In Situ Bio-Remediation via Bio-Reactors under Varying Conditions

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Bio-Enhance/E&LP
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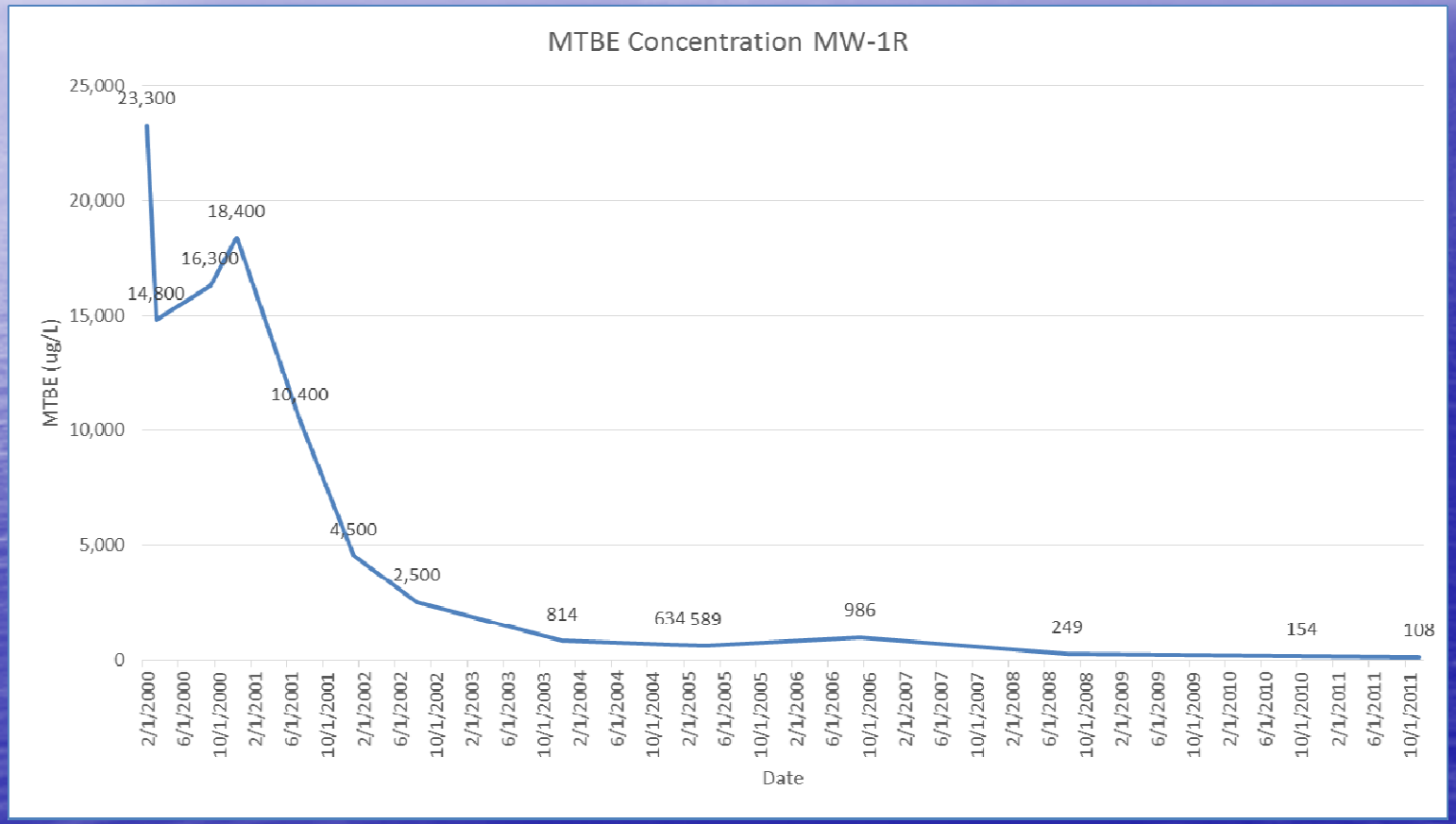
Ever See a Site like…

This?


MTBE Concentration MW-1R
MTBE (ug/L)
25,000
20,000
15,000
10,000
5,000
0
23,300
14,800
16,300
18,400
10,400
4,500
2,500
814
634 589
986
249
154
108
2/1/2000
6/1/2000
10/1/2000
2/1/2001
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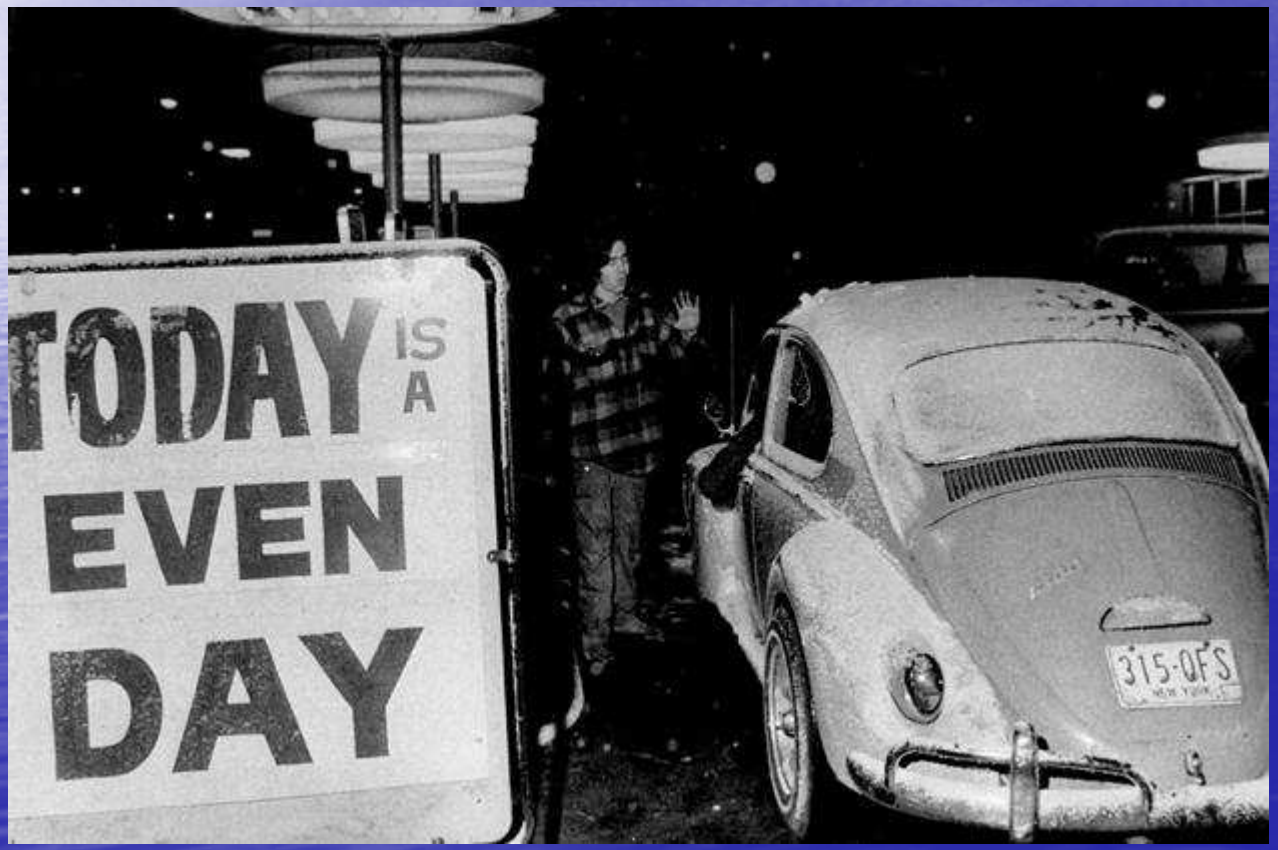
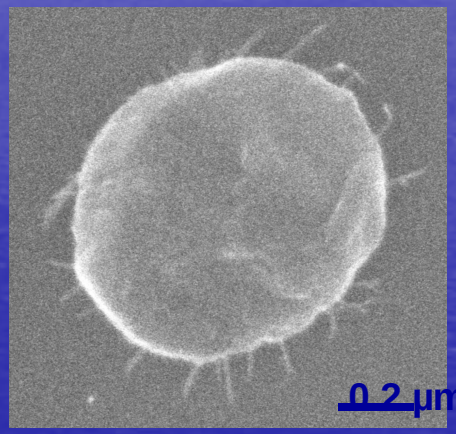
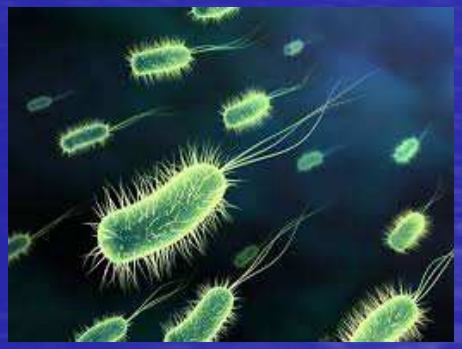
Date

Here's the Problem.







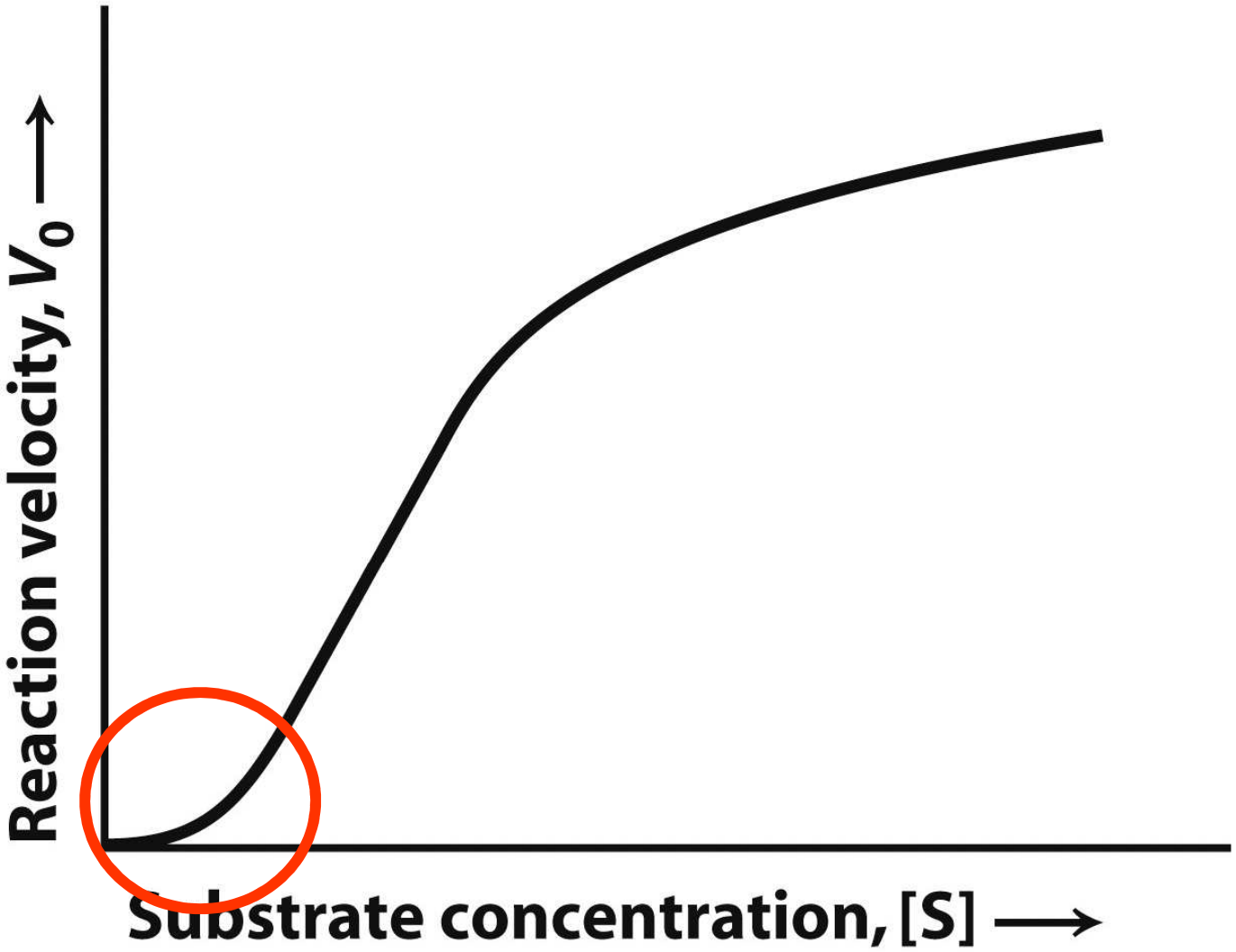
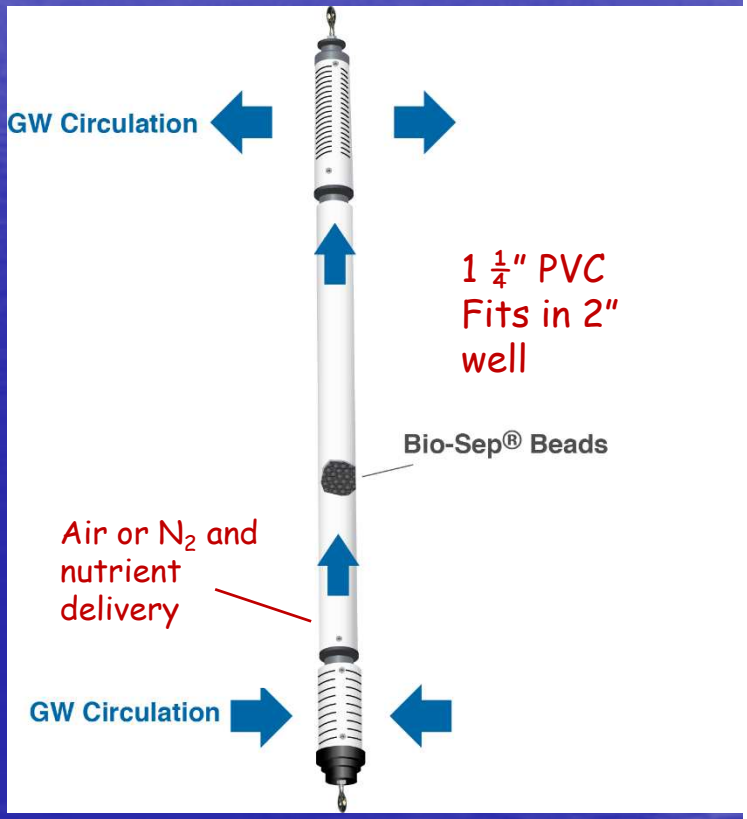


Figure 8.13
***Biochemistry*, Seventh Edition**

The Bio-Enhance ISBR

- Bio-Sep beads provide an incredible surface area for **microbial growth**
- Gas sparging (air or N_2) creates an airlift for circulation of groundwater through the bioreactor.
  - Contaminated groundwater is treated as it moves through the column of Bio-Sep beads
- Nutrient addition (N, P, electron donors, electron acceptors) support growth of desired indigenous microbes
- Water exiting the reactor carries contaminant-degrading microbes into the aquifer

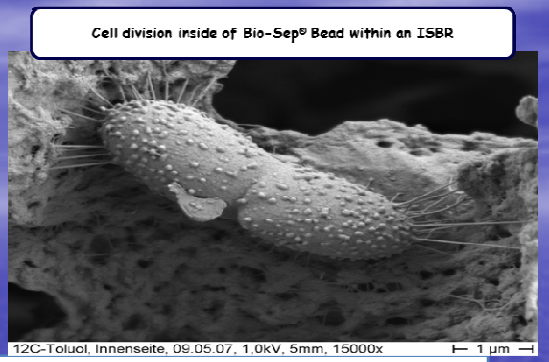


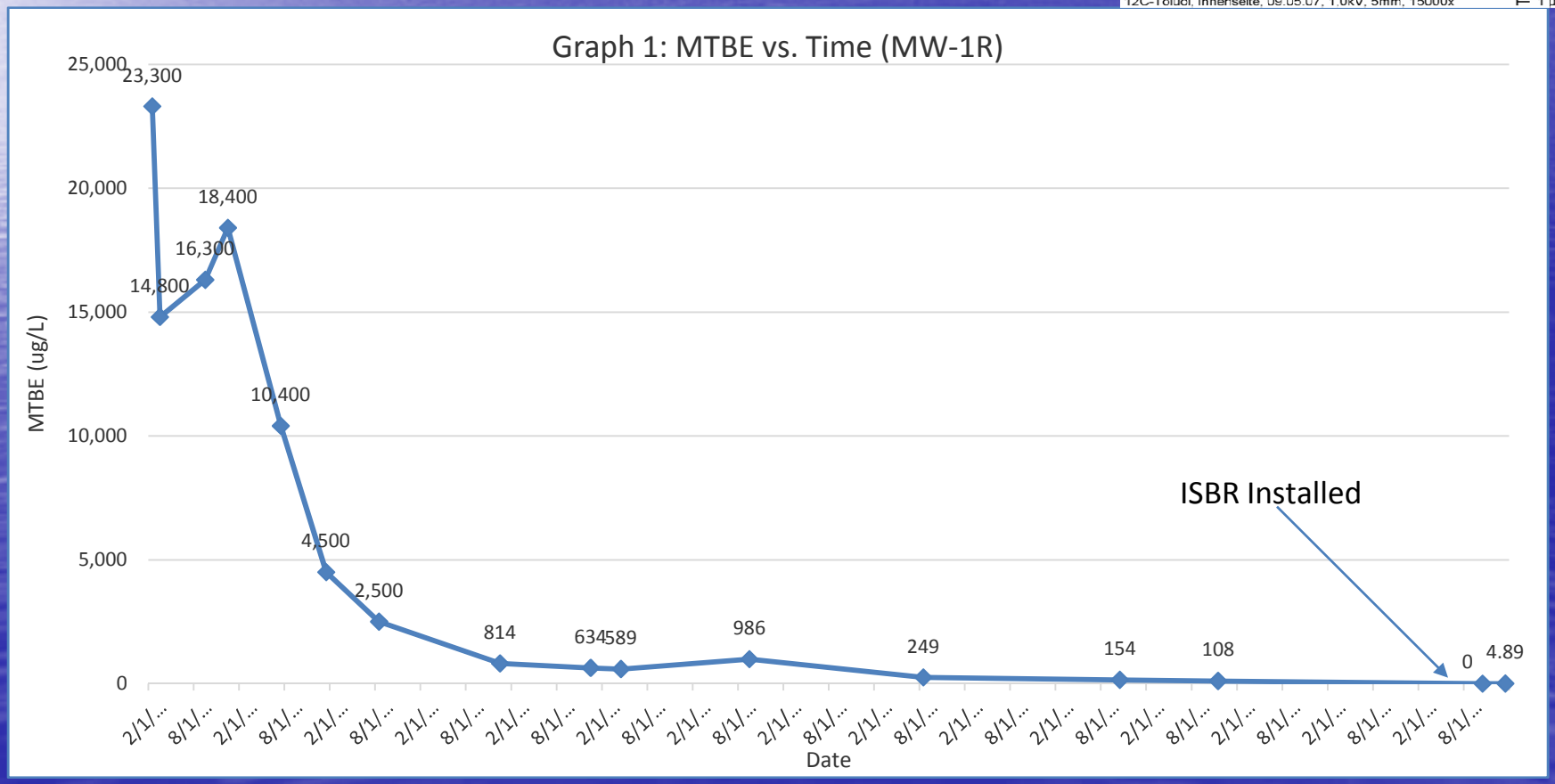
BioEnhance

Topside control

- Nutrient reservoirs and pumps
- Air pump
- Air flow control

Same Site, Different Outcome





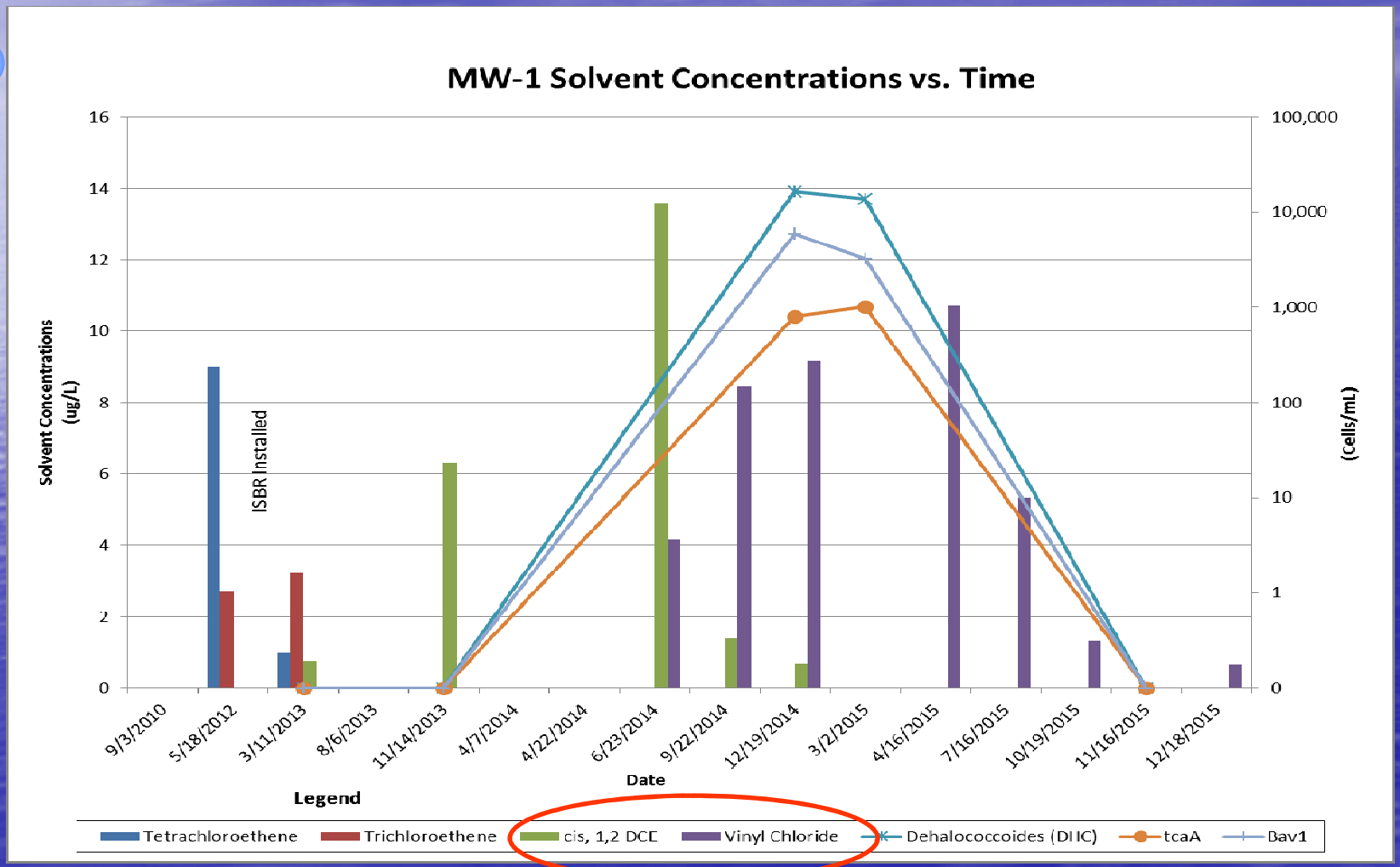

MASTERFLEX
MASTERFLEX

Bio-Sep ISBR Applications

- Petroleum hydrocarbons
  - Aerobic
  - Anaerobic
- Chlorinated hydrocarbons
  - Anaerobic
- Fuel oxygenates (MTBE, TBA)
- Emerging contaminants (1,4-Dioxane)

Anaerobic Degradation of PCE

Chlorinated Solvents

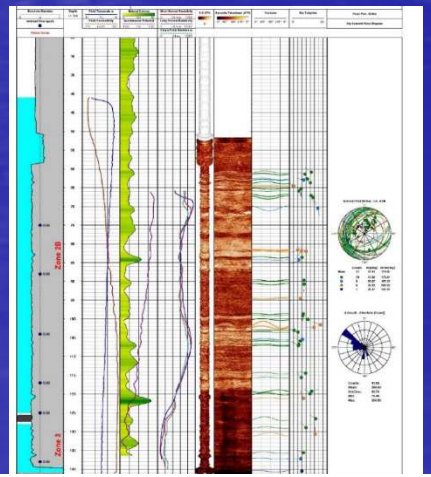


Full Anaerobic Bio-Degradation Presentation

Wednesday: 9:15-9:40 – Royal B

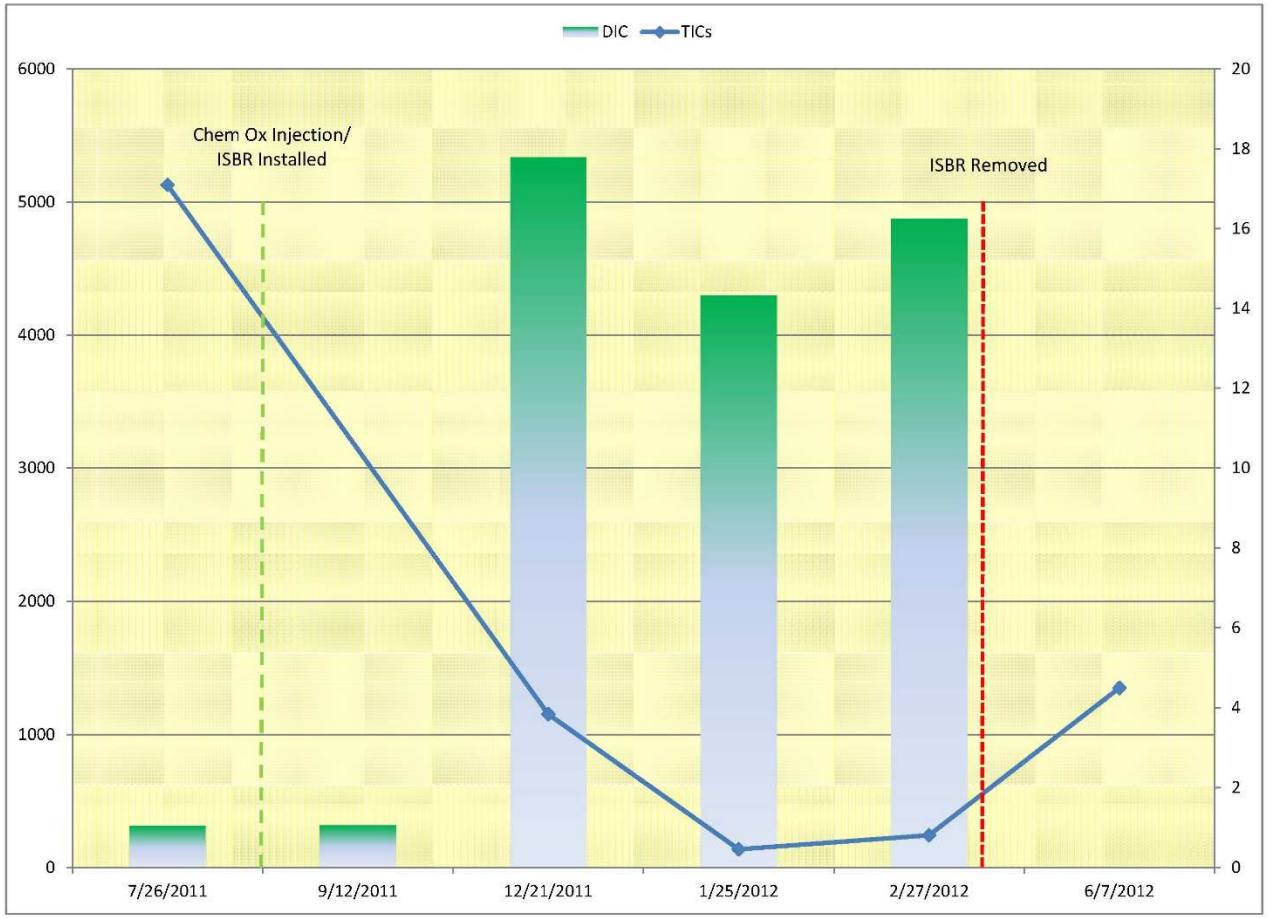
ISBRs for Effective Bioremediation of Chlorinated Hydrocarbons in Deep Aquifers

- Fresh Spill
- Deep Bedrock
- Treatment Train with Plume Stop

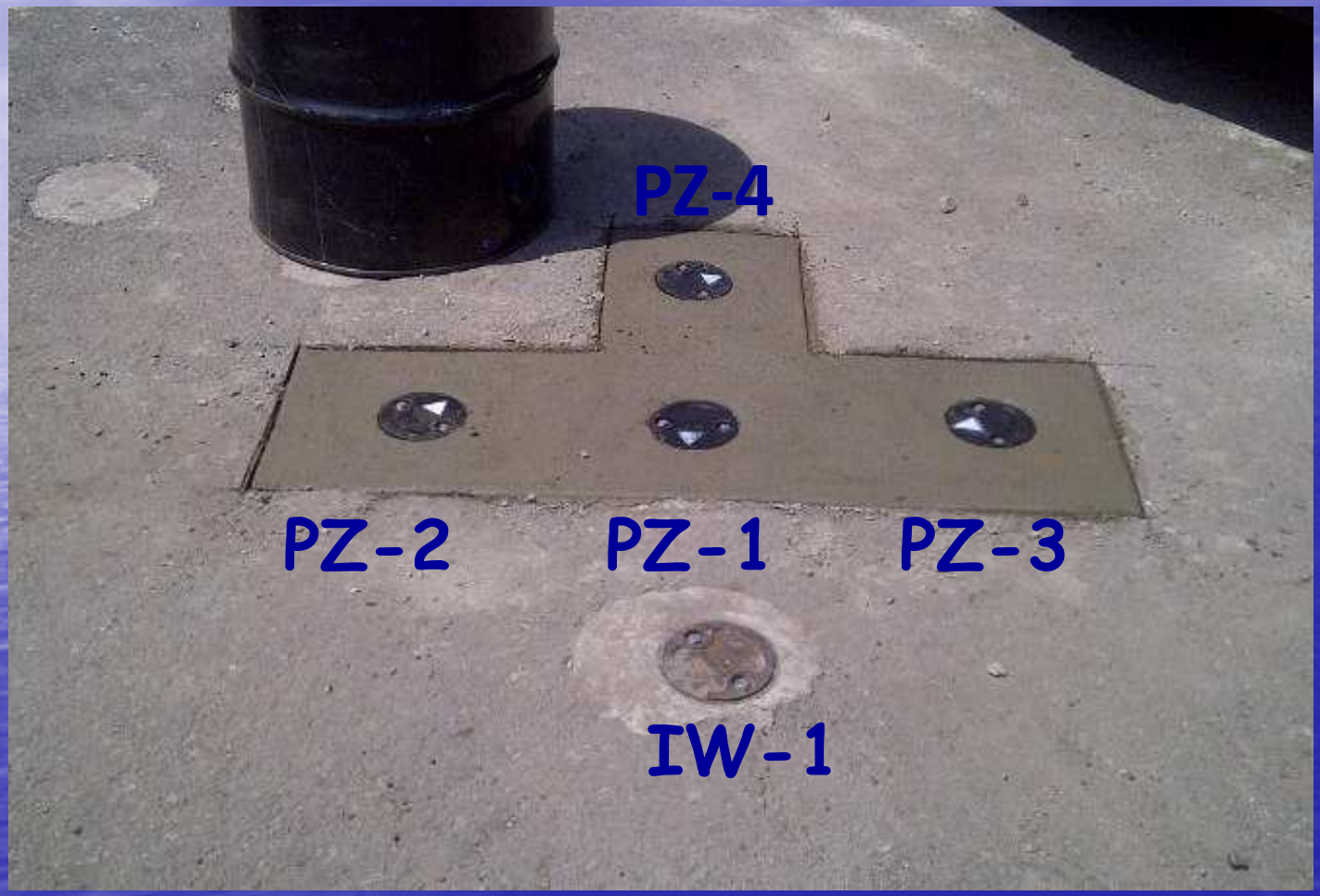


Chemical Oxidation & Aerobic ISBR

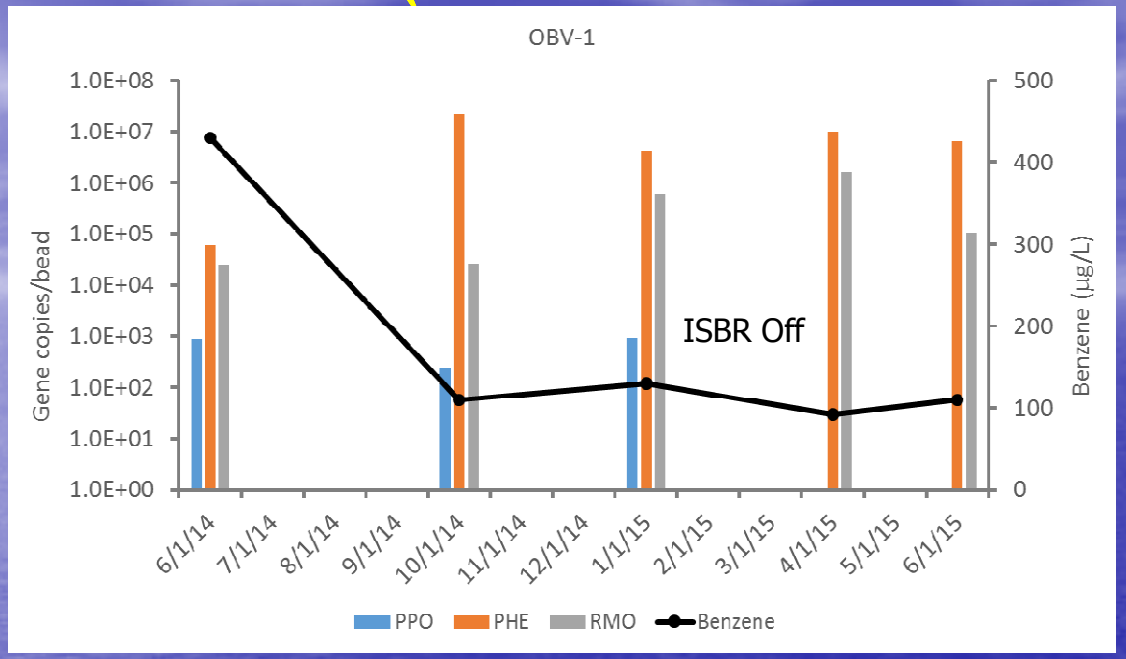
Aerobic Remediation of Fuel Oil during ISCO

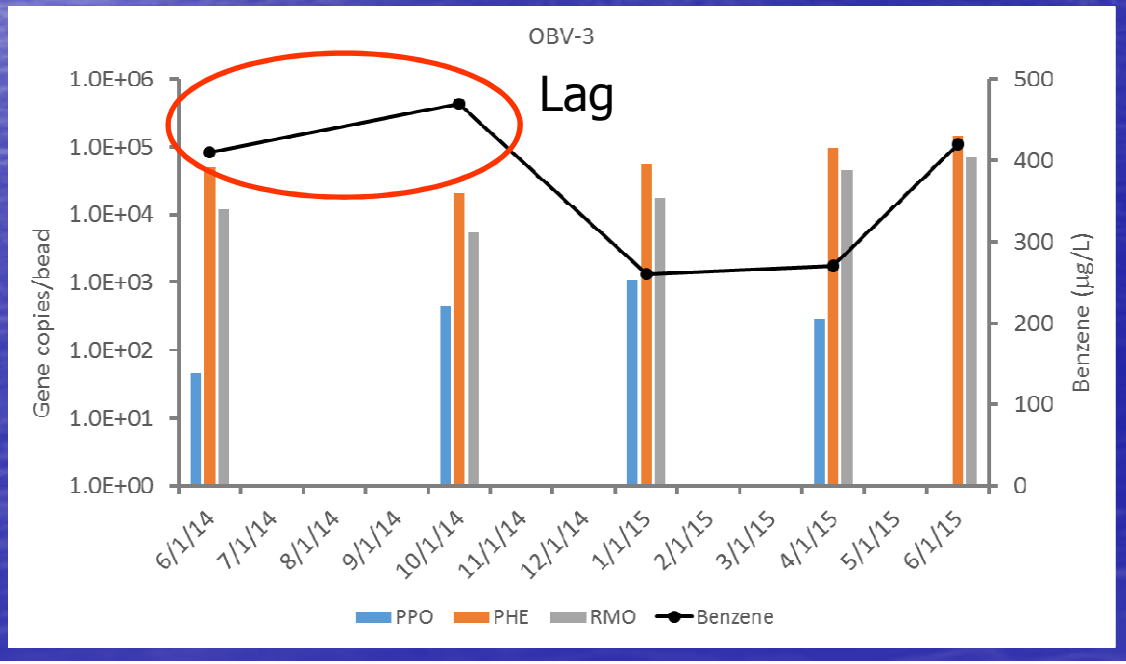


Radius of Influence

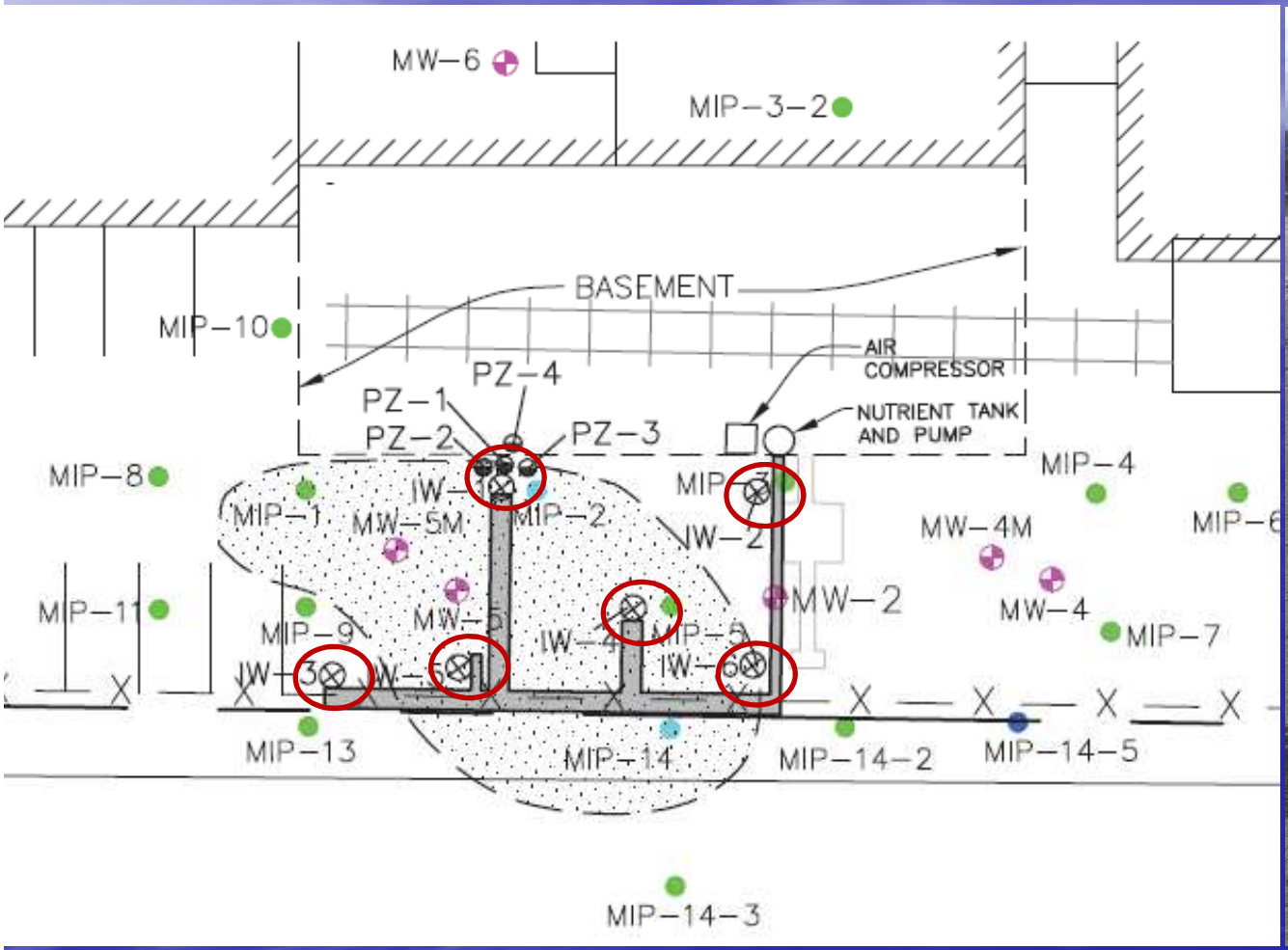


Formation Well (15' Down-Gradient)

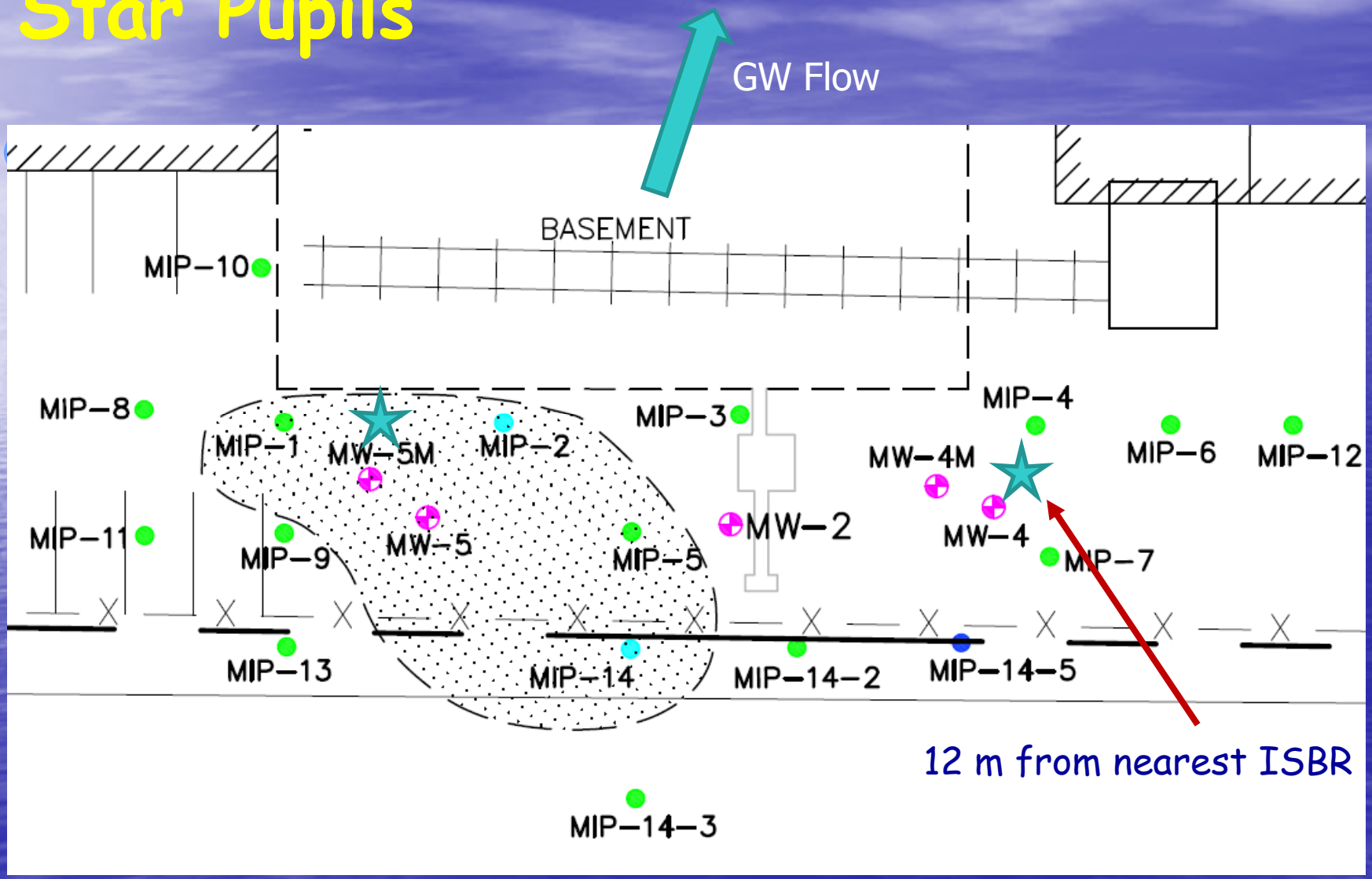




Aerobic ISBR - Pilot Study



Star Pupils

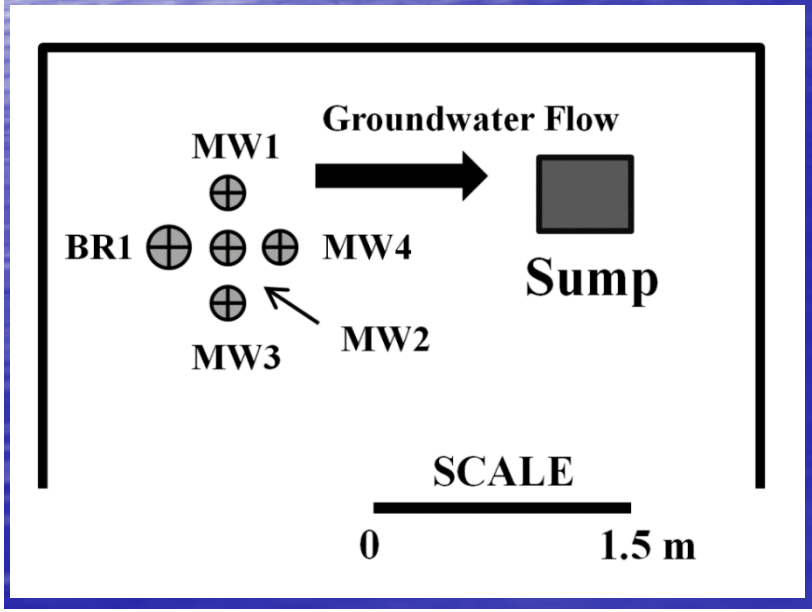

GW Flow
BASEMENT
MIP–10
MIP–8
MIP–1
MW–5M
MIP–2
MIP–3
MIP–4
MW–4M
MIP–6
MIP–12
MIP–11
MIP–9
MW–5
MW–2
MIP–5
MW–4
MIP–7
MIP–13
MIP–14
MIP–14–2
MIP–14–5
12 m from nearest ISBR
MIP–14–3

Full Aerobic Bio-Degradation Presentation

Wednesday: 8:25-8:50 – Royal B

An In Situ Bio-Reactor (ISBRR) for Treatment of Hydrocarbon-Impacted Ground water

- Technology Demonstration Project
- Remediation of Inhibitory Levels of Toluene



When to consider an ISBR

- Inhibitory contaminant concentrations
- Dilute plumes (persistent low levels of contaminants)
- Following ISCO
- Difficult situations
  - Limited physical access
  - Where one-time amendment injection is not feasible
  - Where bioremediation has failed previously

ISBR Limitations

- Aerobic operation limited to low concentrations of reduced iron (fouling)
- Radius of influence decreases with increasing hydraulic conductivity of aquifer matrix
- Works best with contaminants adsorbed by activated carbon

ISBR O&M

- O&M
  - System checks every 2-4 weeks
  - Power
  - Nutrients
  - Water level (ISBR must be totally submerged to function)

ISBR Costs

- Costs
  - Life of project rental
    - $10,000 for one unit (ISBR and controller)
    - $15,000 for two units
    - Decreasing per unit costs with addition of more units at a given site
  - Nominal Rental fee beyond 1 year

BioEnhance

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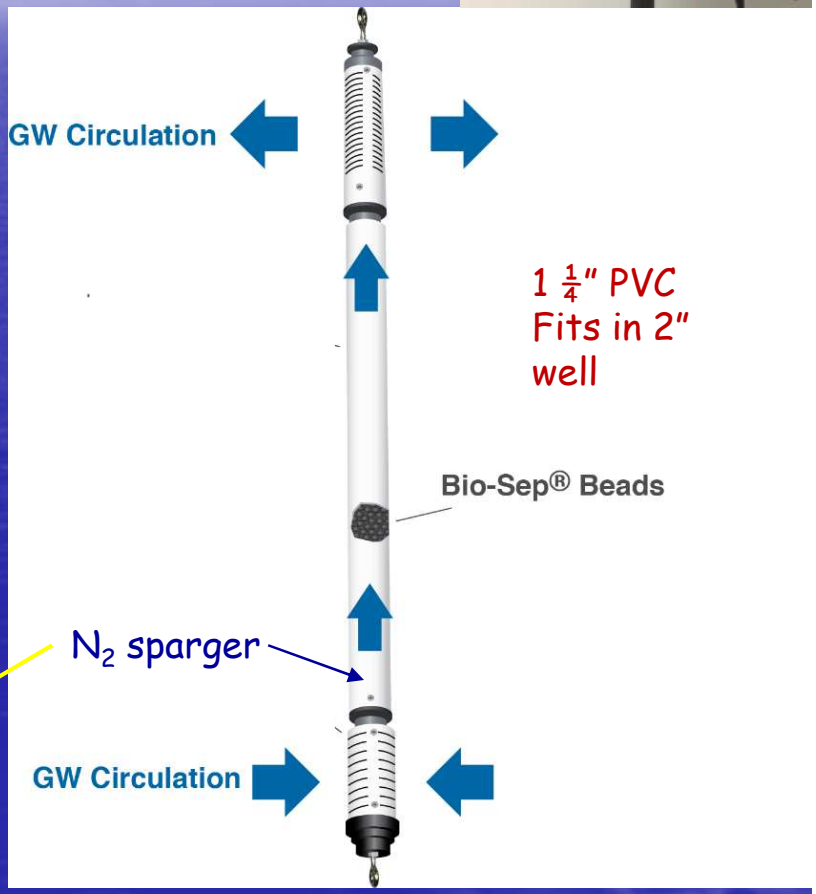
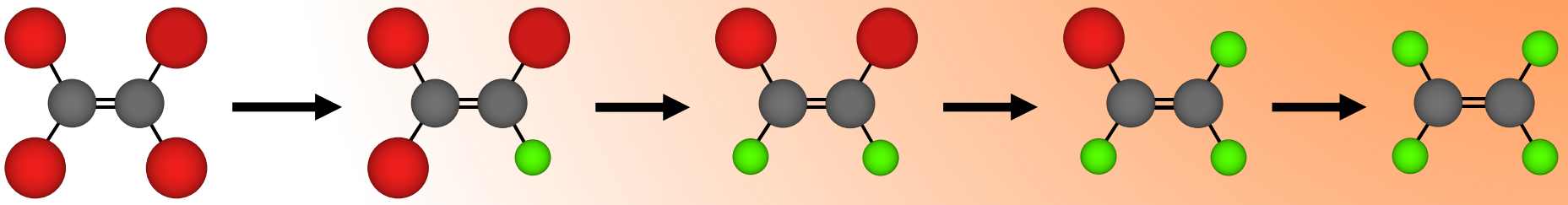
Anaerobic ISBRs, the same but different



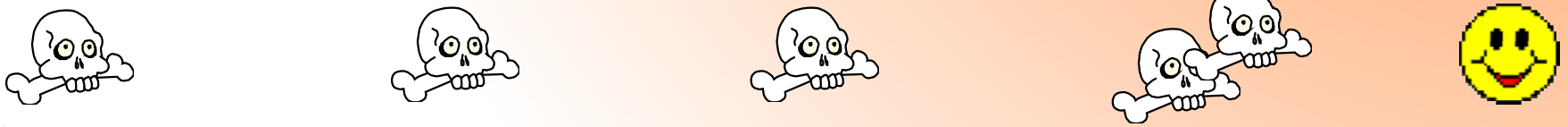
(ISBRs) for Effective Bioremediation of Chlorinated Hydrocarbons in Deep, Fractured Bedrock Aquifers

Eric J. Raes, P.E., LSRP

What is the problem?



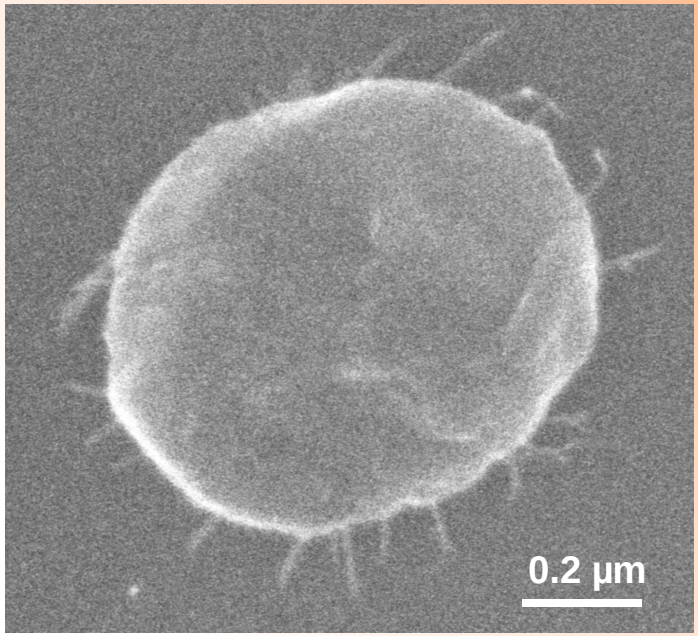
PCE **TCE** ***cis*-DCE** **VC** **ETH**



- Under reducing conditions, a variety of microorganisms reductively dechlorinate PCE to TCE or dichloroethenes (DCEs)

- **Kirsti M. Ritalahti**
- UNIVERSITY of TENNESSEE

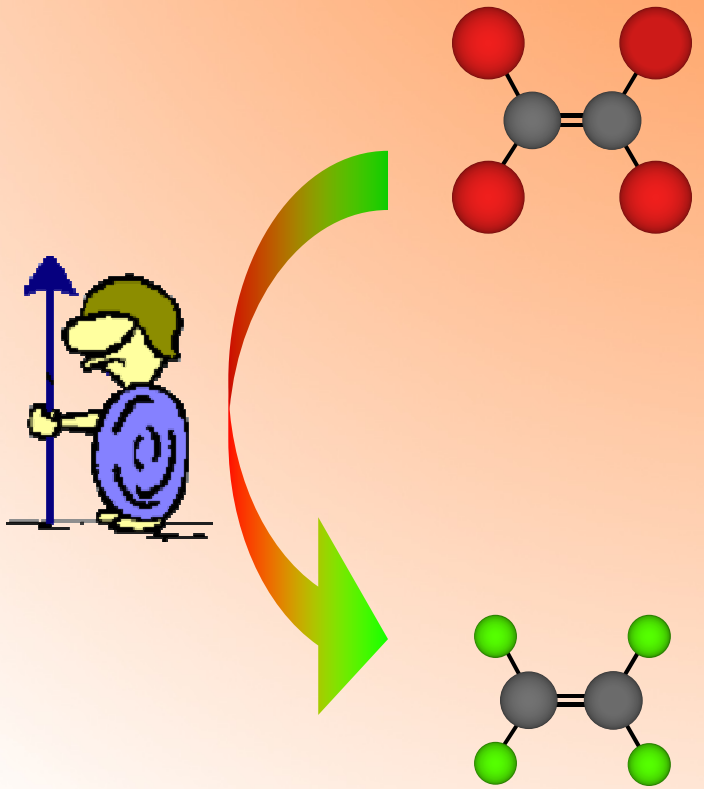
Dehalococcoides



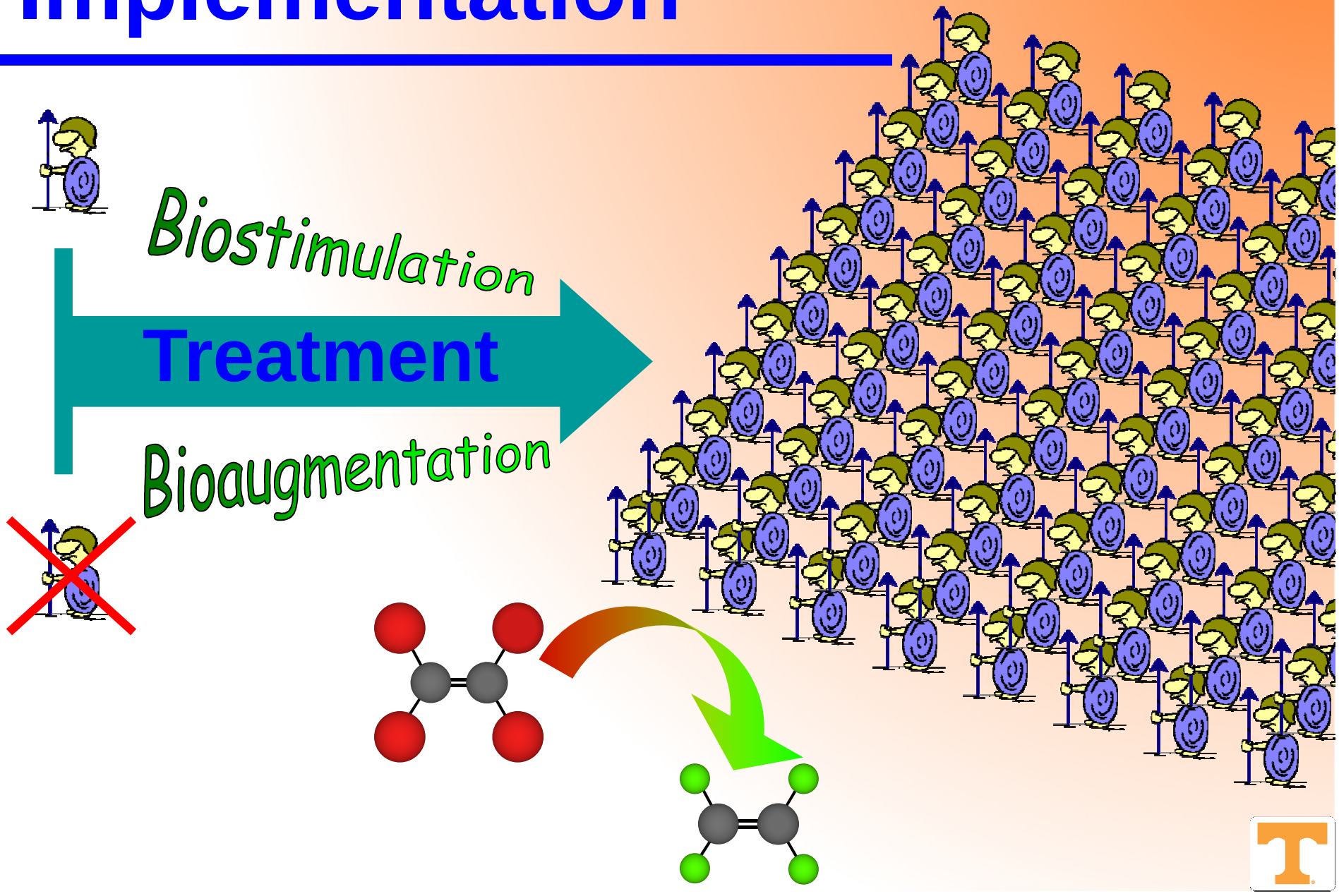
Complete Detoxification

Encouragement

H_2



Implementation



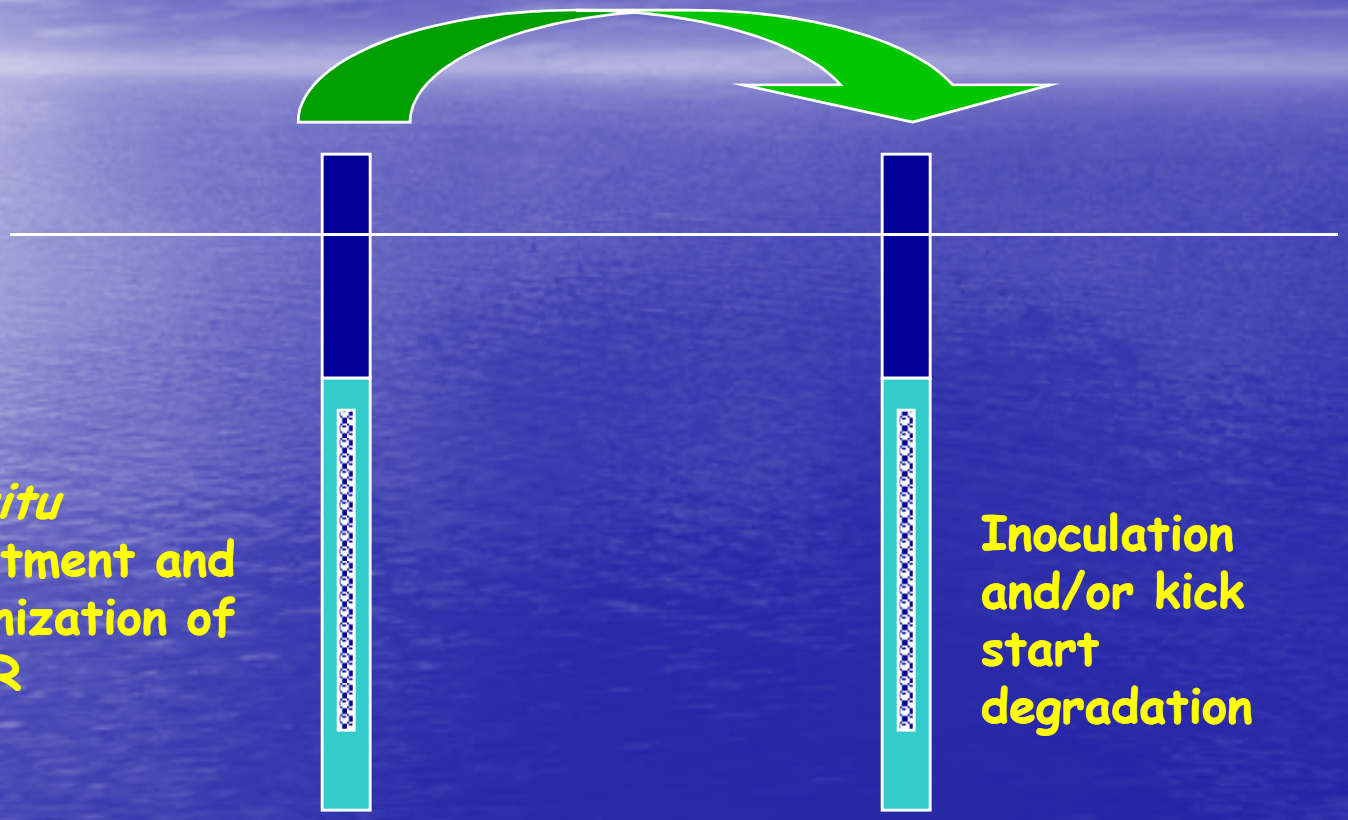
Properties of Bio-Sep® Beads Useful for Treatment Applications

- Adsorptive surface
  - Concentrates contaminants present at low concentrations
  - Reduces aqueous phase concentrations at high contaminant concentrations
- High porosity and surface area
  - Rapidly colonized by indigenous microbes
  - Release microbes into the aquifer once carrying capacity of the beads is reached

microbialinsights

The University of Tulsa

ISBRs Will Transfer Degraders from One Well to Another



In situ treatment and colonization of ISBR

Inoculation and/or kick start degradation

Transfer of DHC in a TCE Plume