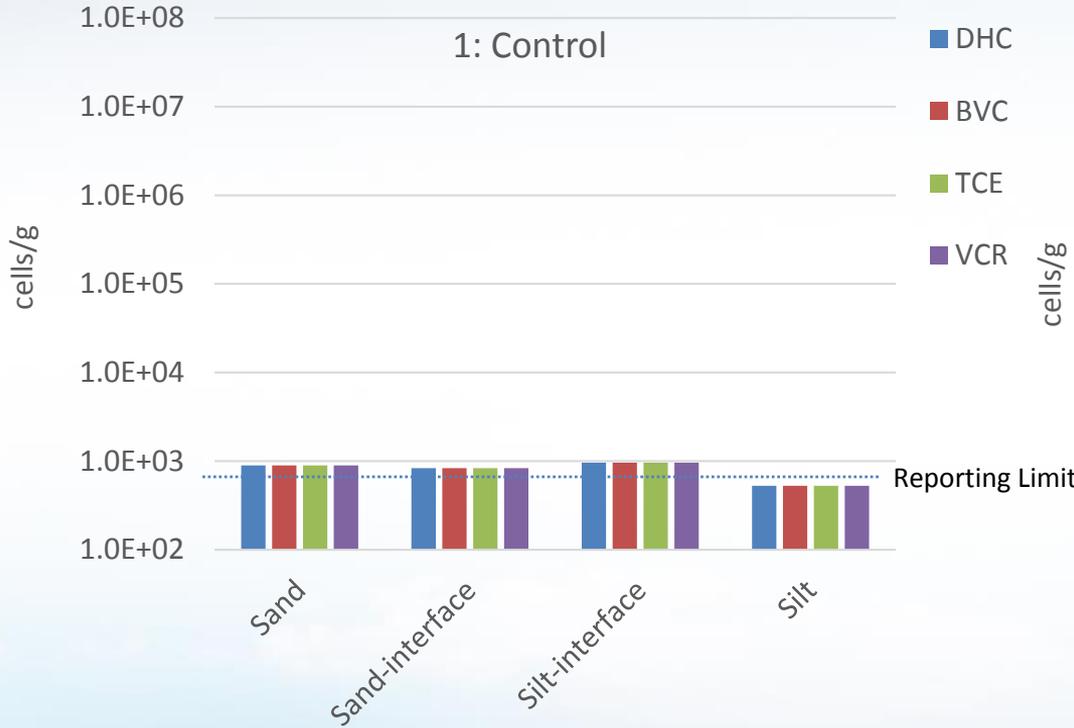
qPCR Data: Water

Enhanced DHC + functional gene populations measured in PS-DHC-L tank.



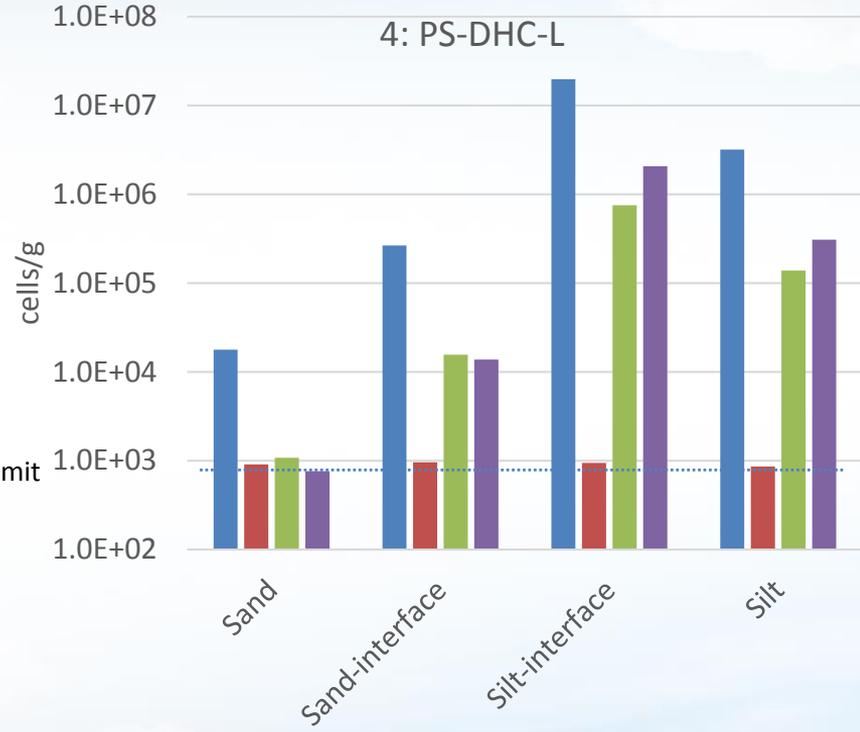
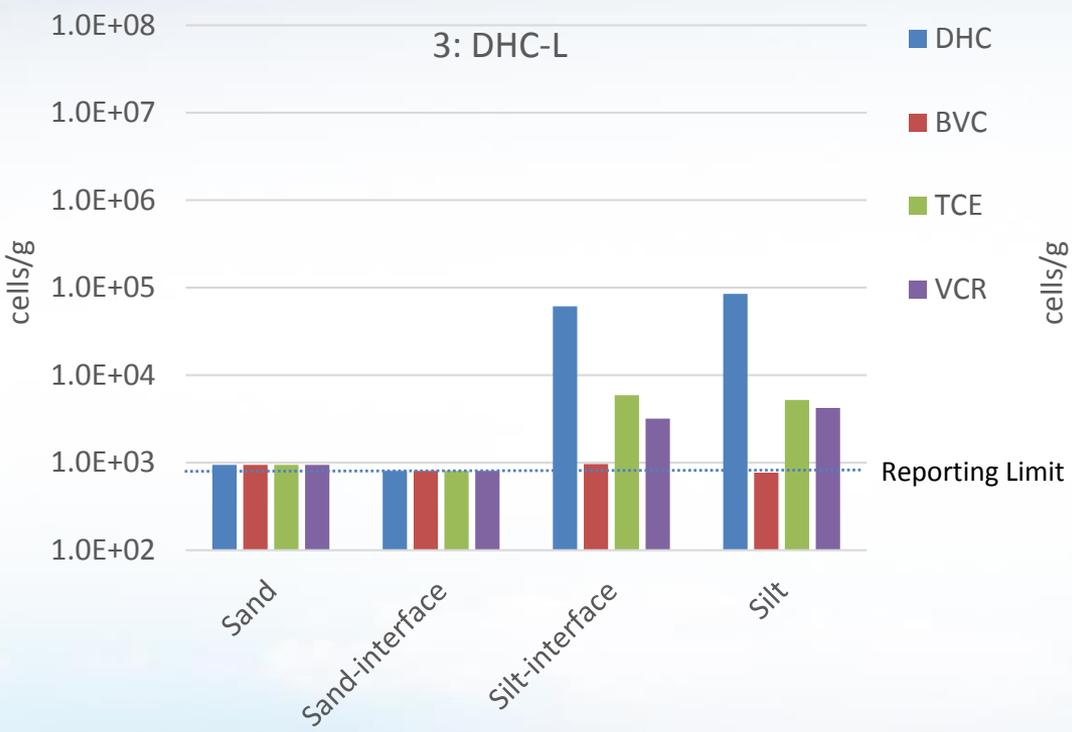
qPCR Data: Soils

No detectable DHC on soils in tanks that were not bioaugmented



qPCR Data: Soils

Over 2 orders of magnitude
DHC population increases
in presence of PlumeStop



Conclusions & Recap (1/2)

This study demonstrated:

- PlumeStop showed improved containment of back diffusing VOCs over DHC-L treatment alone
- Minimal daughter products observed with PlumeStop-only; primary initial removal mechanism is through sorption
- Enhanced effluent removal of VOCs in the PS-DHC-L compared to DHC-L, which had equivalent effluent VOCs to the control (mM)

Conclusions & Recap (2/2)

This study demonstrated:

- Greatly improved sweep efficiency of PlumeStop through low k soils compared to other treatments
- High volume of emplaced PlumeStop in both high and low K soils
- Orders of magnitude increases in *Dehalococcoides* + functional genes (soil and water) in the presence of PlumeStop