



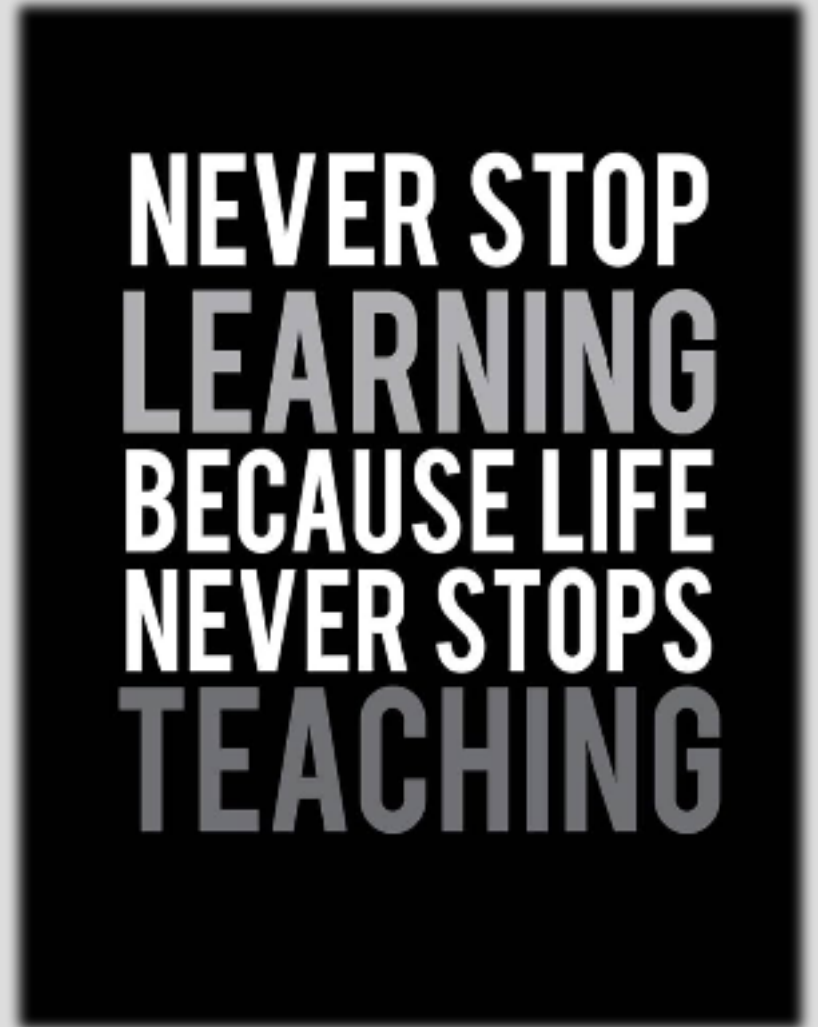
20 Years of Clean-Up: A Tale of 6 Remedies

Jason McNew
Angela McGinty

Story Time!

Objectives:

- Provide overview of the site and site history
- Discuss the various remedial phases
- Highlight successes (and misses)
- Summarize the changes in plans
- Identify key communications
- Lay out the path to closure
- Share some valuable lessons learned (hopefully)



Site Background

- Former sand/gravel quarry from 1962 until 1970s
- Mixed residential and commercial area
- Hidden from main road
- 3-acre disposal area (1969-1974) → 15-acre treatment area
- ~700,000 gal of waste disposed (Eastern Area)
- 3 Operable Units
- Lithology:
 - ♦ Alternating sand and clay layers
 - ♦ 3 aquifers (upper, middle, lower sand)
- Receptors:
 - ♦ Drinking water wells (screened in deep)
 - ♦ Workers, trespassers (shallow soil and ponds)
- Contamination: VOCs, SVOCs, metals, PCBs
 - ♦ Principal Threat: $>10^{-4}$ risk
 - ♦ Low-Level Threat: 10^{-4} to 10^{-6} risk



Early Actions

- 1970s - Initial investigations, Odor Complaints, neighbor complaints
- 1974 – Chemical fire, ~200,000 gal of liquid waste removed
- 1983 – Put on National Priorities List (NPL)
- 1984 – Gate put up into property with signage
- 1985 – Initial RI/FS
- 1985 – 1st ROD (drum removal, shallow pump and treat)
- 1989 – Perimeter fence
- 1990 – 2nd ROD (deeper aquifer)
- 1991 – Removal of ~1,200 buried drums
- 1996 – Pump and treat system startup
- 2002 – 3rd ROD (soil, sediment, shallow groundwater)

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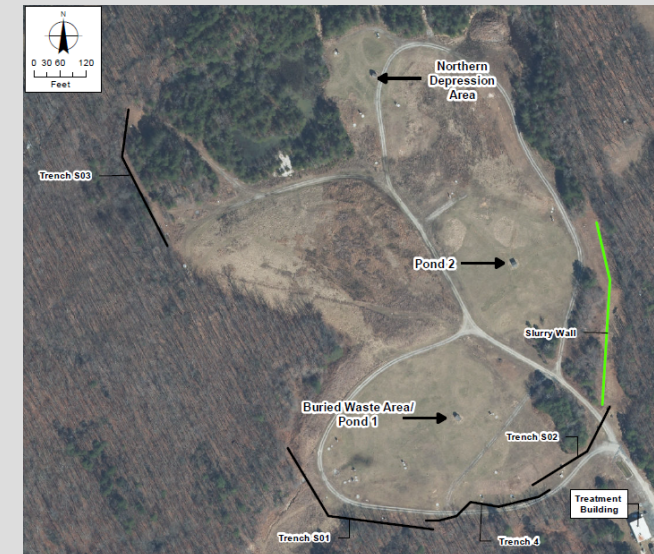
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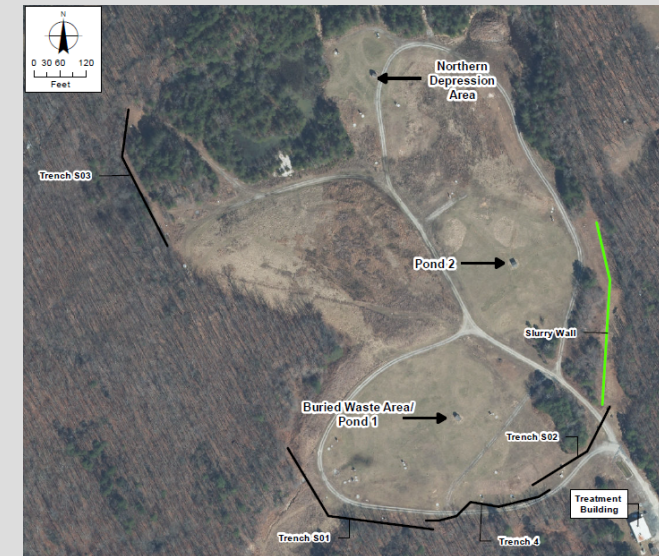
Remedy 1 – Pump and Treat

- Initially installed to contain and treat groundwater leaving site
- Extraction trenches around downgradient perimeter
- Air stripper treatment, discharge to on-site surface water
- Slurry wall to prevent migration from upper to middle sand
- Operate until GW concentrations meet cleanup levels
- 1996 - 1998 – Pump and treat system startup, prove-out, initial operation
- Still running....



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Remedy 2, 3, 4 and 6 Strategy

- What we thought we knew:
 - ◆ Mix of chlorinated VOCs with other COCs
 - ◆ Excavation/thermal remedy/off-site disposal would remove most mass
 - ◆ Follow-up bioremediation would take care of the rest
 - ◆ From ROD (2002):
 - Enhance natural occurring processes to speed up anaerobic biodegradation and reduce remedial timeframe
 - *Remember this objective.....*
- What was planned:
 - ◆ Remedy 2: Excavation and Ex Situ Thermal Treatment (VOCs/SVOCs)
 - ◆ Remedy 3: Excavation and Off-Site Disposal (Metals, PCBs)
 - ◆ Remedy 4: Bioventing of Vadose Zone Soils (outside of excavation area)
 - ◆ Remedy 6: In Situ Enhanced Bioremediation (groundwater)

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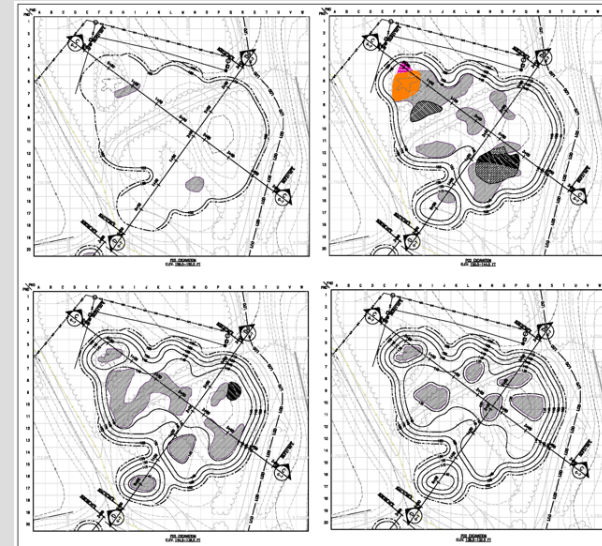
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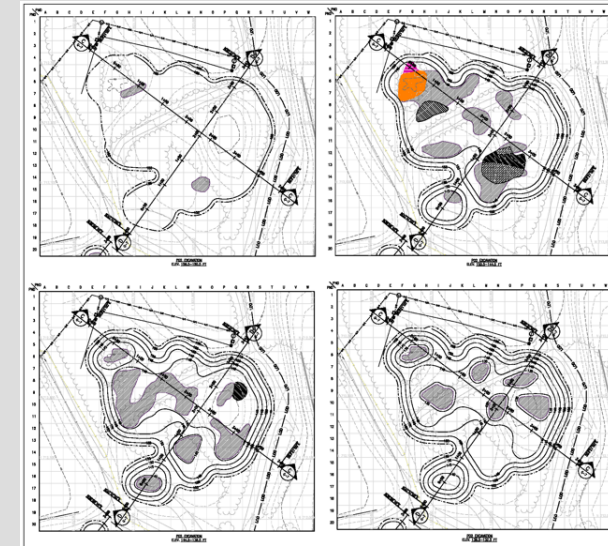
Remedies 2&3 – Excavation & Thermal Treatment/Disposal

- 2009-Installation of dewatering system (trenches and wells)
- 2010-Excavation and ex-situ low temperature thermal desorption (LTTD)
- “Surgical” excavation in lifts up to 35 feet bgs
- ~58,000 TN of soil excavated, treated, and backfilled
- Off-site disposal of ~10,000 TN of metals/PCBs
- >3,000 soil samples for VOCs
- 86 batches of treated soil



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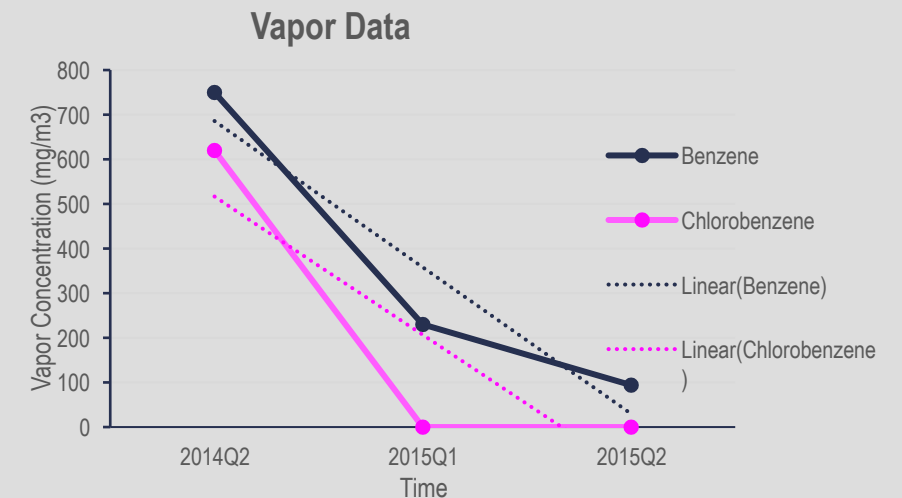
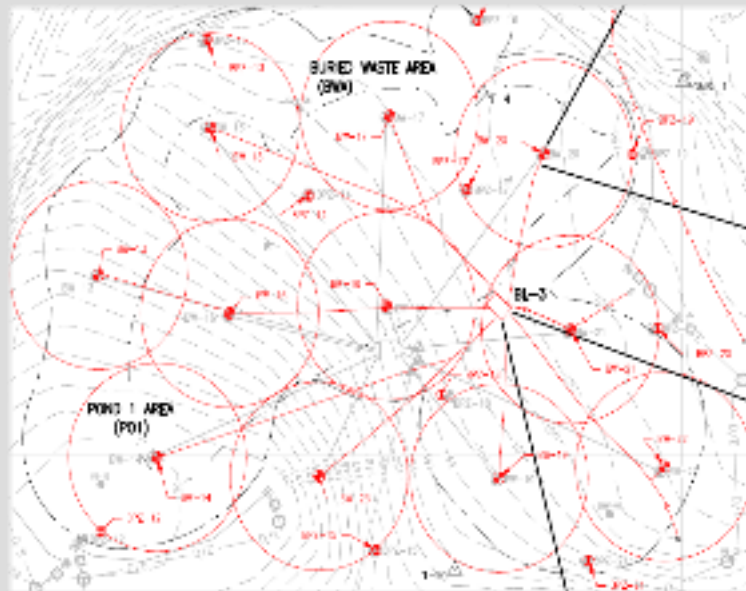
- Results are on..... Big success!
- What we Thought Following Excavation
 - ◆ Ready for bioventing for vadose zone outside excavation area
 - ◆ Definitely set up for in situ anaerobic bioremediation for groundwater
- Let's move forward with bioventing design

Client/stakeholders/EA =



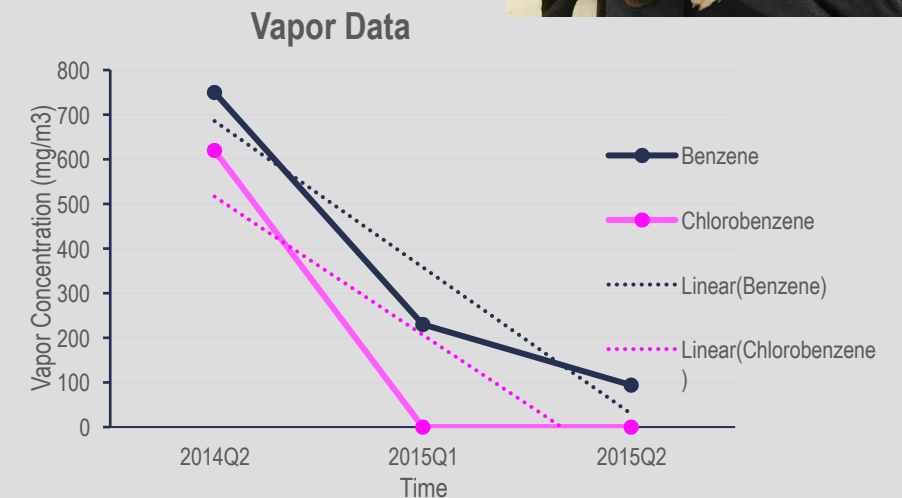
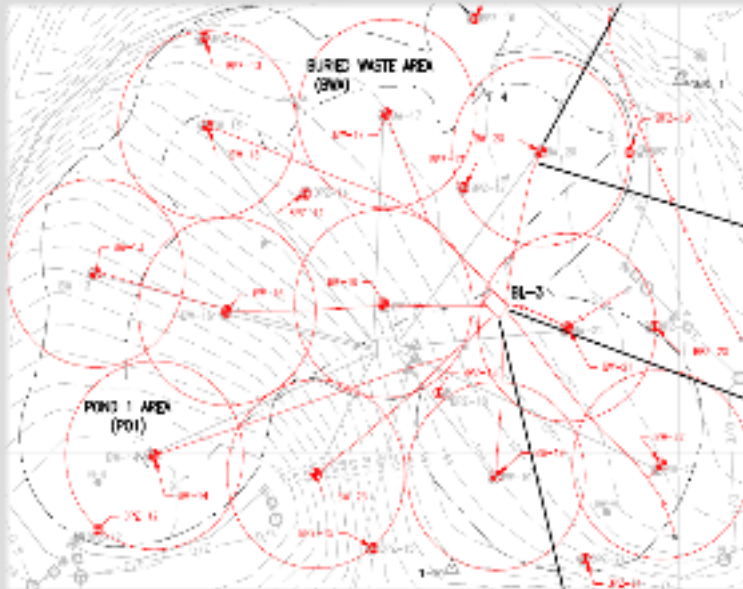
Remedy 4 – Bioventing

- Address vadose zone VOCs
- Treatment area outside of excavation (low-level threat)
- 21 bioventing wells with 27 monitoring points
- 3 areas each with a blower (11-18 cfm per well)
- Operated 2011-2016
- Reached asymptotic conditions with low VOCs



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Move On To Next Remedy.. Right?

■ What We Thought:

- ◆ Ready for In Situ Bioremediation – Remedy 5
- ◆ Plan to grab current groundwater data
- ◆ Prepare design for injections
- ◆ Perform injections, watch concentrations drop, get closet to closeout



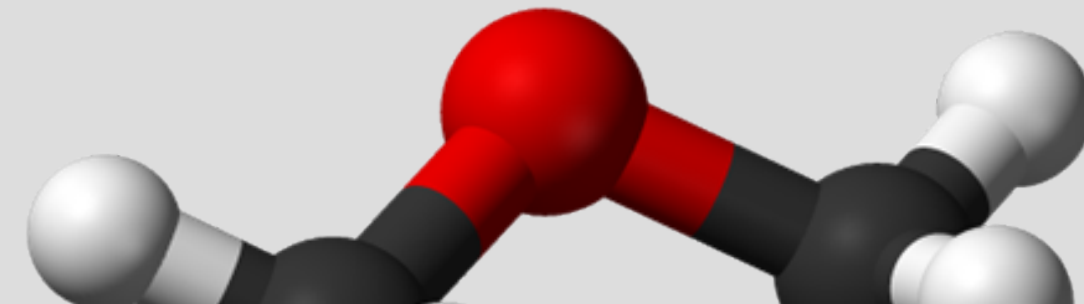
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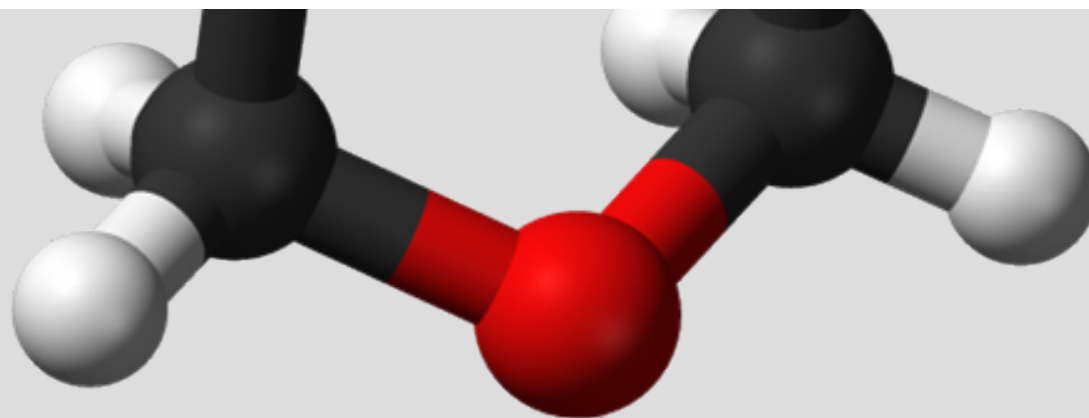
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BUT THEN.....

Move On To Next Remedy.. Guess Not..



1,4-Dioxane !!!!!

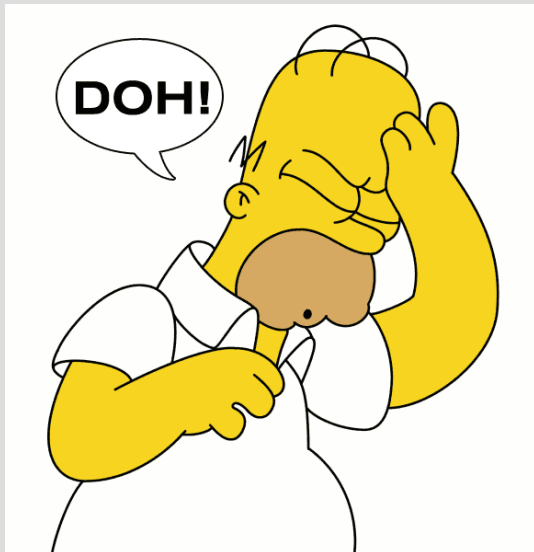


Now What....

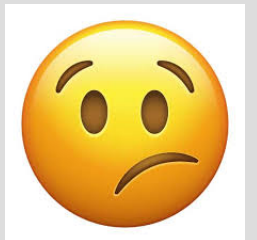
■ What We Learned Very Quickly:

- ◆ 1,4-dioxane joined the party
- ◆ Anaerobic bioremediation is not going to get us there alone
- ◆ We need a new plan...
- ◆ and a new design

Me =



Client/stakeholders =



Revised Remedial Strategy.. Welcome New Remedy 5

■ Remember our Goals:

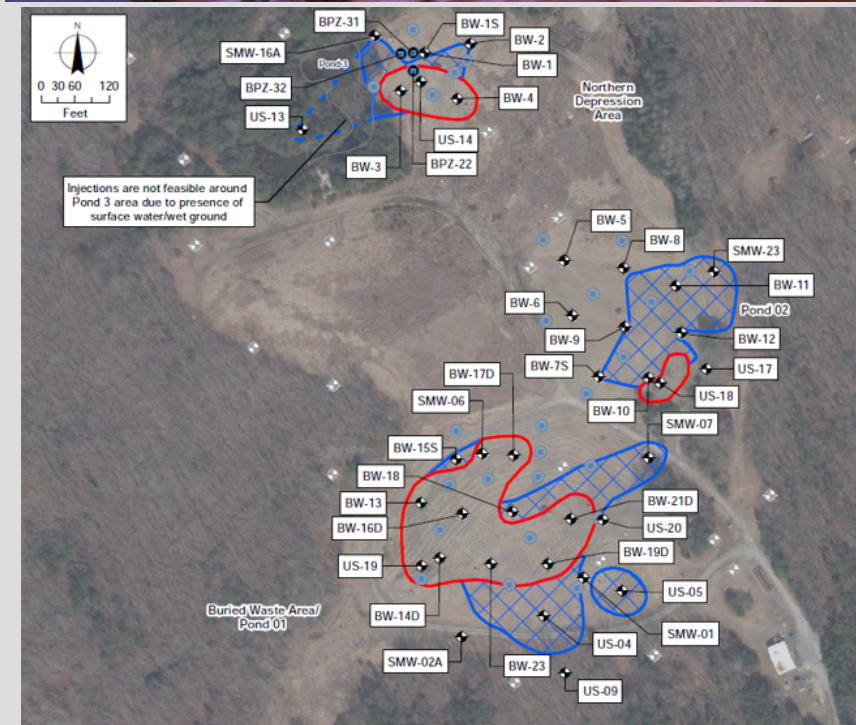
- ◆ Reduce Contaminant Mass
- ◆ Accelerate Biodegradation
- ◆ Reduce Overall Remedial Timeframe

■ Challenges:

- ◆ Mixed plumes: anaerobically vs. aerobically favored degradation
- ◆ Didn't want to diminish existing conditions favorable for bioremediation

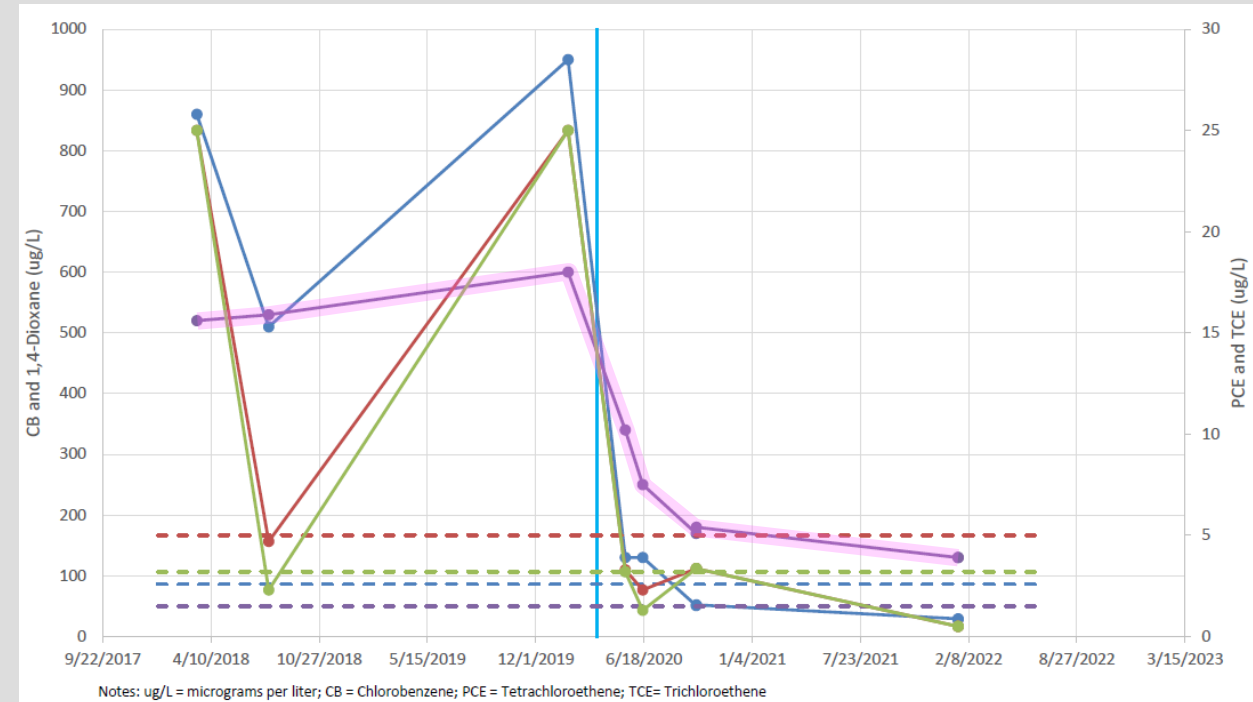
■ Strategy:

- ◆ Phased in situ injection approach
- ◆ First: Target 1,4-dioxane via ISCO – New Remedy 5
- ◆ Then: In Situ Enhanced Bioremediation (IESB) to address cVOCs – Remedy 6



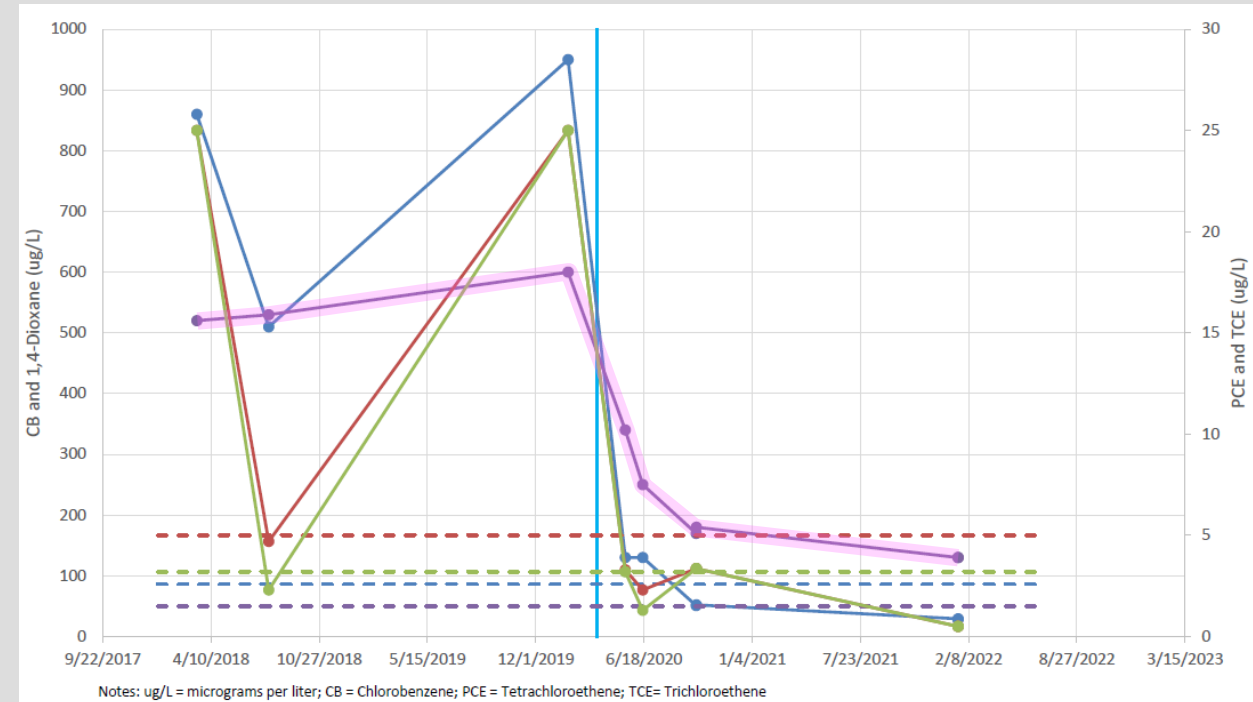
Remedy 5 – In Situ Chemical Oxidation

- Performed ISCO bench study to help select/dose reagent
- ISCO Injections Completed in June 2020
 - ◆ 188 points (~214,000 lbs of Provect-Ox)
 - ◆ Done in ~2.5 weeks (3 injection setups)
- Quick Results Summary
 - ◆ 60-day: ~87% mass reduction
 - 1,4-dioxane delay observed
 - ◆ 180-day: ~93% mass reduction



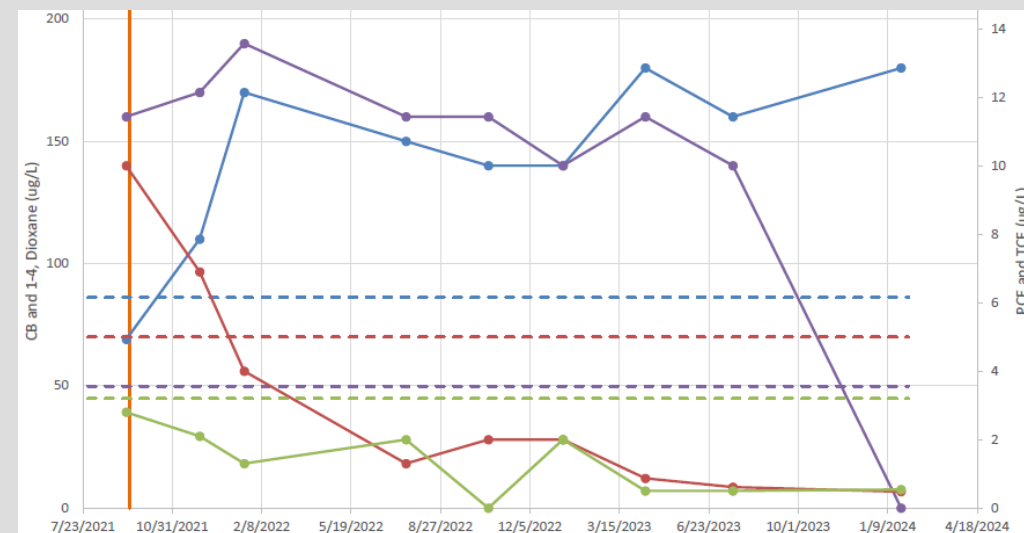
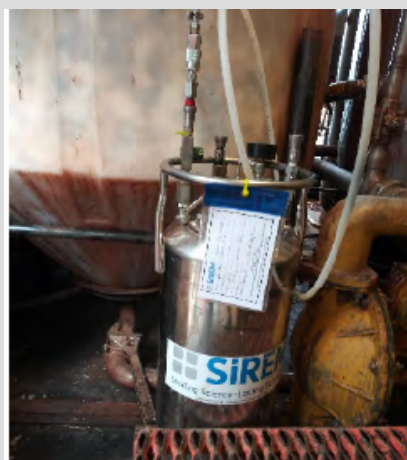
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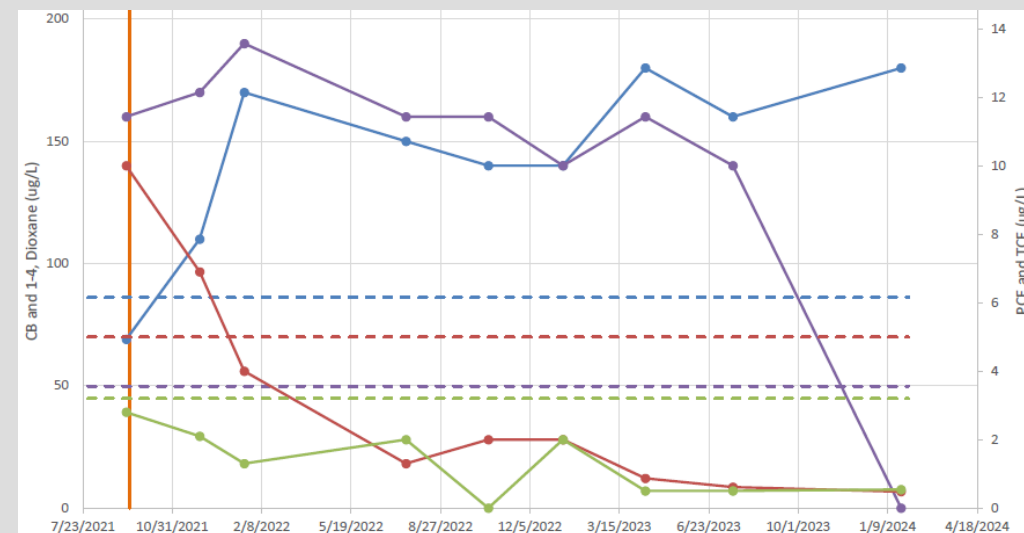
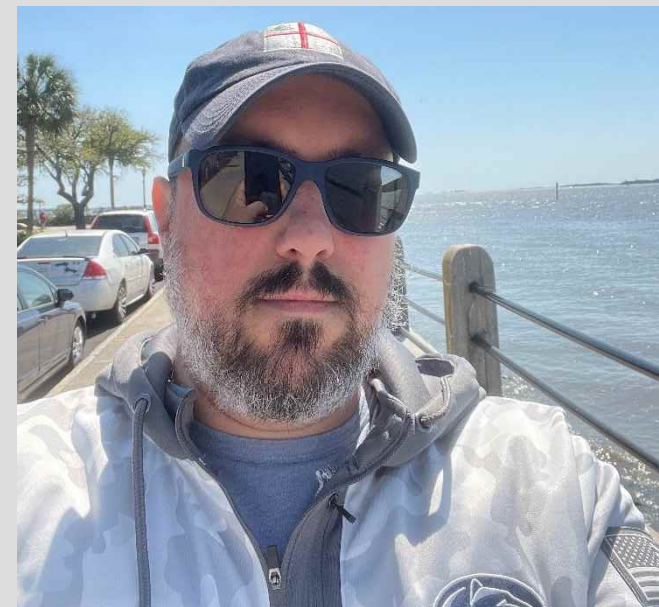
Remedy 6 – In Situ Enhanced Bioremediation

- Performed pilot study (distribution)
- IESB Injections Completed in September 2021
 - ◆ 120 points (~11,155 gal of EVO/lactate)
 - ◆ KB-1 (microbes), pH buffer, nutrients, AMR
- Quick Results Summary
 - ◆ Favorable anaerobic conditions were established
 - ◆ Decreasing concentration trends (TCE and PCE)
 - ◆ Some locations have met cleanup goals already



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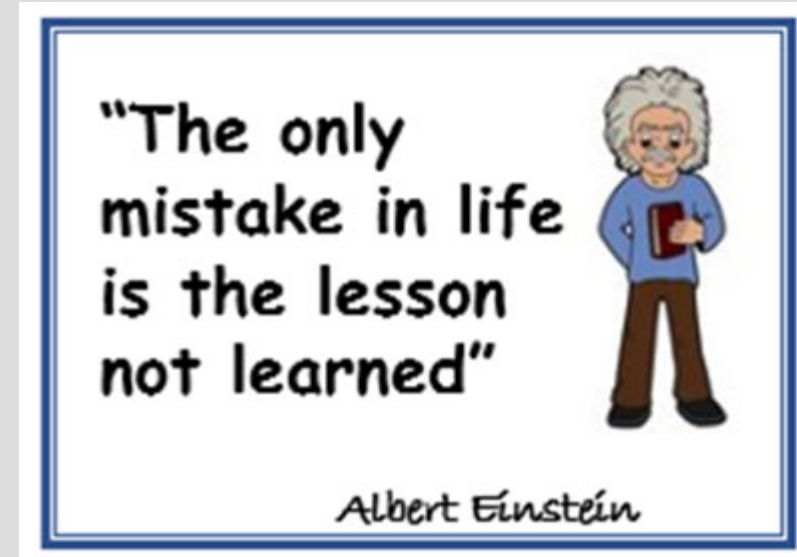


Next Steps...

- **Preparing for some hot spot ISCO injections**
 - ◆ Address stubborn 1,4-dioxane/chlorobenzene outside original ISCO area
- **Continue monitoring groundwater**
- **Continue operating perimeter pump and treat system**
- **Once groundwater concentrations approach remedial goals:**
 - ◆ Perform updated risk assessment
 - ◆ Move site to closure
 - ◆ Reuse/redevelopment?

Conclusions/Lessons Learned

- Your CSM can quickly become outdated (PFAS anyone?)
- Engage project stakeholders early in the process
- Critical to step back, evaluate overall strategy
- Consider your goals, work within your constraints
- Utilize bench tests (and pilot studies) to support remedy evaluation/design
- There may not be a one-size fits all remedy, multiple remedies can present the most efficient strategy
- Invest in up front understanding, will save you from headaches (and save \$)
- Don't be afraid to admit when your plan isn't going to work



Final Thoughts....

Optimistic Timeframe For Site Closure...

Final Thoughts....

Optimistic Timeframe For Site Closure...



Final Thoughts....

Hopefully Not....

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Thank You!

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