A Synopsis of Key Lessons from more than 100 Sites in Kentucky Injected with Carbon to Remediate UST Releases

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September 2018

National Tanks Conference

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Carbon in Soil Boring

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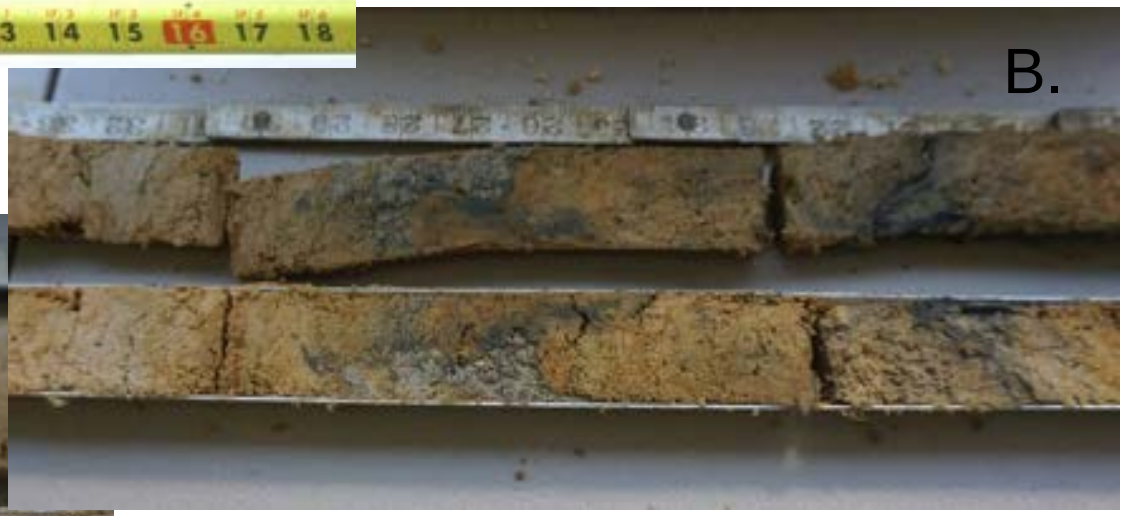
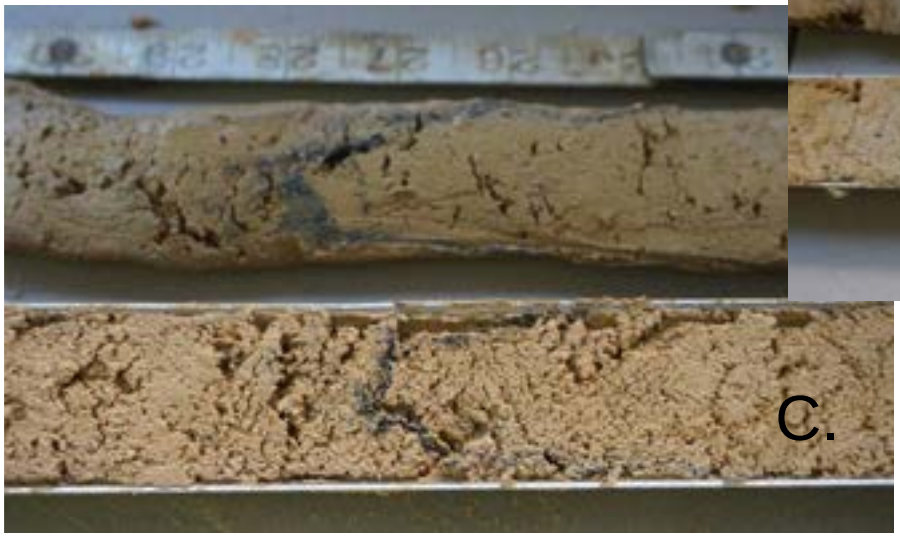
Vertically Split Borings





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Seemingly Small Seams Can Fill Large Voids

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Well mixed Carbon and Media

Excavation Post-injection Carbon Distribution

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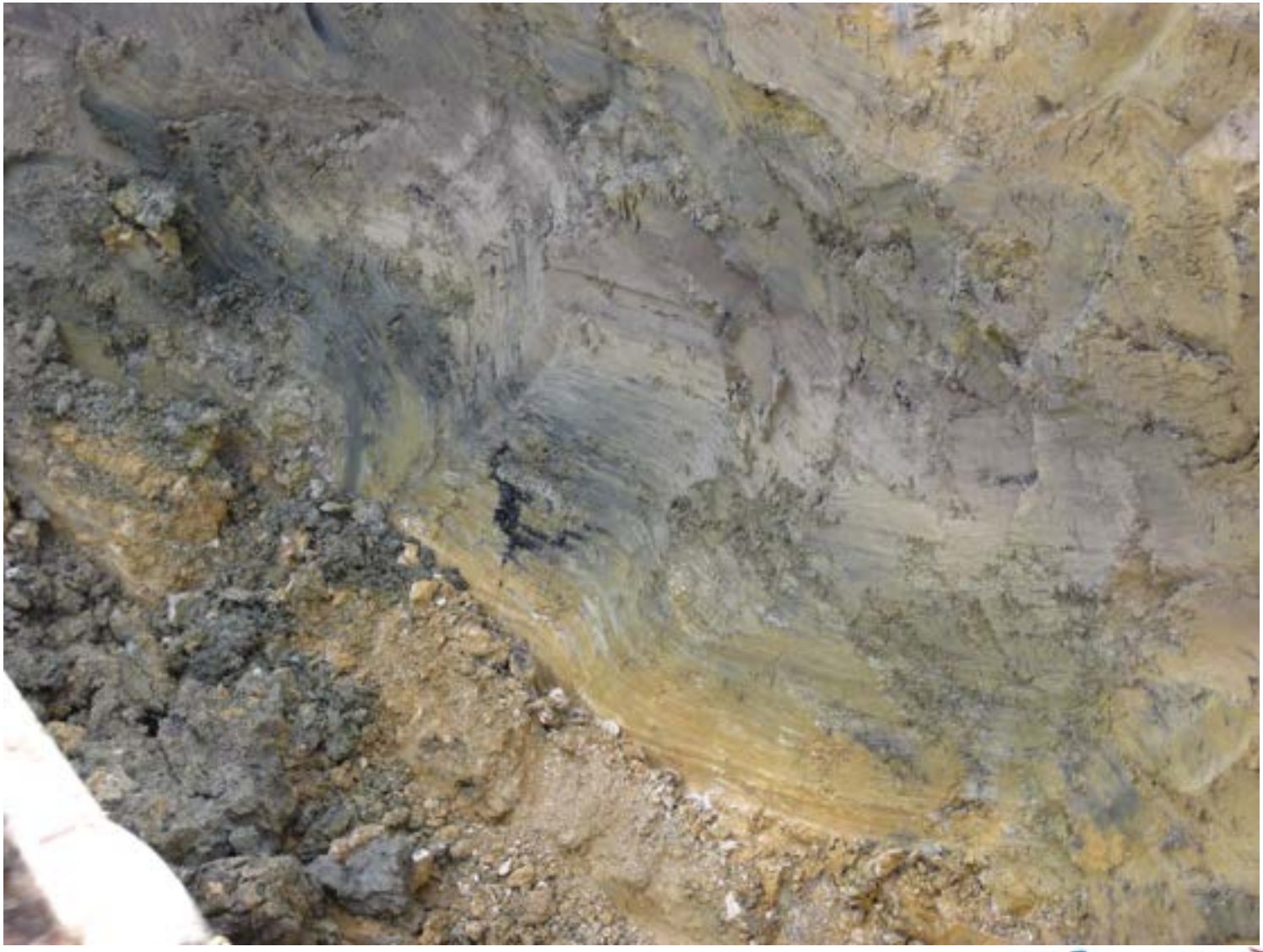
Lines of Carbon in the Soil

Carbon Heavy Features

Flat Sheets Vertical & Horizontal

Within the Hydrated Zone



Vertical Carbon Sheets

Closer Examination of Core Slices

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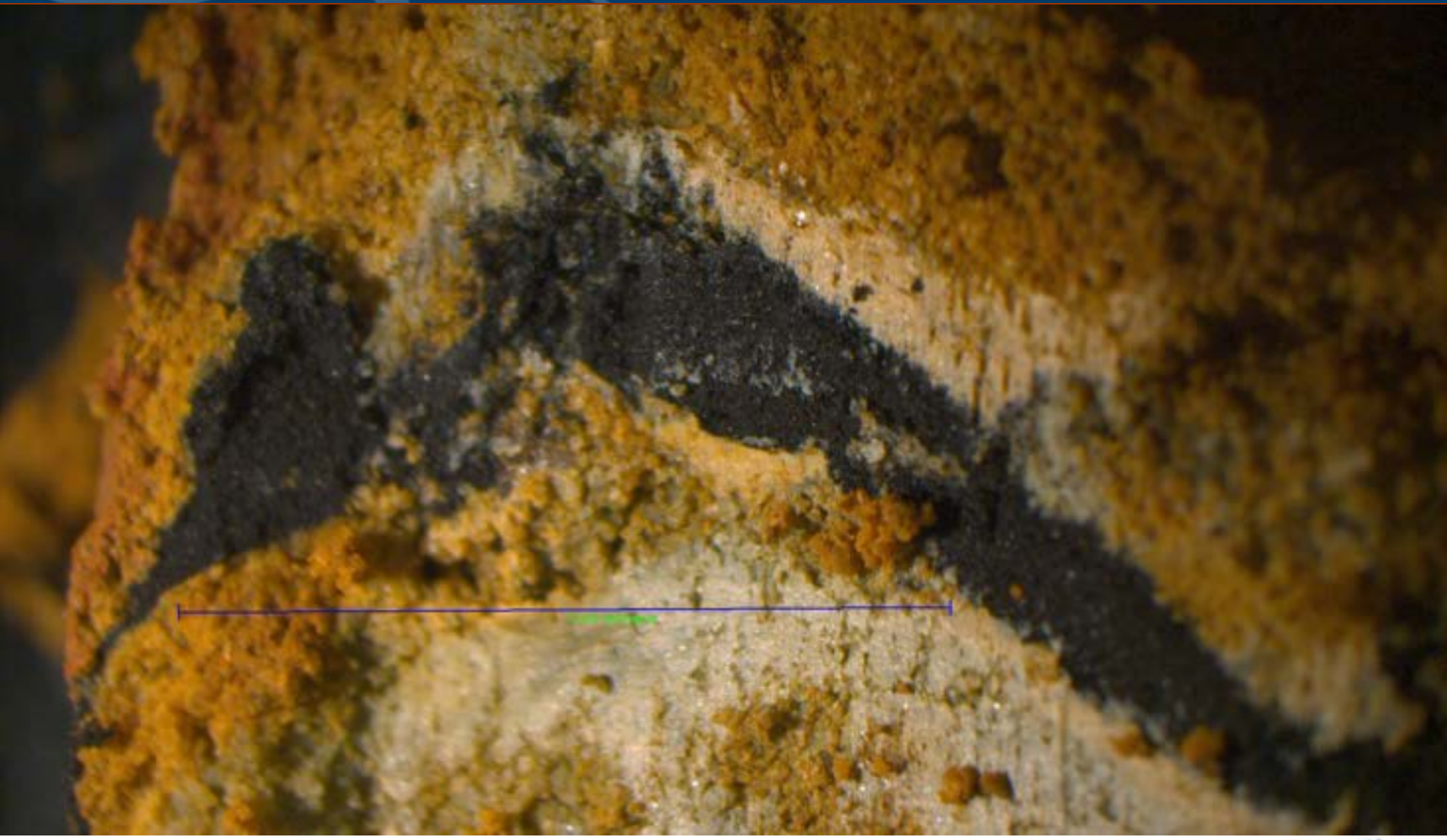
Carbon Intersecting Between Soil Textures

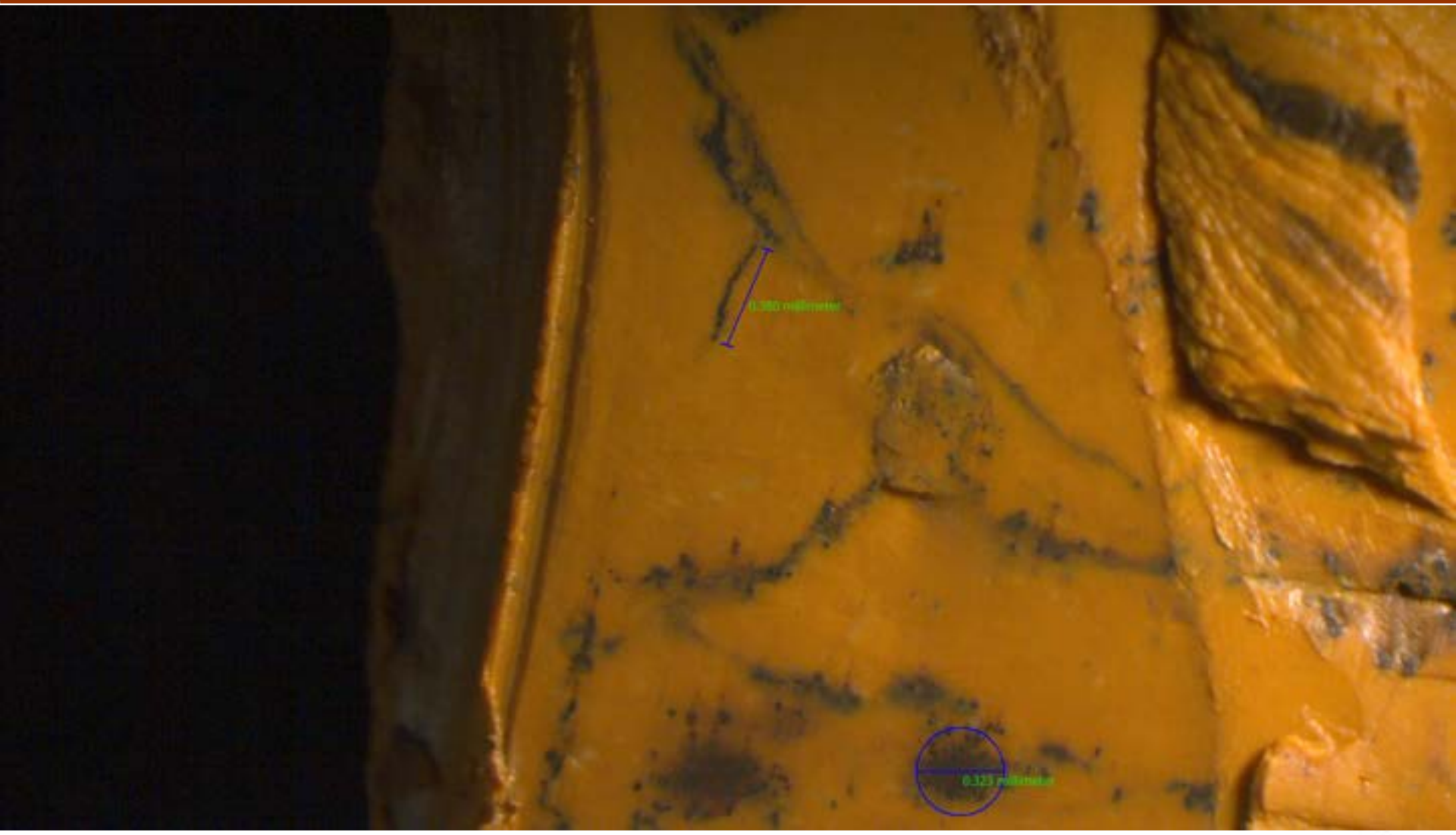
More



Intercalation Between Clays

Dendritic Distribution Patterns

Many Fine Features



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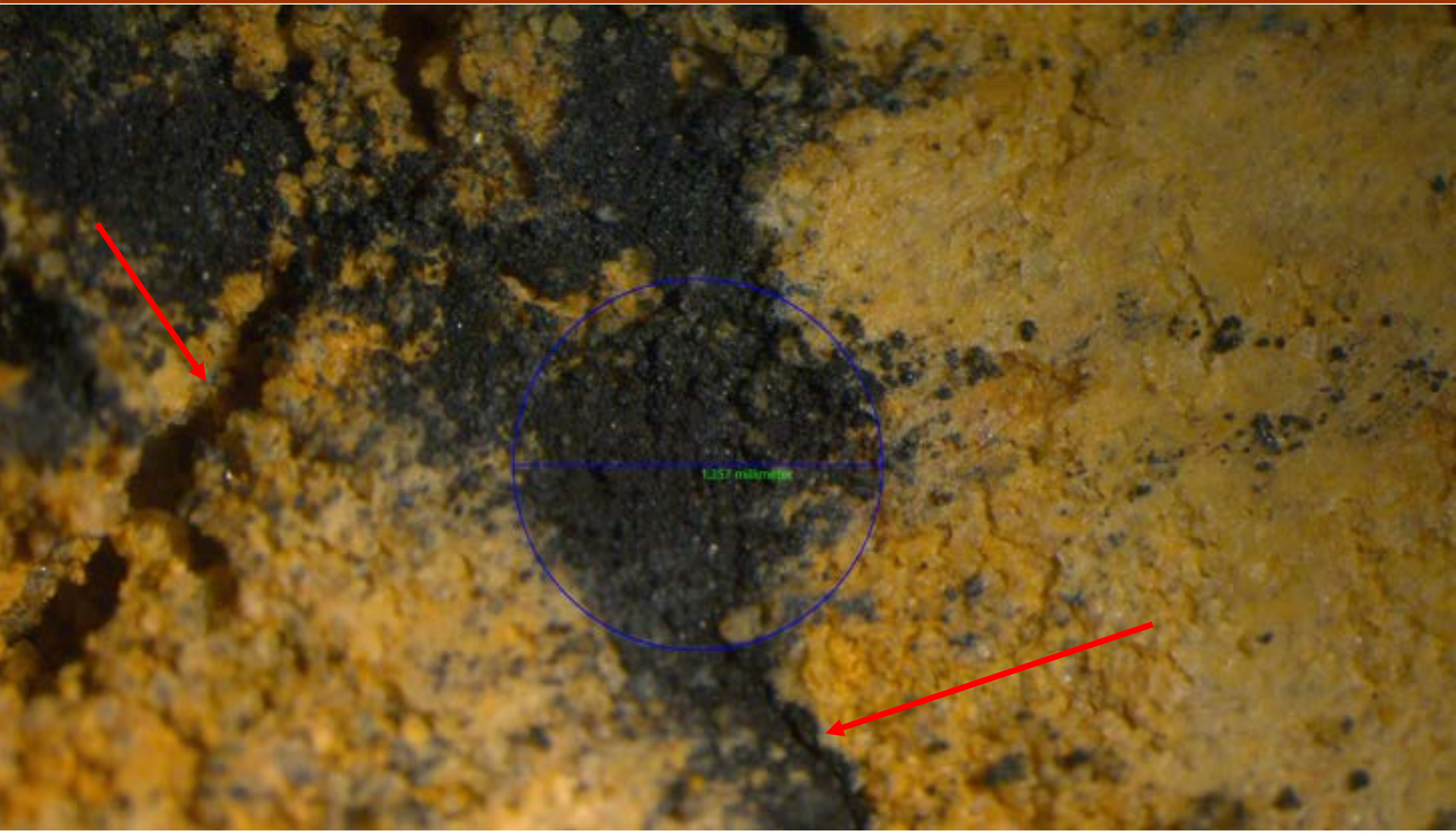
Carbon Filling Macropores in the Media



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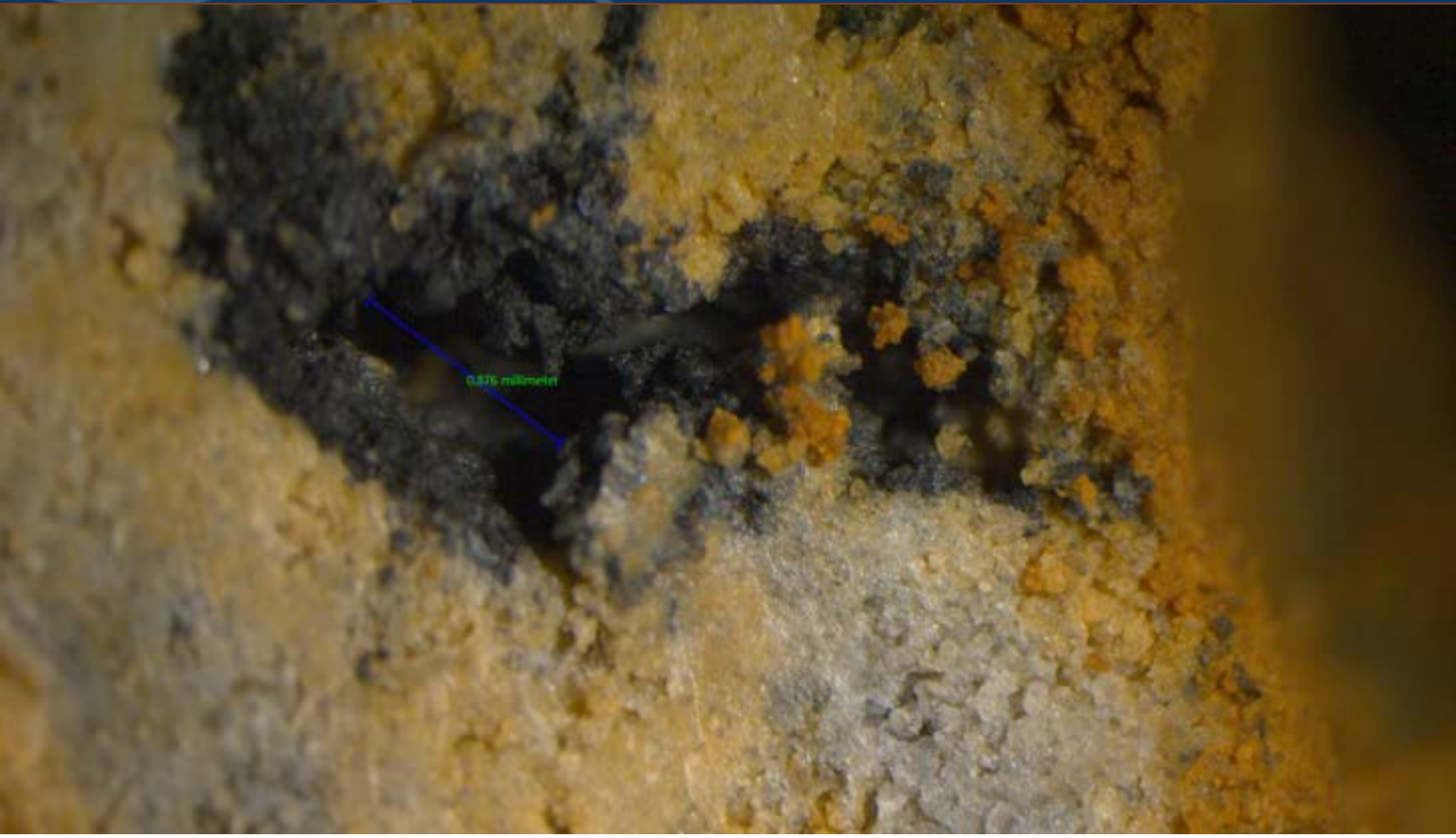
Another Pore



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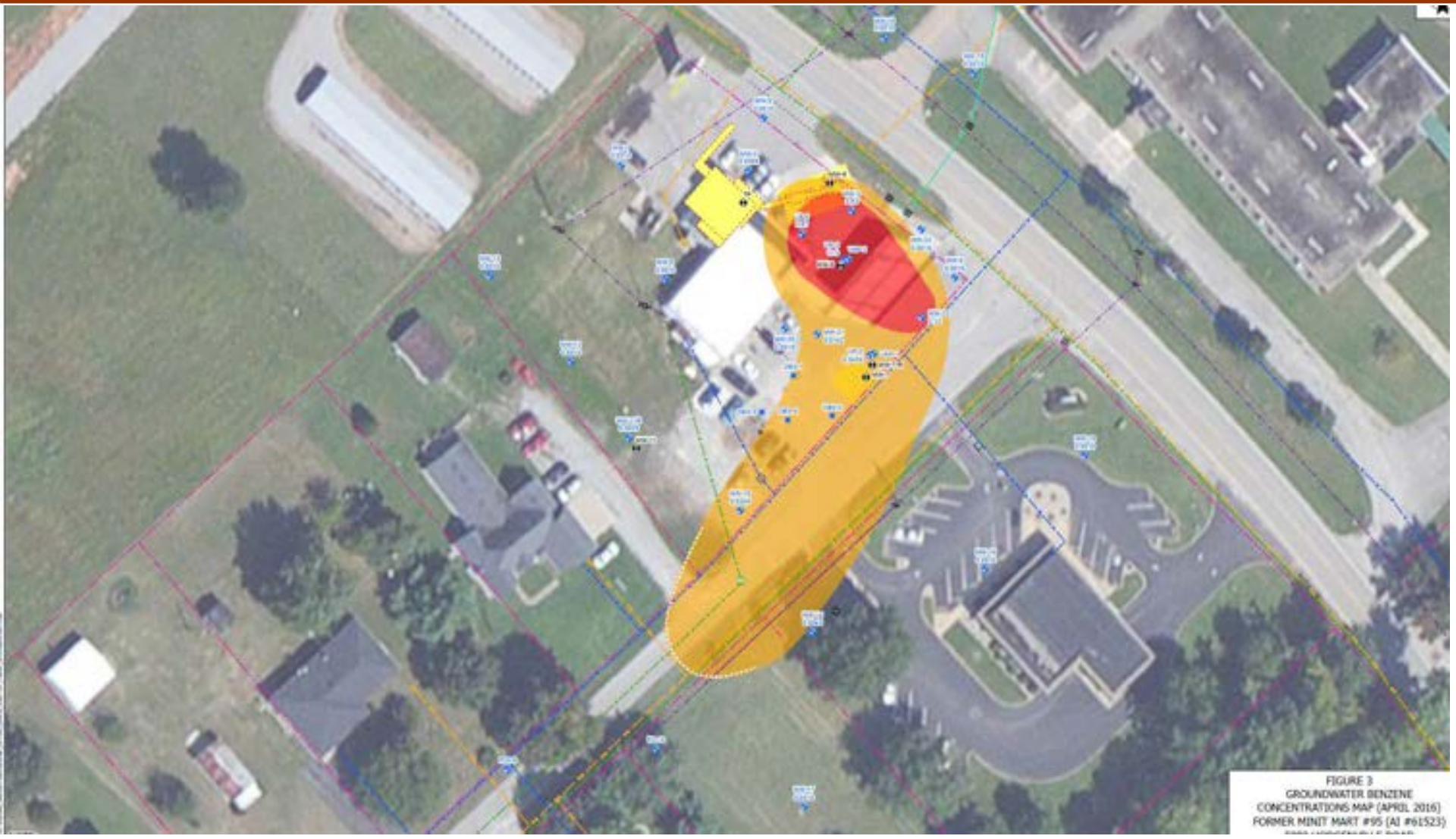
Minit Mart Prior to Injection



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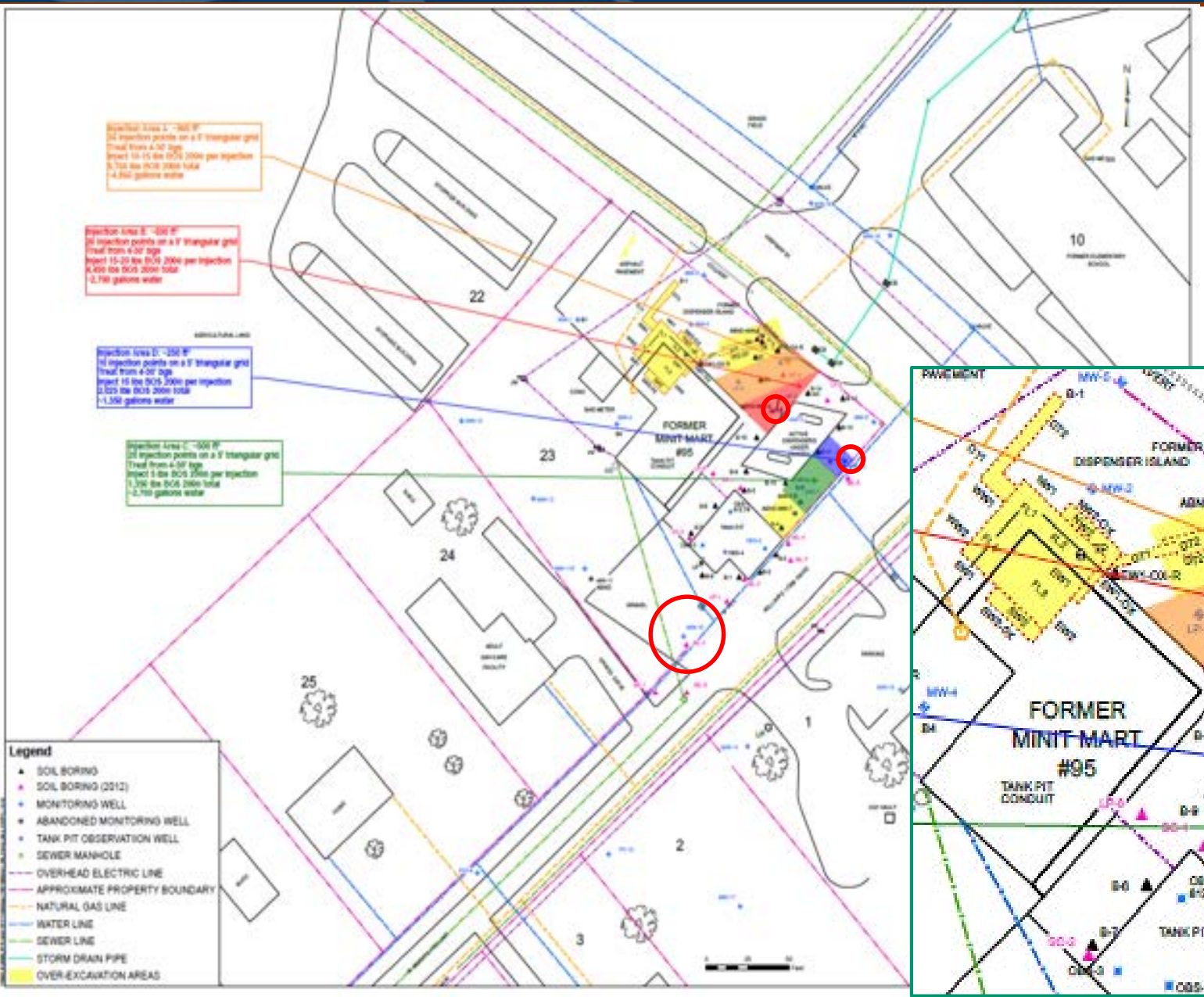
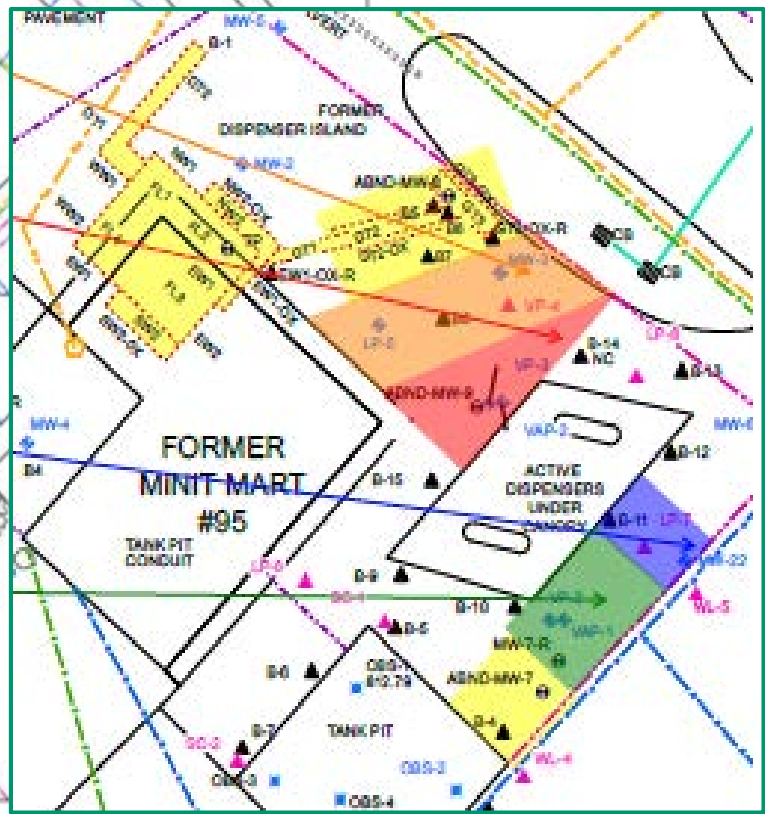
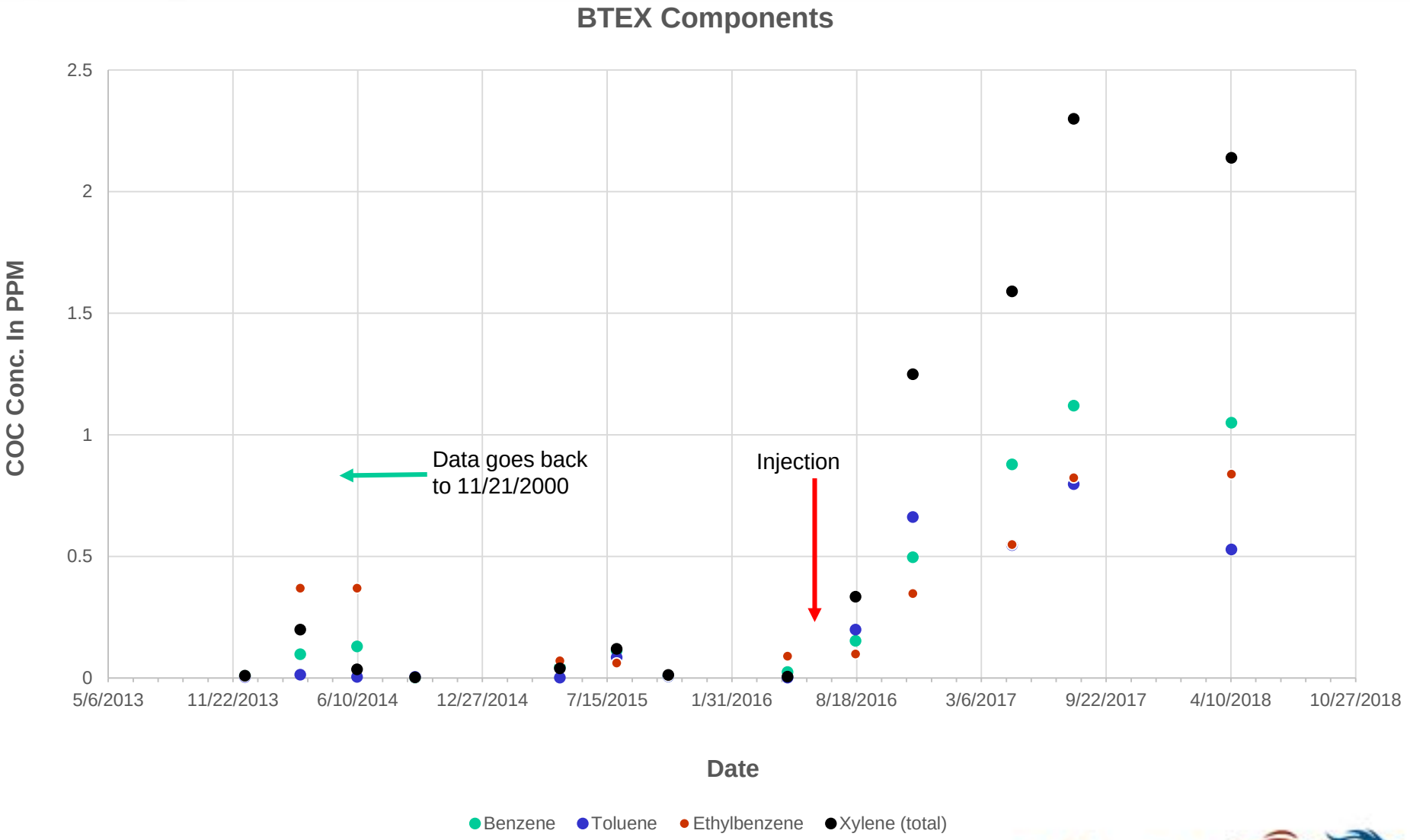
The Coloration Marks Injection Areas





Post-injection COCs Increase in MW-10, Outside Injection Area



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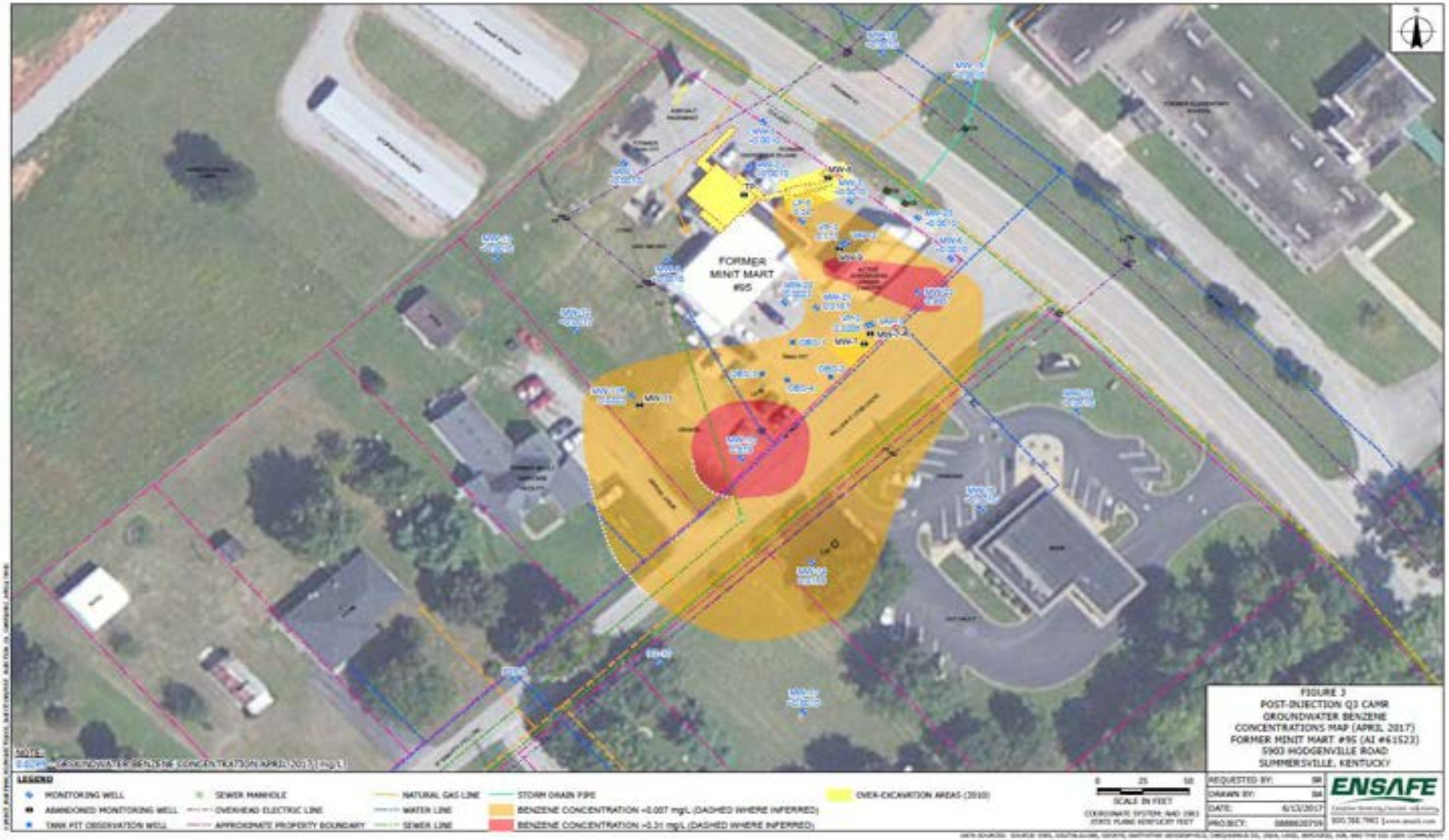
Minit Mart Post Injection



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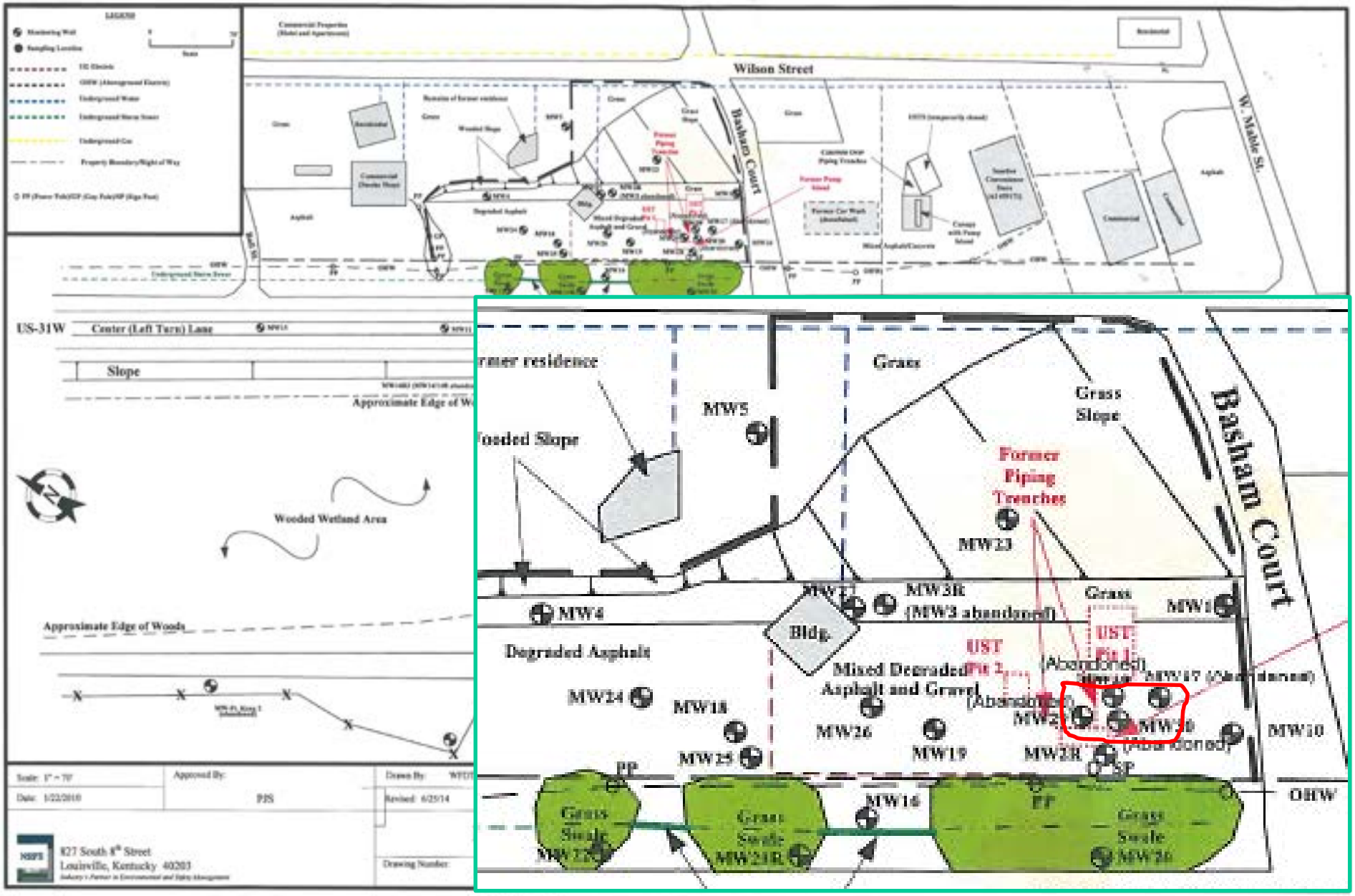
Fort Knox Self Service
(You've seen this before)



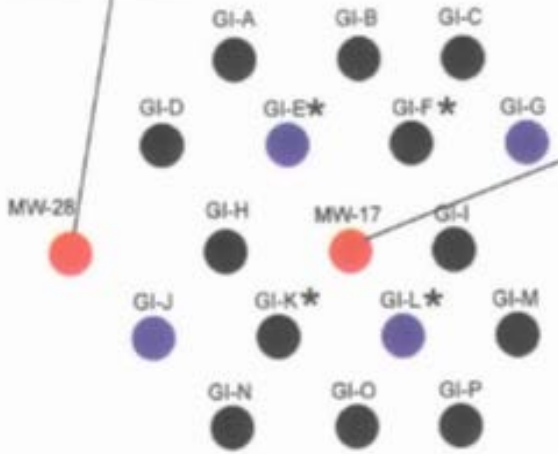
“Push” by Gravity Feed Liquid?

MW-28

	Pre-Injection	Post-Injection	Reduction
B	2.562	2.419	6%
T	2.944	1.339	55%
E	0.428	0.375	12%
X	1.49	2.267	(34%)
GRO	15.005	10.996	27%

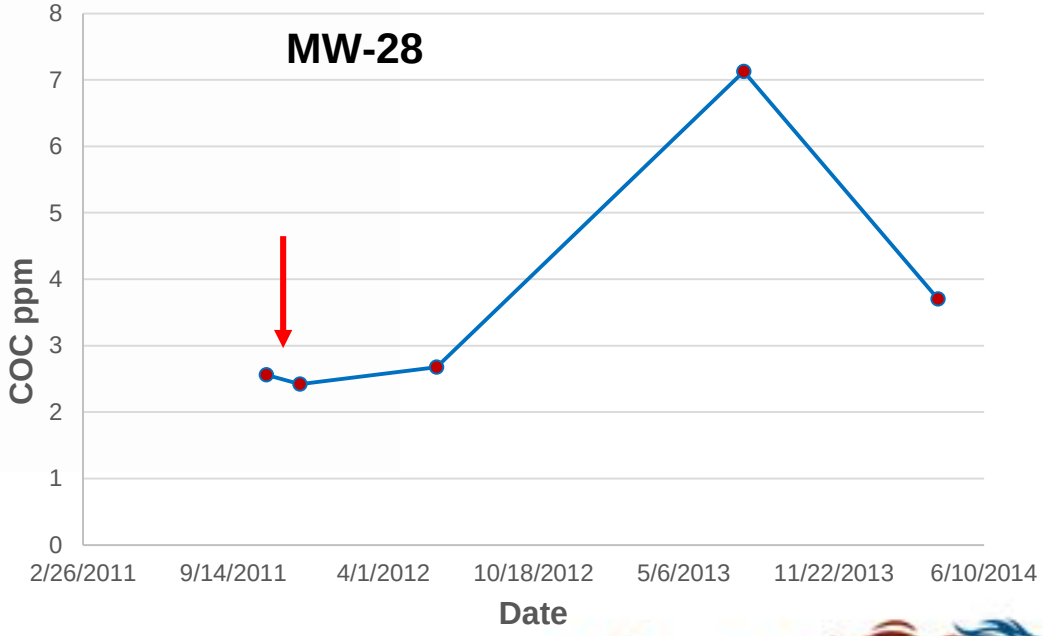
MW-17

	Pre-Injection	Post-Injection	Reduction
B	0.533	0.468	12%
T	0.047	0.0203	50%
E	0.598	0.348	42%
X	0.969	0.060	94%
GRO	7.253	6.47	11%



Legend

- Monitoring Well
- Injection Point for 3 Tier Technologies Fluids
- ★ Also Received ORC Fluids
- Co-Located Injection Point (3 Tier Technologies Fluids) and Soil Sample Boring



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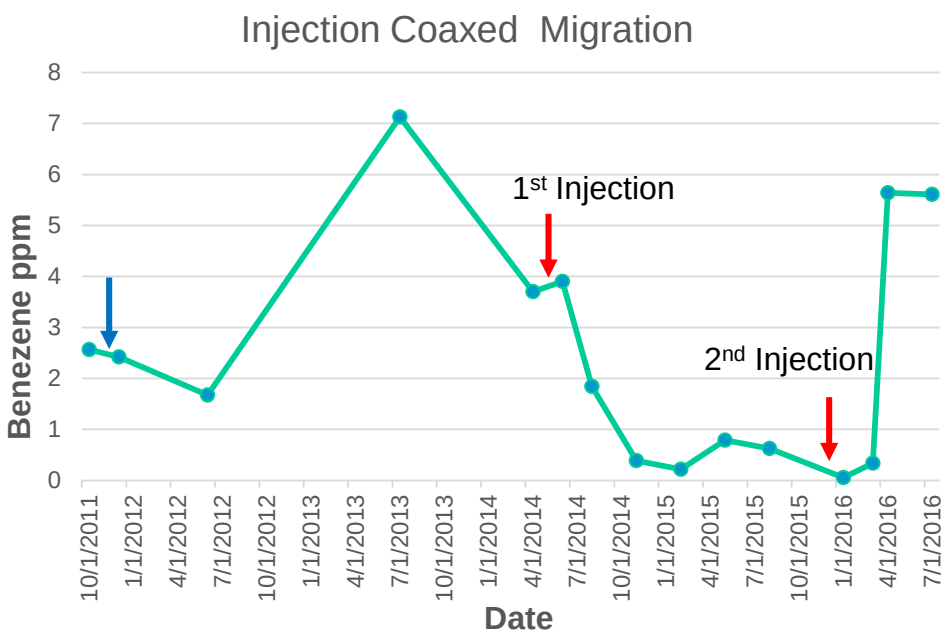
Post-injection ¼ Inch Free-Product in MW-28



MW-28	10/28/2011	2.562	2.944	0.428	1.49
MW-28	12/12/2011	2.419	1.339	0.375	2.267
MW-28	6/11-13/12	1.675	0.338	0.571	1.131
MW-28	7/25/2013	7.127	3.378	1.033	4.656
MW-28	4/10/2014	3.7	0.37	0.5	1.14
MW-28	6/11/2014	3.9	1.7	0.18	0.59
MW-28	8/21/2014	1.84	0.203	0.0329	0.959
MW-28	11/6/2014	0.385	0.00515	0.00959	0.03721
MW-28	2/4/2015	0.214	0.00569	0.00942	0.0082
MW-28	5/7/2015	0.788	<0.005	0.0515	0.2042
MW-28	8/4/2015	0.624	<0.005	0.027	<0.015
MW-28	1/7/2016	0.0523	<0.005	<0.005	<0.015
MW-28	3/1/2016	0.338	0.0802	0.0132	0.1507
MW-28	4/27/2016	5.64	1.81	0.782	3.77
MW-28	7/20/2016	5.61	7.17	9.2	120.7

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Yep, now you know where you've seen Fort Knox Self Service!

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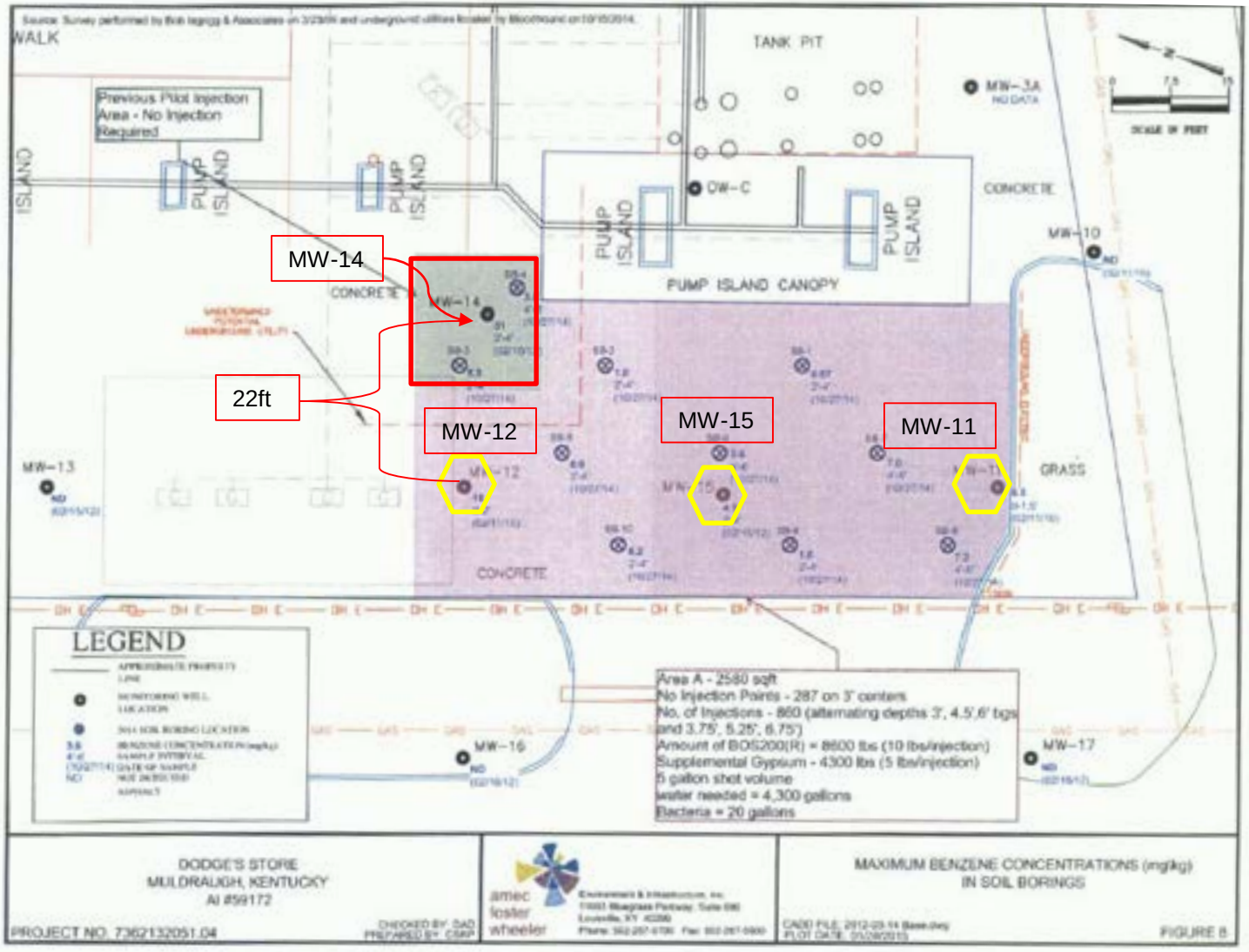
Petroleum Present

Dodge's Store
Pilot Injection MW-14 Decreases BTEX at MW-12



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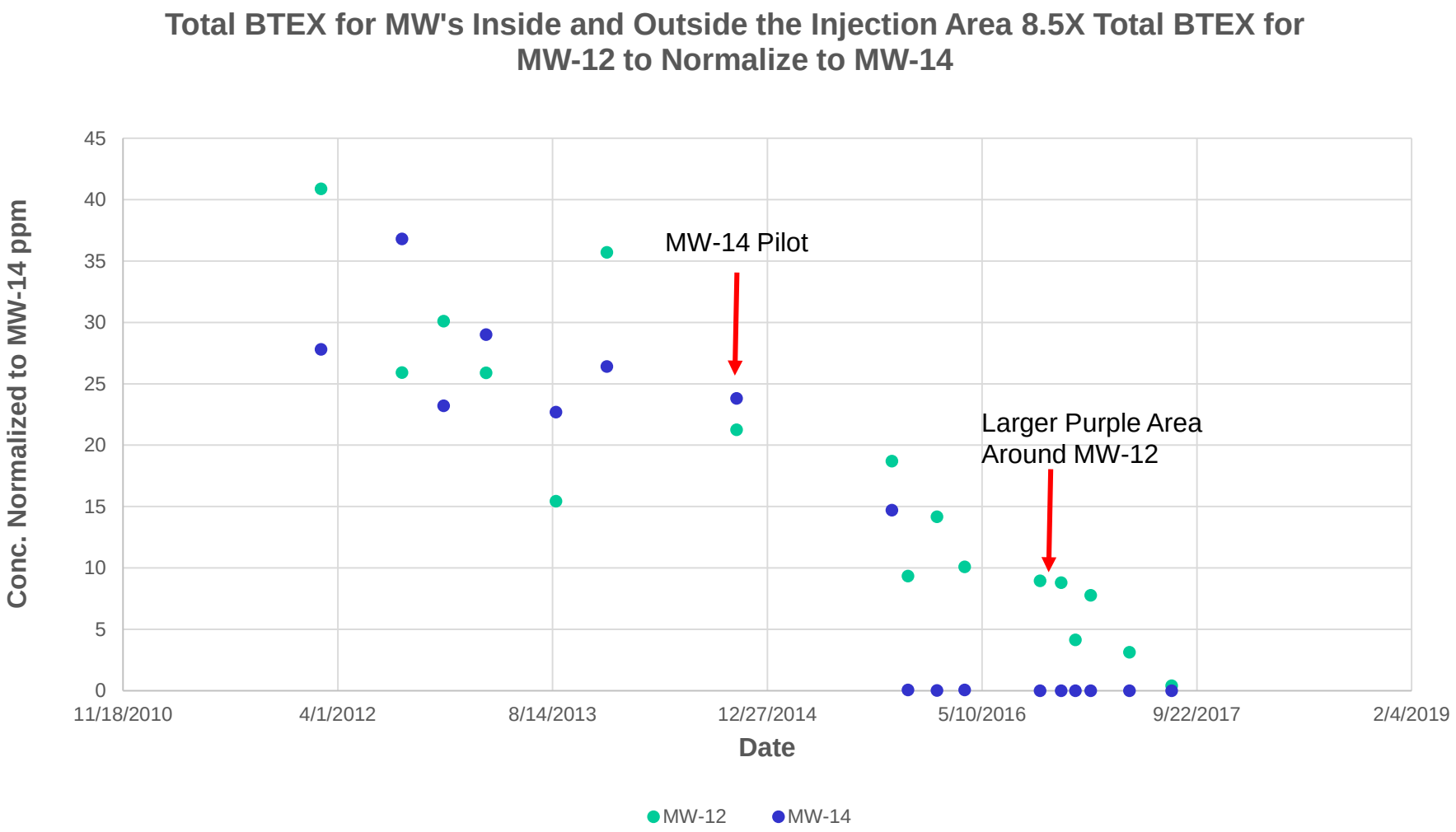
Influence Range of Injection



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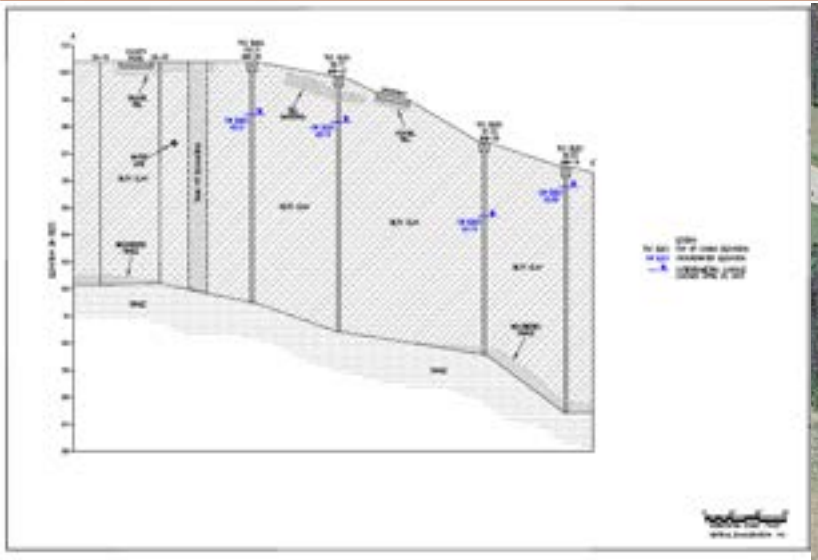
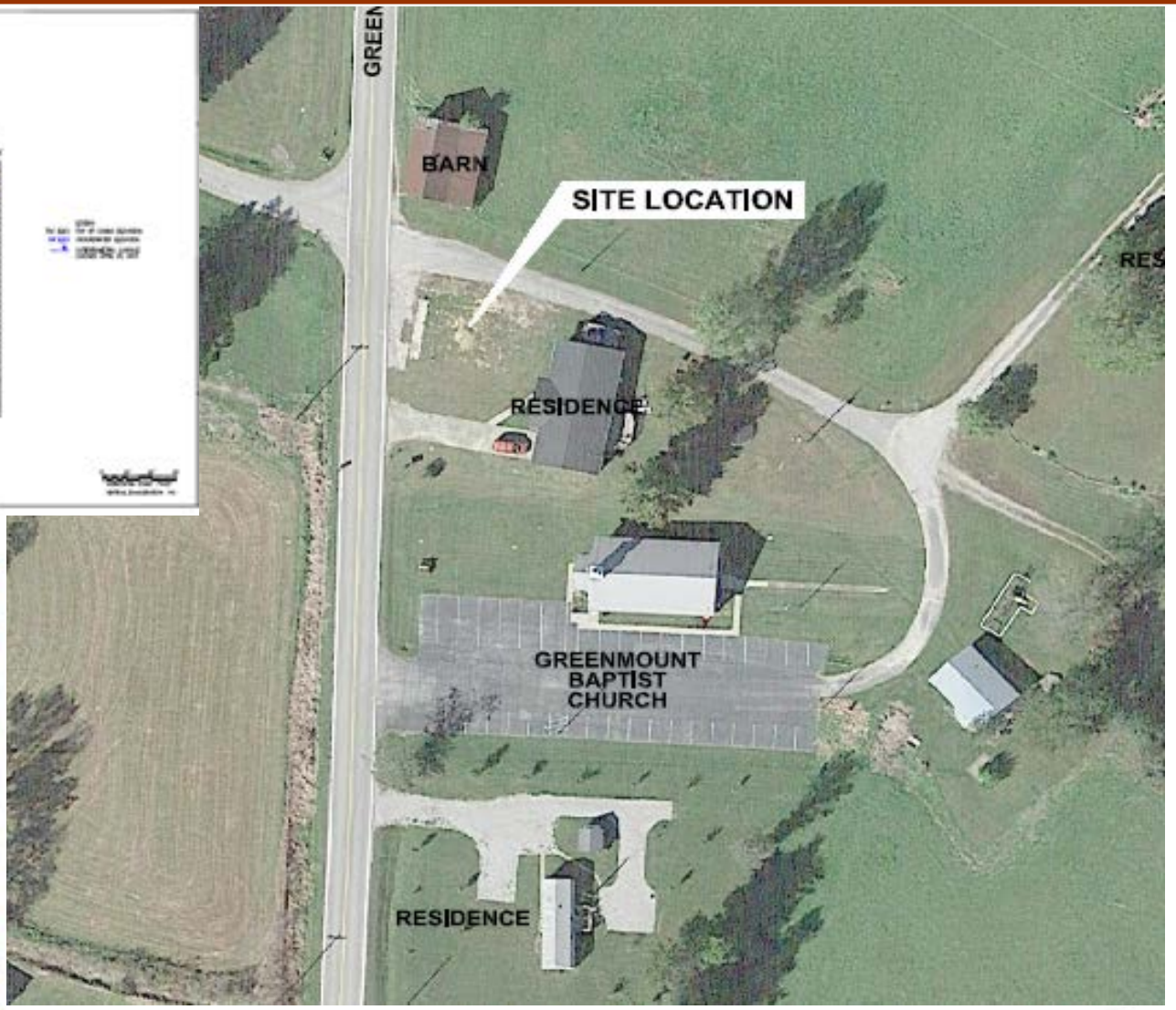
Sloan's (Eat Your Spinach)



BOS Impacts at 4.0-7.5' & 8.25-8.5'



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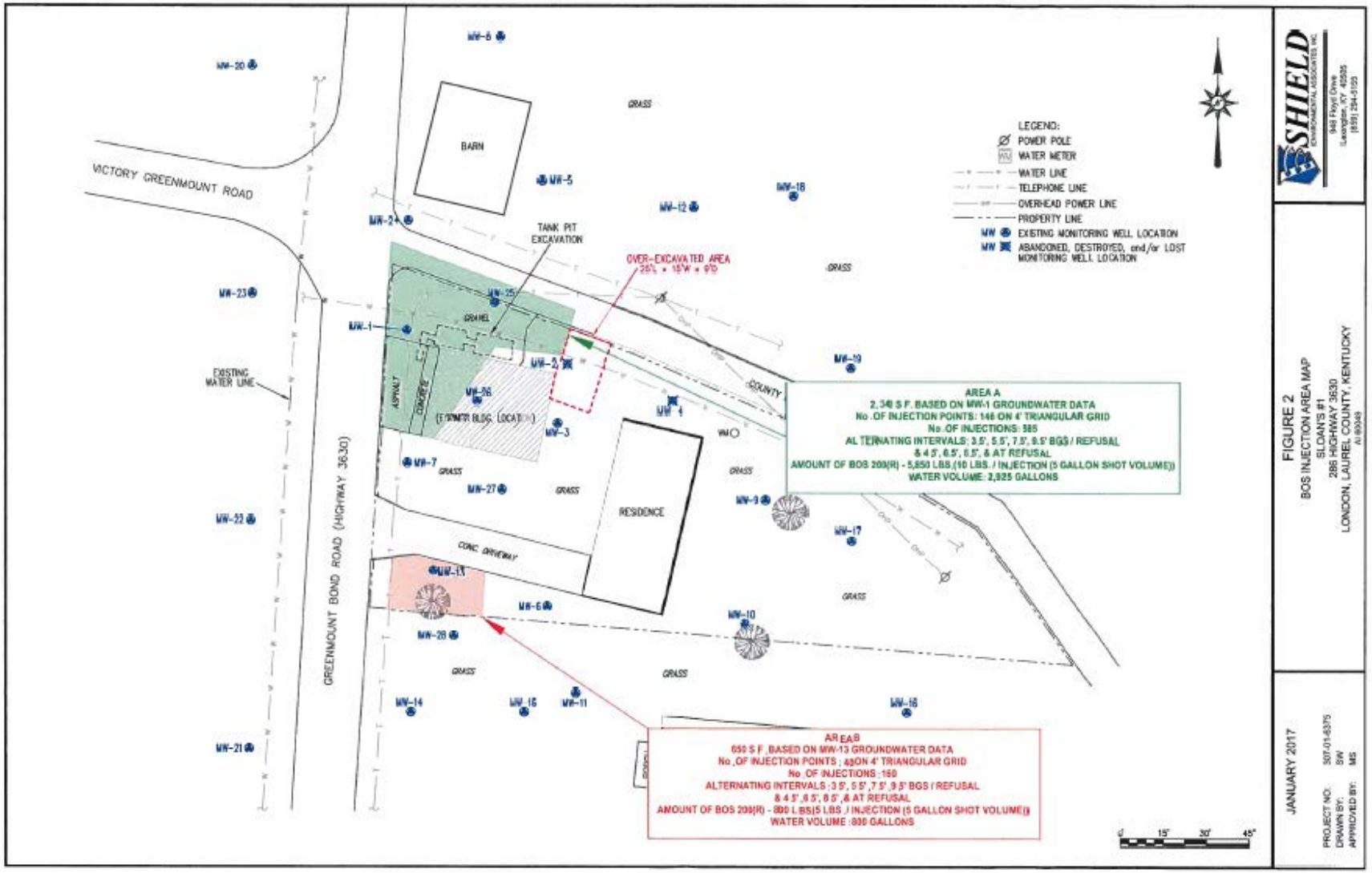
Area Injected



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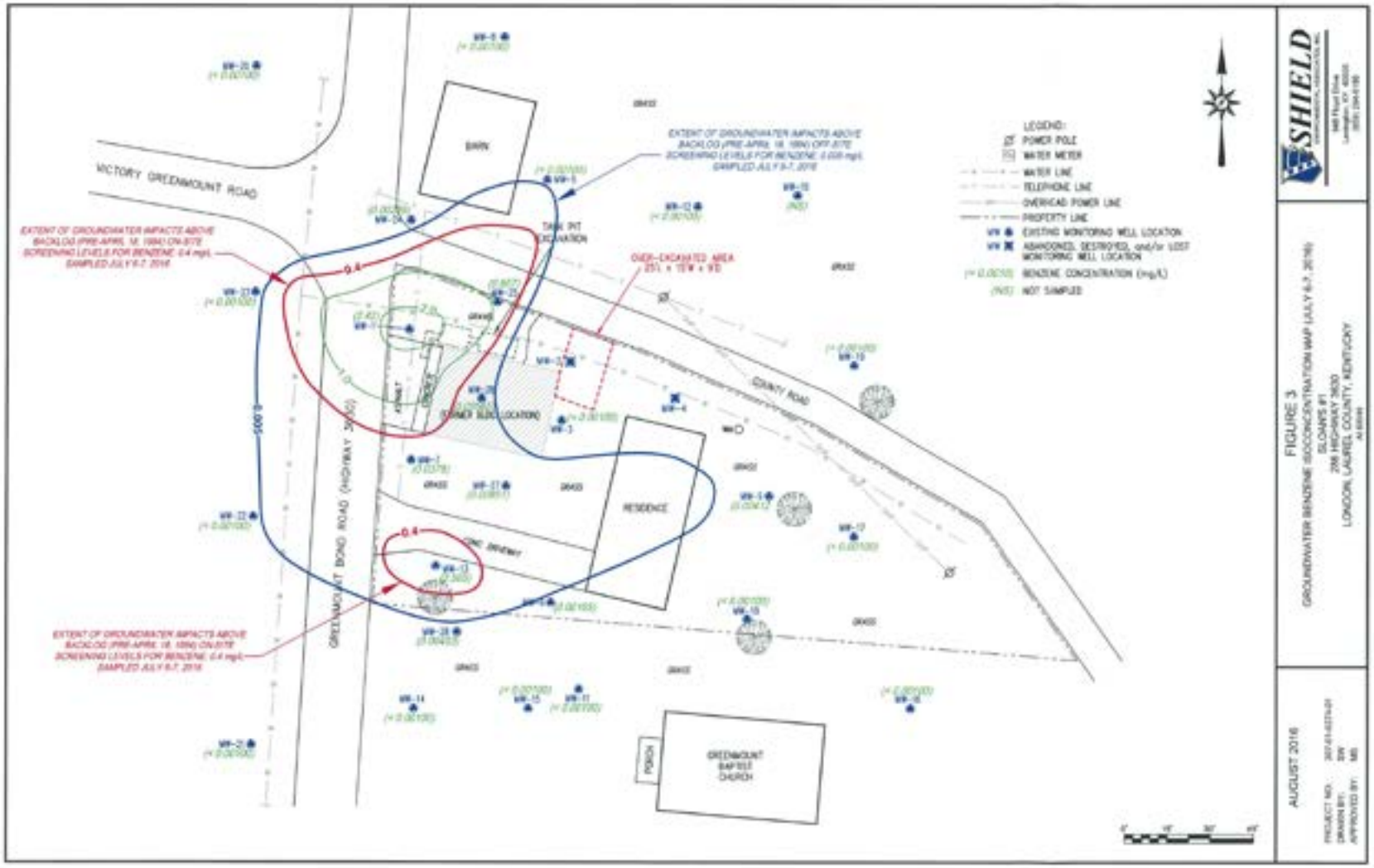
Site Condition Prior to Injection



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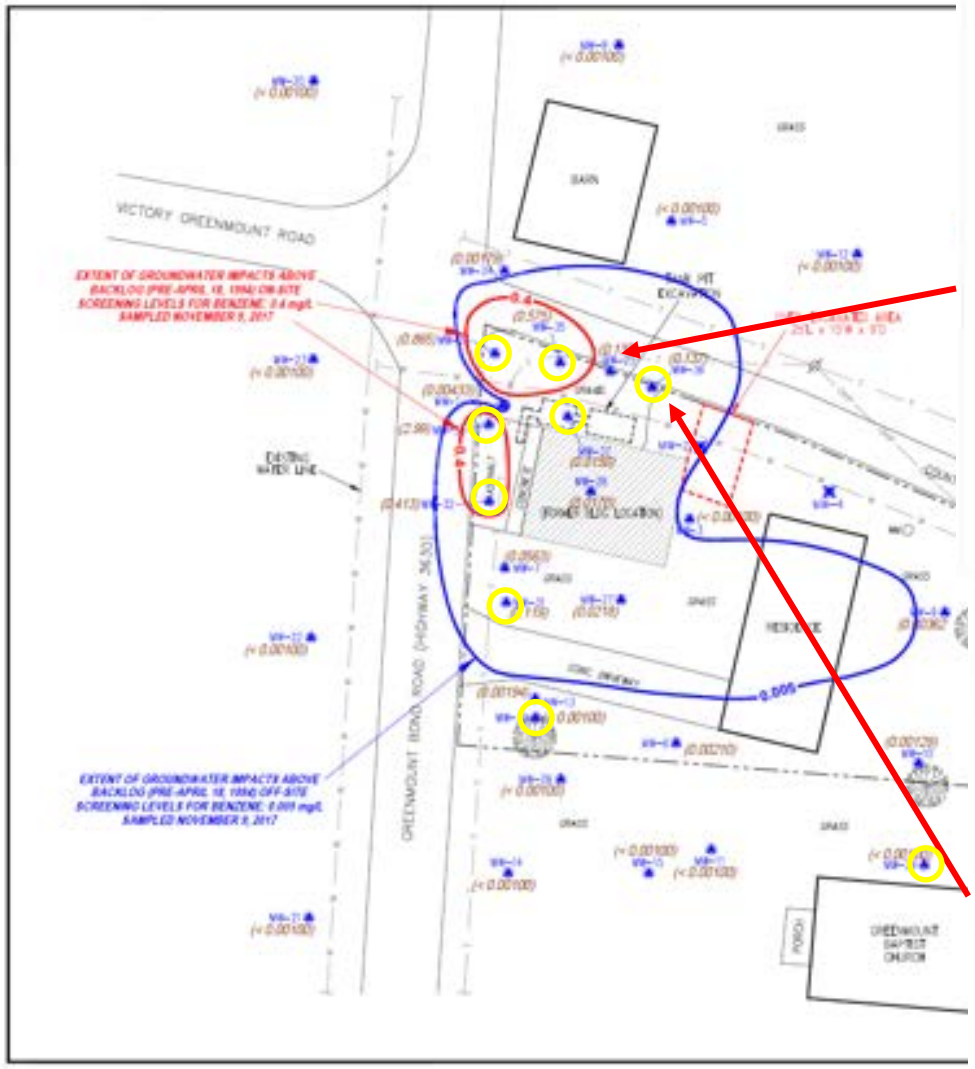
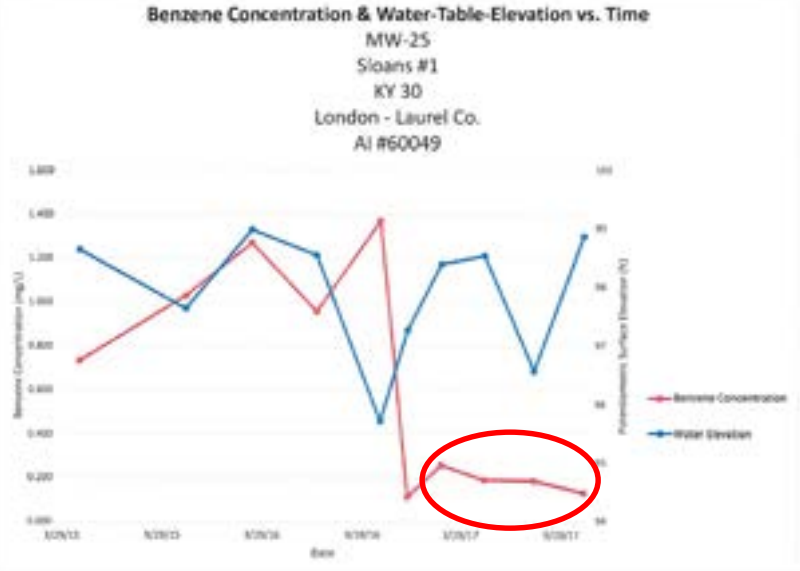
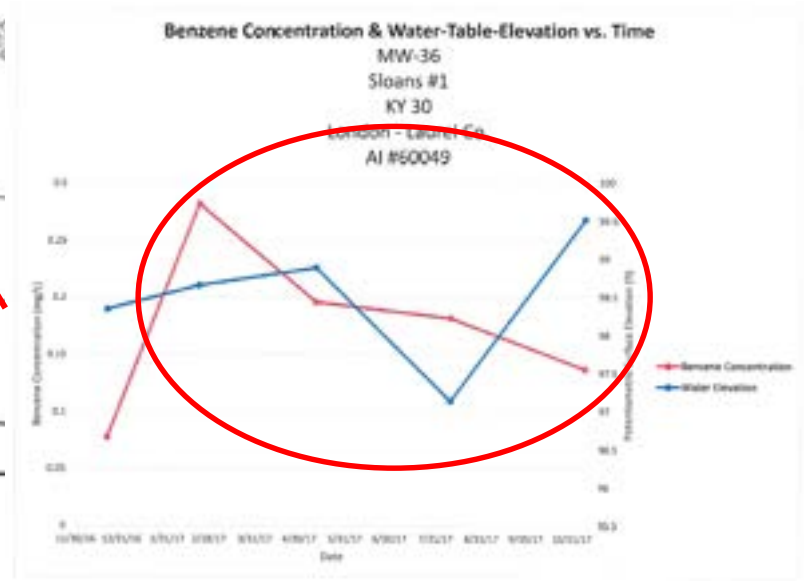
MW-25 Compared to MW-36







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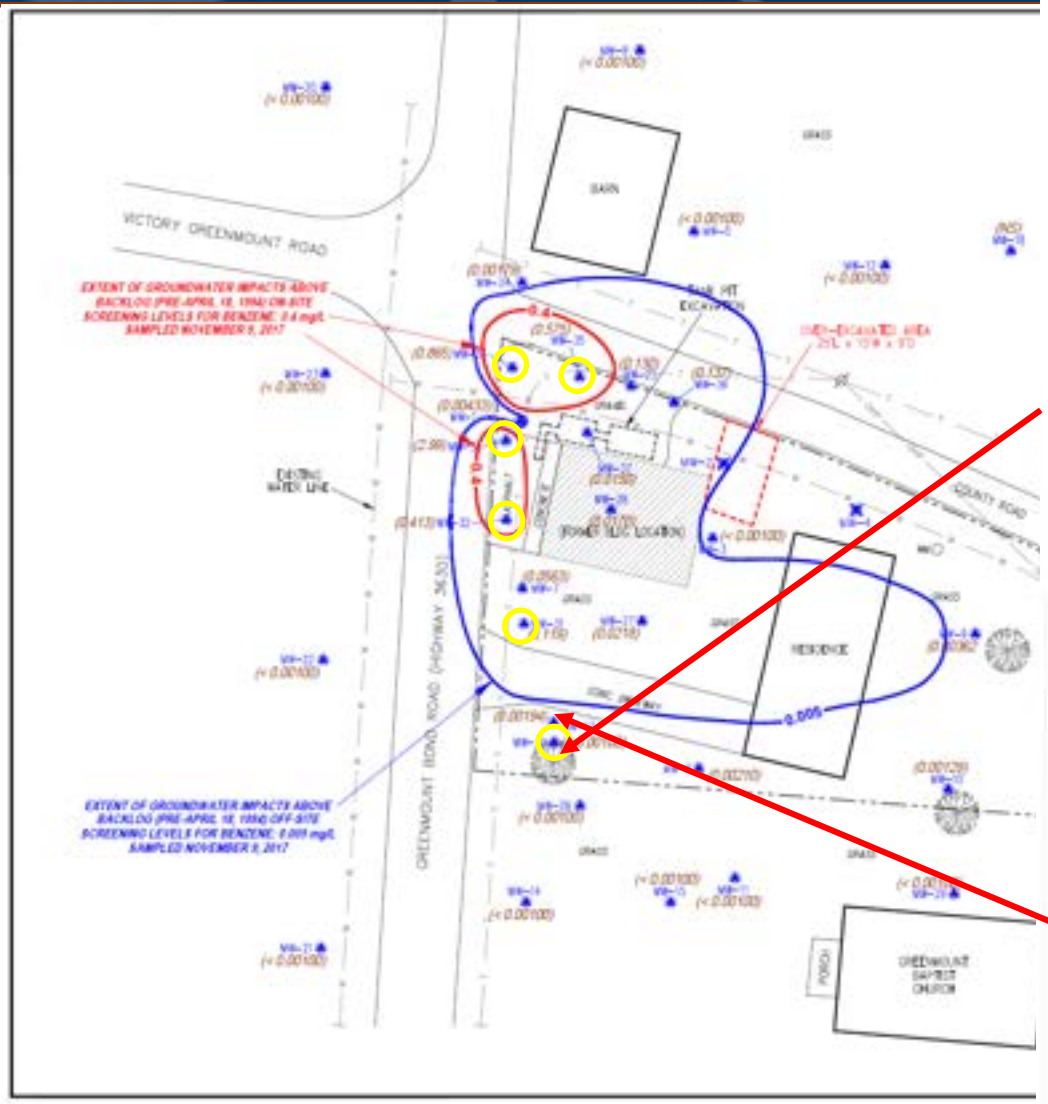
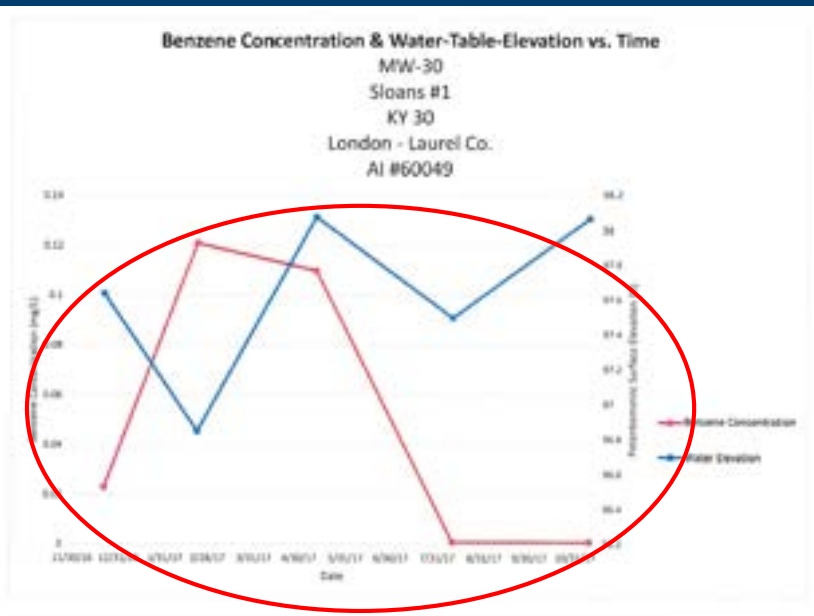
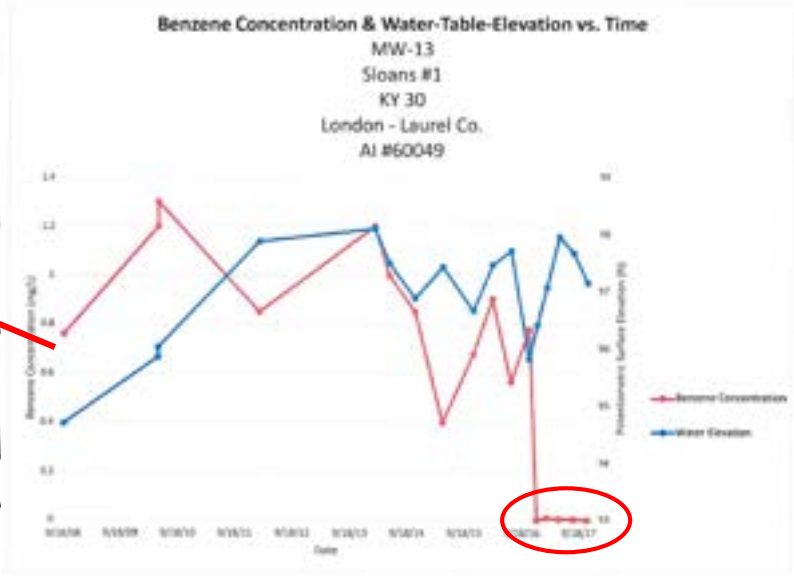
MW-13 Compared to MW-30







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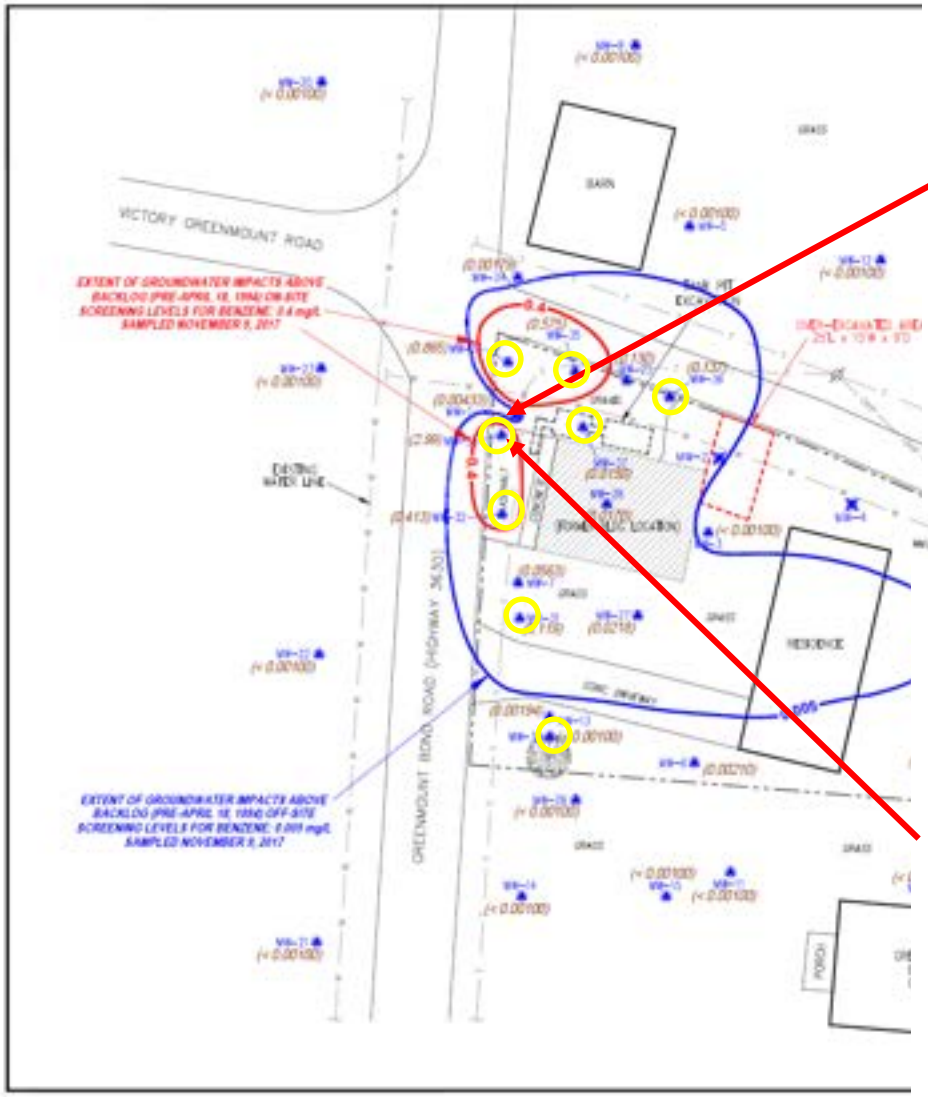
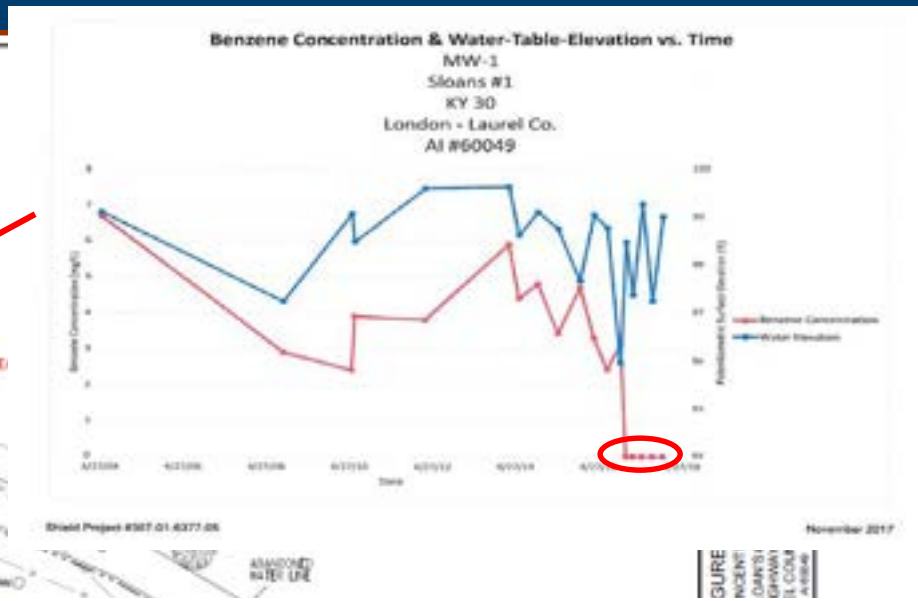
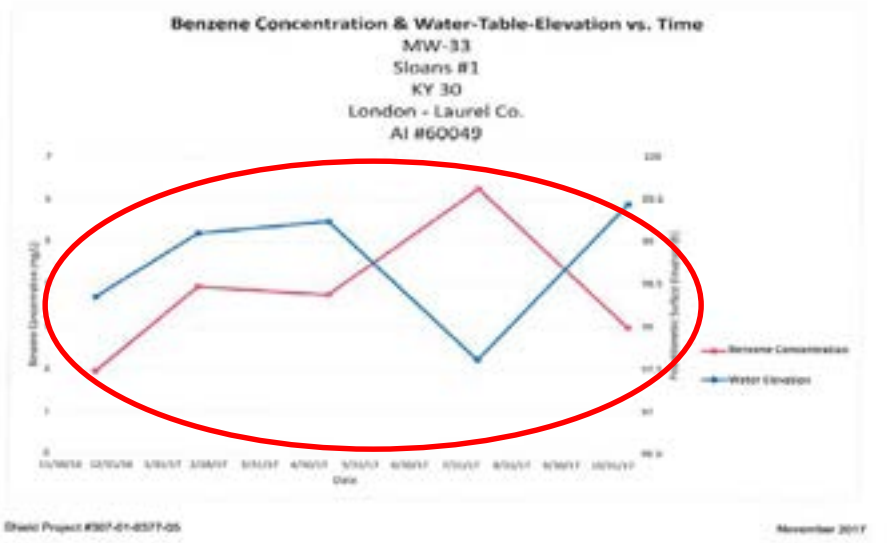
MW-1 Compared to MW-33







Carbon Injection Considerations

- Injectate distribution is largely controlled by the soil matrix
  - Injectates, without regard to installation method, distribute asymmetrically; this is not a strictly a carbon issue.
    - Flow follows paths which offer the least resistance
- Anticipated mobilization of contaminants
  - You can't mobilize that which in not present
  - If you mobilize contamination of which you were unaware of prior to injection, that's inadvertent, further characterization of your site!
    - For site that have demonstrated monitoring well concentrations for benzene greater than 5 ppm or soil concentrations greater than 300 ppm, don't be surprised when you see free product (Generalization that varies greatly depending on geology but a useful rule of thumb).
    - Some remedies double as characterization tools; although, one wishes they would not.
- Monitoring well filter packs may be impacted by carbon as well as other injectates, but we have not seen evidence of this as a general rule. It is an occurrence.
  - The general rule is that monitoring wells change what they indicate after the installation of thousands of pounds of material into the subsurface.
  - Reasonable caution, multiple lines of evidence, efforts coordinate to risk are all suggested.

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Expectations

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Reality

Questions

I appreciate the work of those who contributed to this presentation either in its development or by executing the on the ground work. Regardless of individual contributions, the ideas expressed are my own and may or may not be shared by those who contributed. I'd like to thank the following individuals:

Brad Highley Kentucky DWM UST Branch
West Johnson Kentucky DWM UST Branch
Todd Mullins Kentucky DWM UST Branch
Michael Albright Kentucky DWM UST Branch