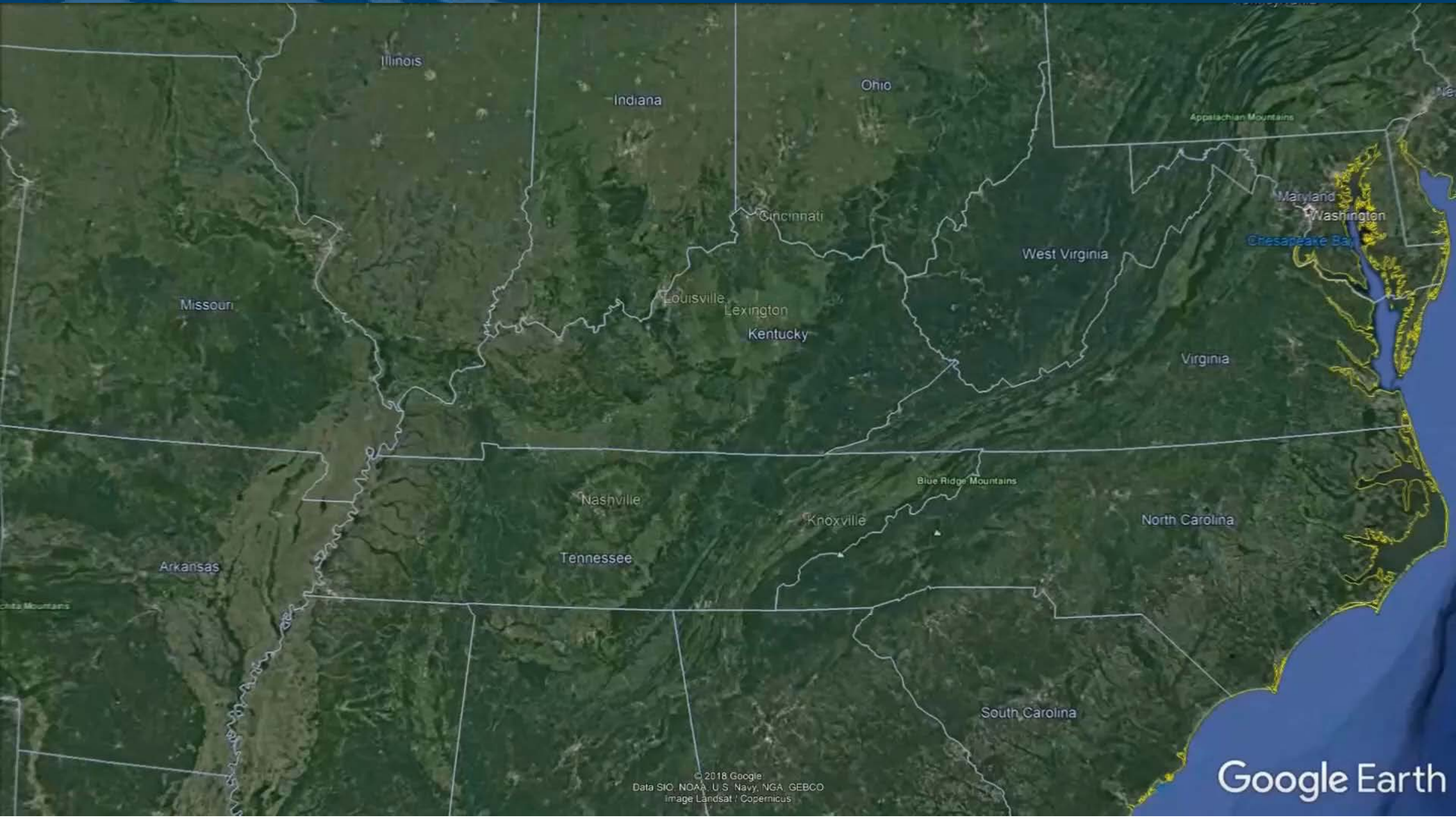
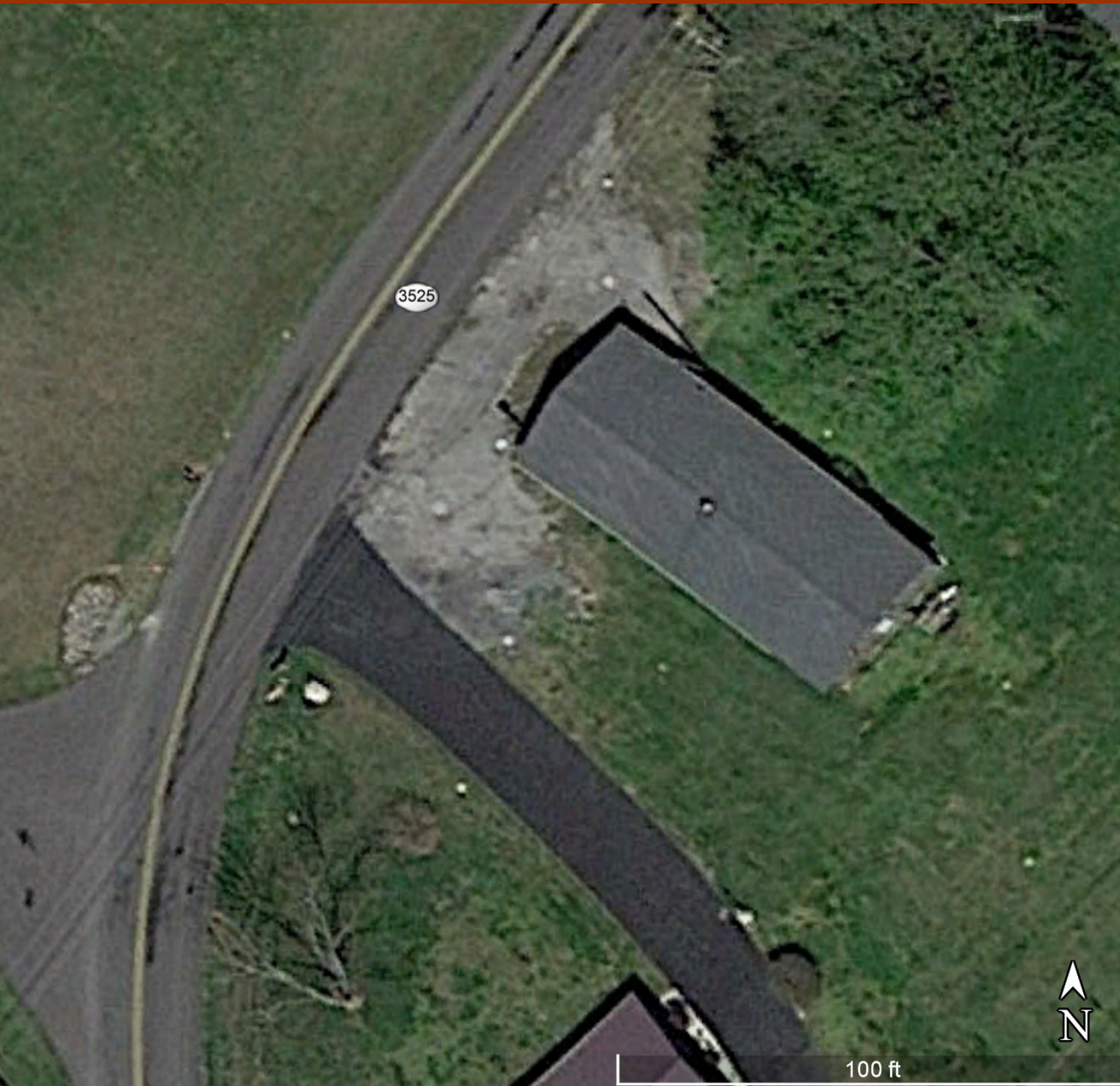




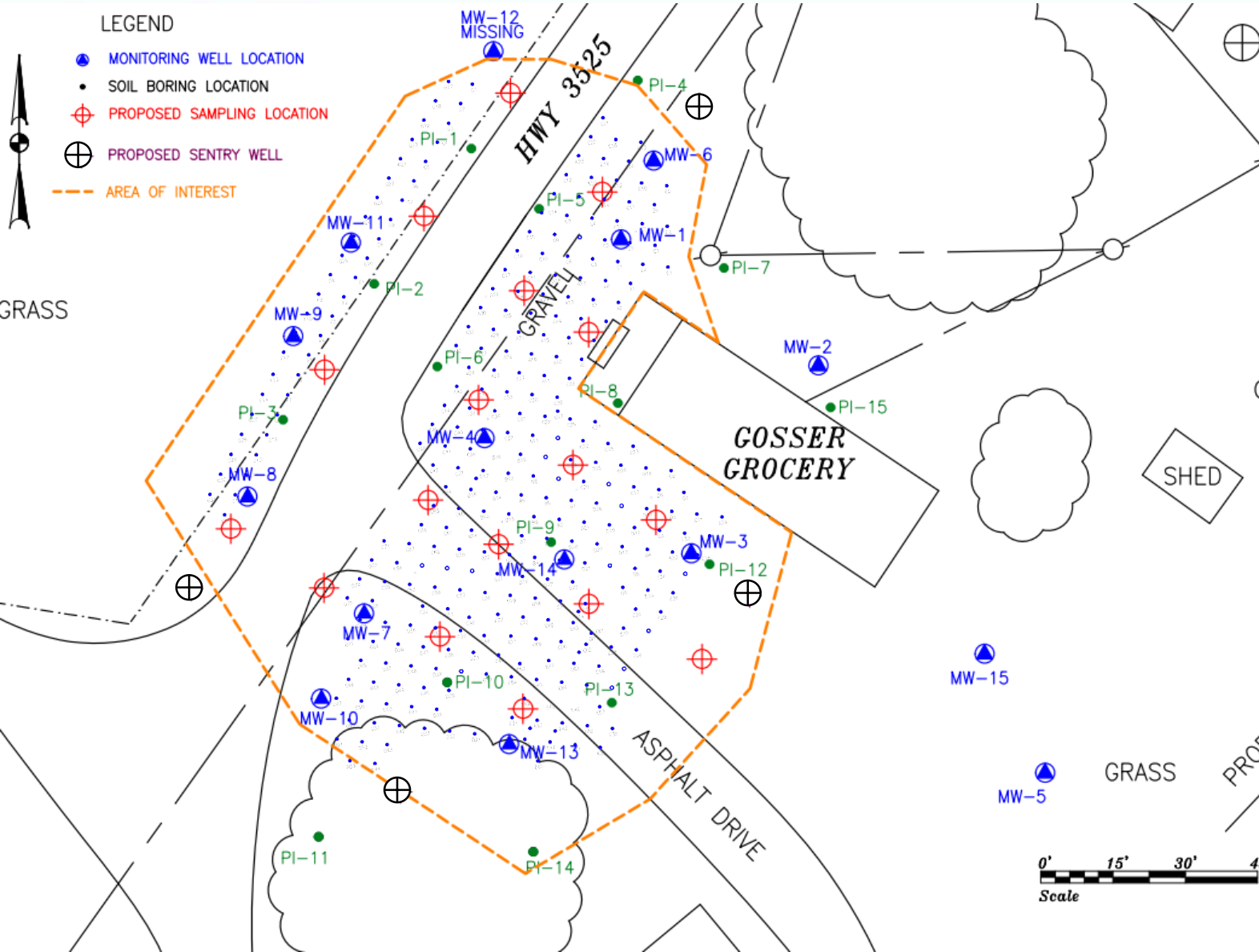
Site History



Former UST Facility, Russell Springs, KY

- UST Closure 2000 and 2001 (in-place)
- Site Investigations 2002 thru 2013
- No previous remediation efforts, other than tank closure, prior to carbon injection.
- Benzene concentrations
 - Soil high $\approx$ 16 ppm
 - Water high $\approx$ 9 ppm
- Bedrock $\approx$ 18ft in treatment area

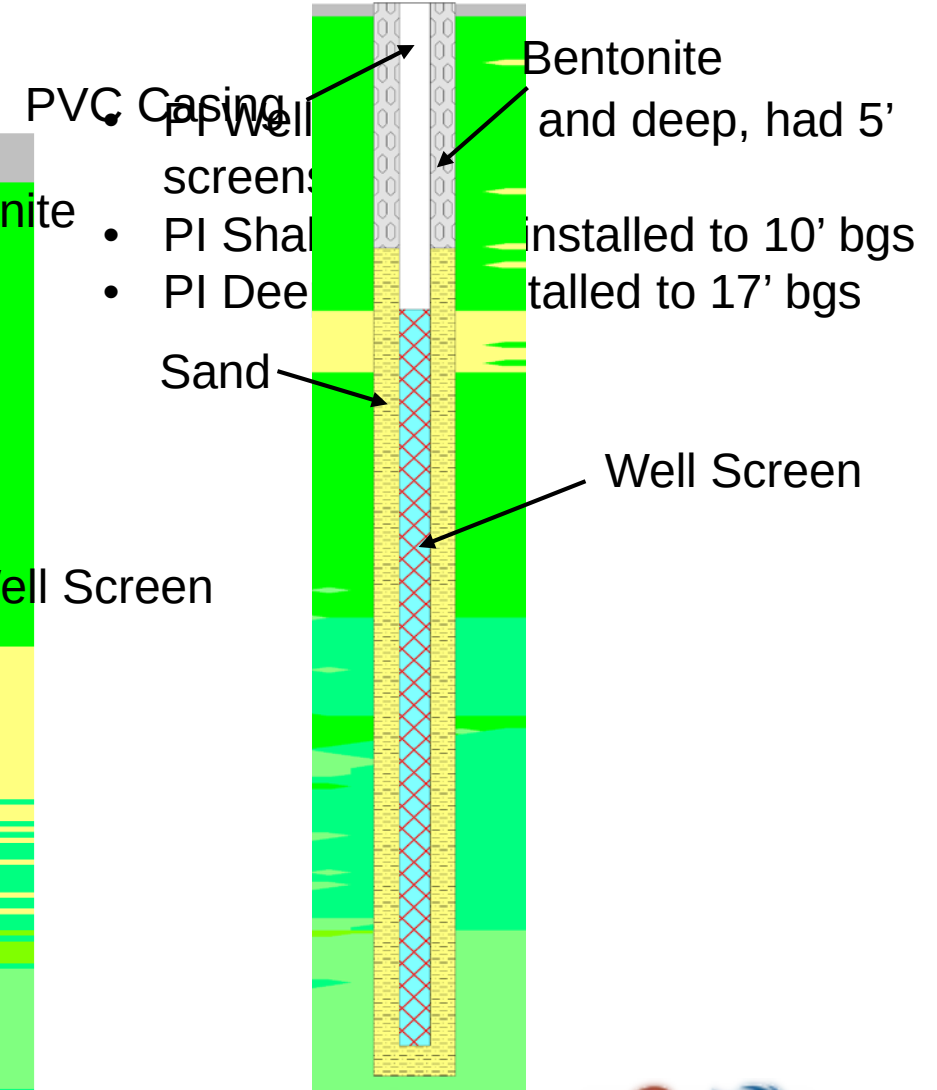
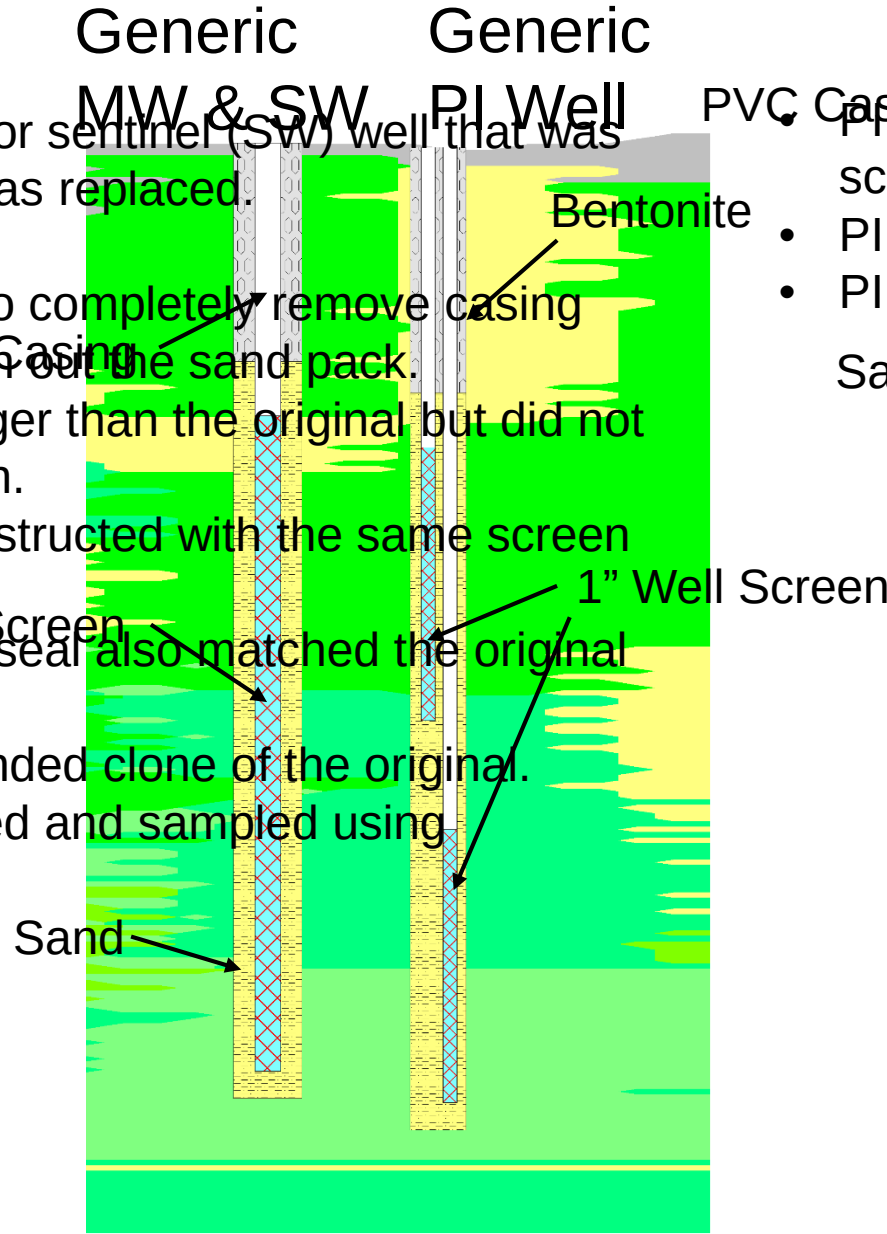
Soil and Groundwater Evaluation



- **11/7/16-11/8/16 Soil Sampling Work**
 - 32 total sampling locations
 - Installation of sentry wells (SW) (4)
- **6/12/17 Groundwater (GW) sampling event**
 - Baseline GW values established for 14 monitor wells (MW) & 4 SWs
- **6/14/17-7/17/17 BOS 200® Injections**
- **7/7/17, 8/14/17 Post-injection GW sampling events**
 - MWs & SWs sampled
- **8/30/17-9/7/17 BOS 200® injection analysis**
 - Soil cores collected and inspected for carbon distribution
 - Installation of PI nested wells (28)
- **9/8/17, 1/31/18, 4/10/18, 6/21/18 Post-injection GW sampling events**
 - MWs, SWs & PIs sampled

Well Construction

- For this project, any monitor (MW) or sentinel (SW) well that was impacted by BOS 200® injectate was replaced.
- 2" Monitor Wells (MW) had 10' screens with wells installed to 18' bgs
- 2" Sentry Wells (SW) had 10' screens with wells installed to 19' bgs
- Existing well was over-drilled to completely remove casing and screen materials and clean out the sand pack.
- New bore hole was slightly larger than the original but did not extend below the original depth.
- The replacement well was constructed with the same screen and riser lengths.
- New sand pack and bentonite seal also matched the original construction.
- The replacement well is a intended clone of the original.
- The clone wells were developed and sampled using accepted procedures.



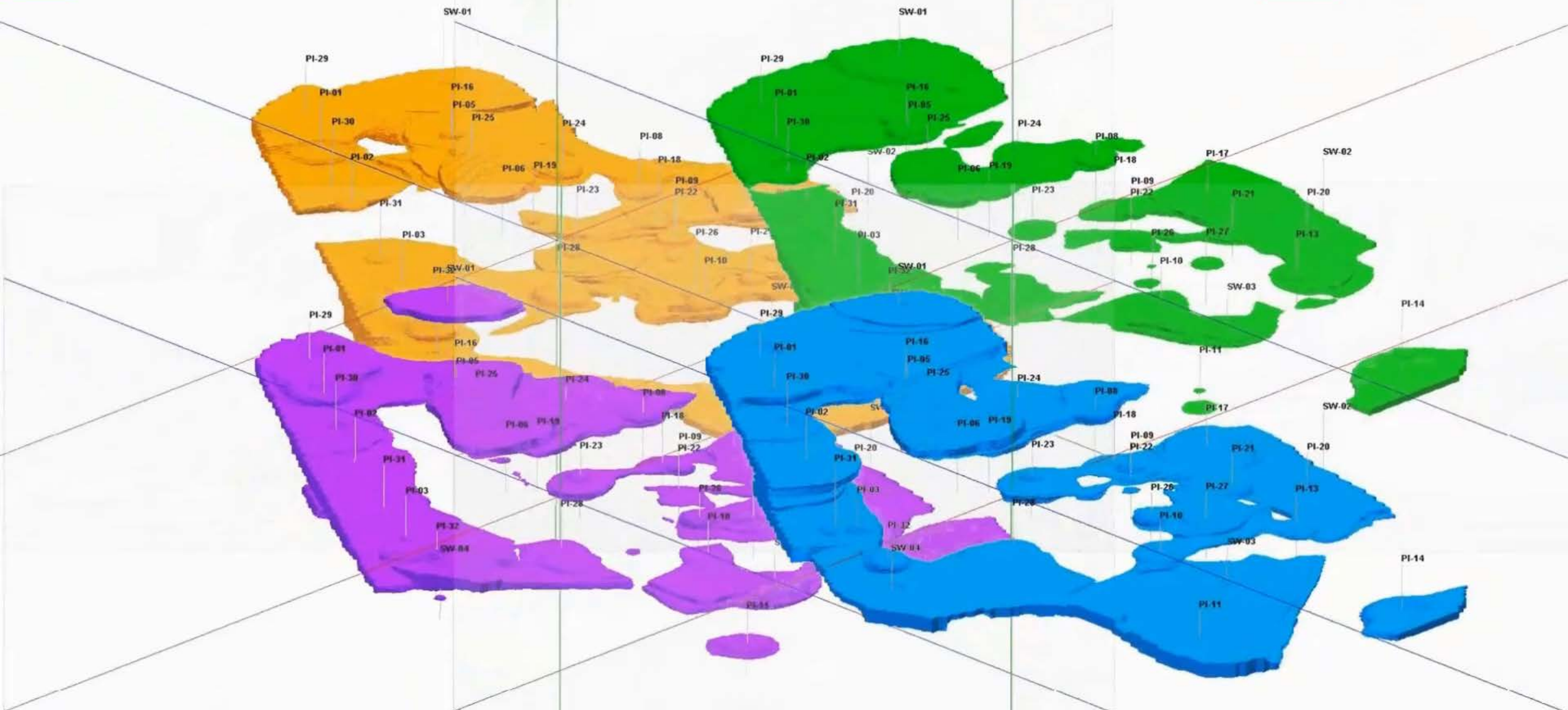




Benzene



Toluene



Total Xylene

(> Mean + 1 Standard Deviation)



TVPH



Benzene



Toluene

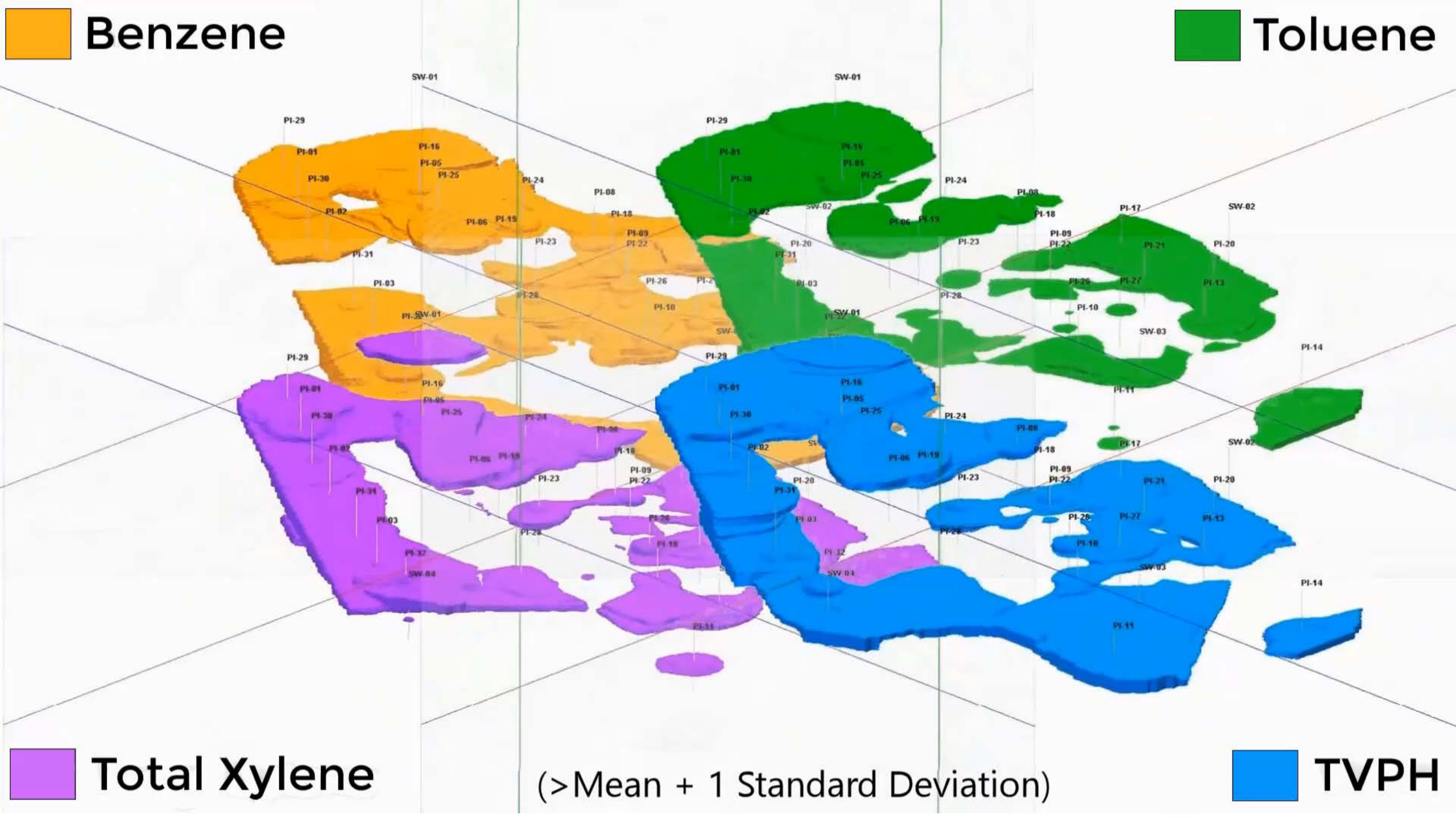


Total Xylene



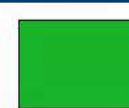
TVPH

(>Mean + 1 Standard Deviation)

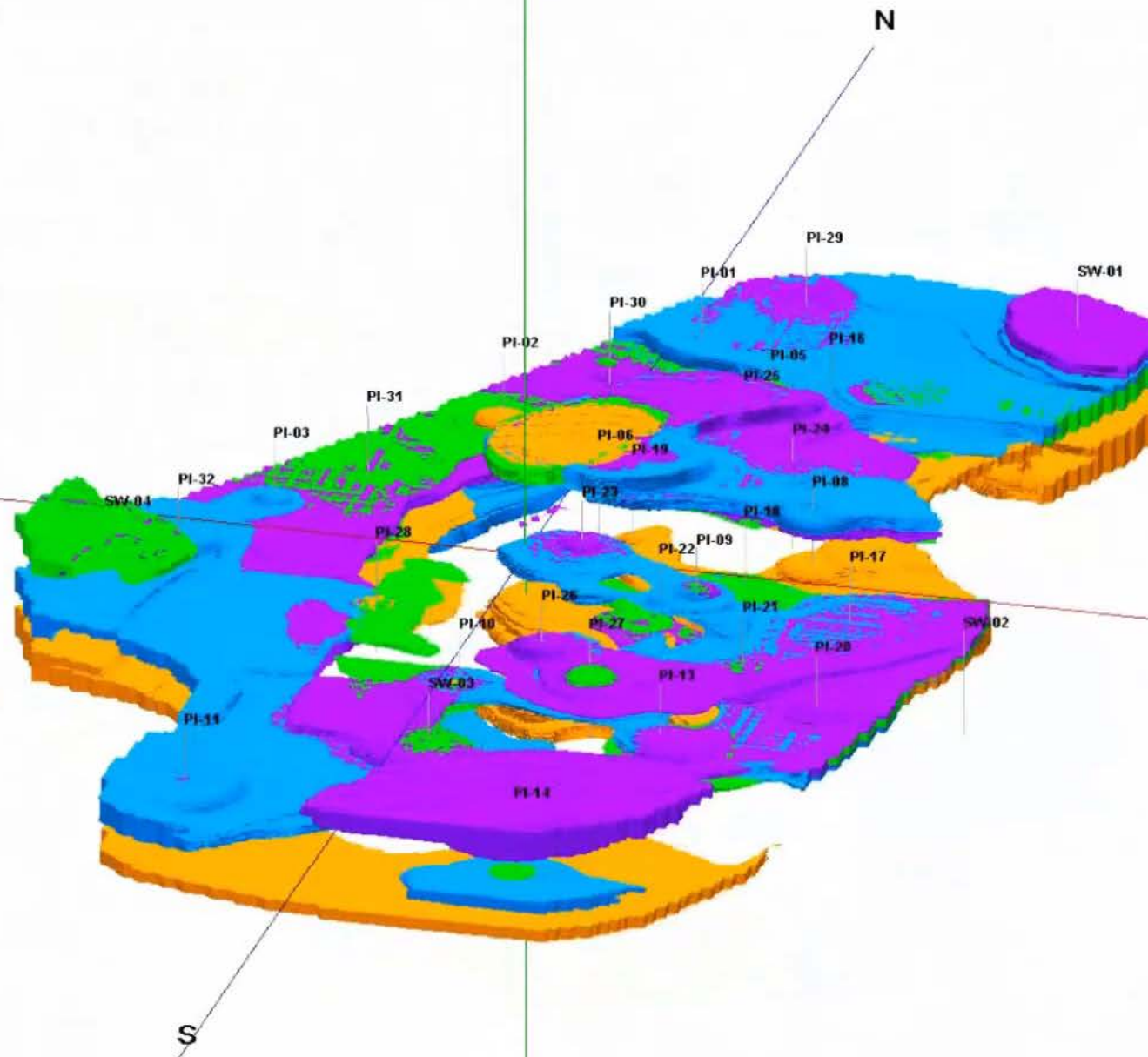




Benzene



Toluene



Total Xylene

(> Mean + 1 Standard Deviation)



TVPH

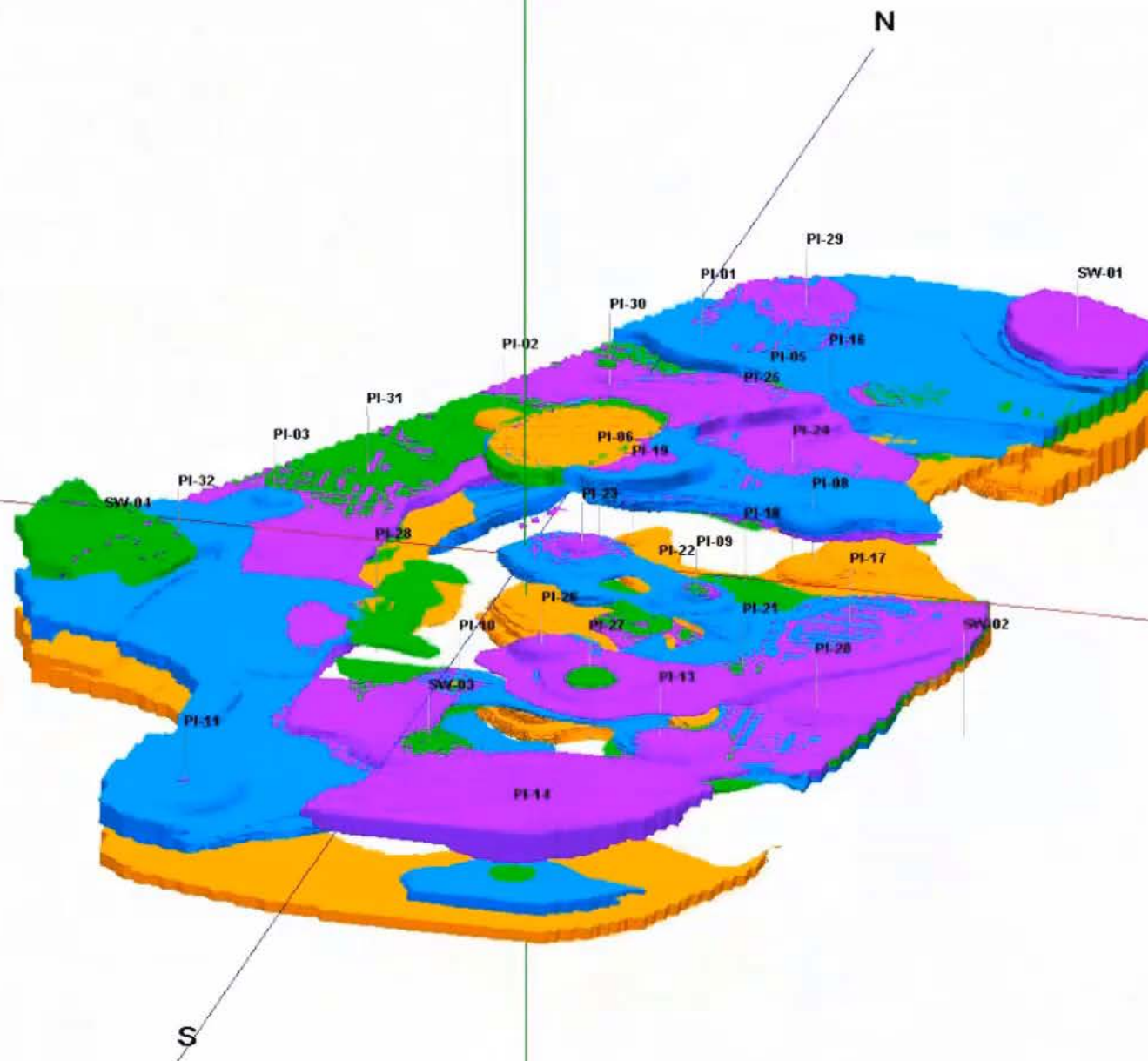
 Benzene

 Toluene

 Total Xylene

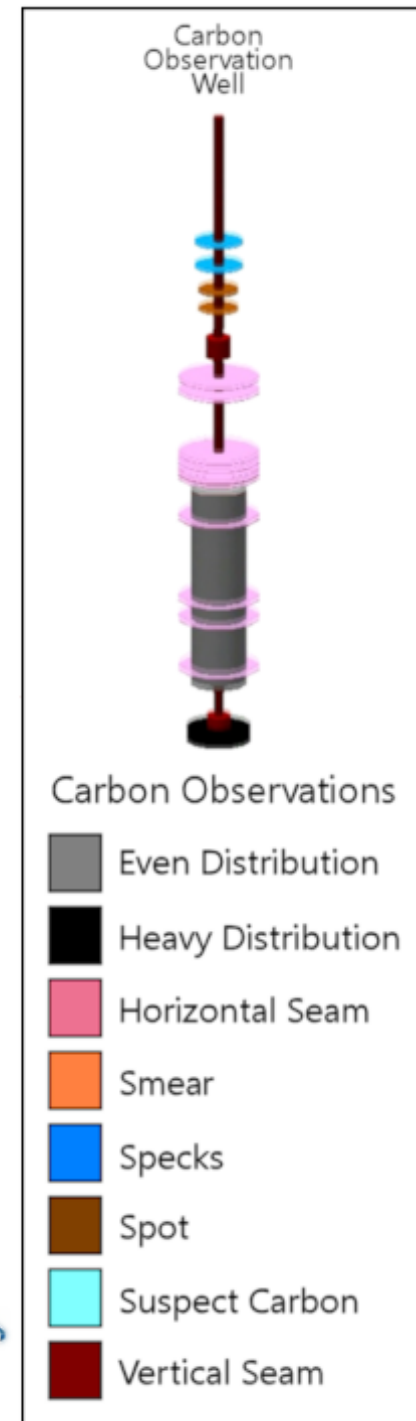
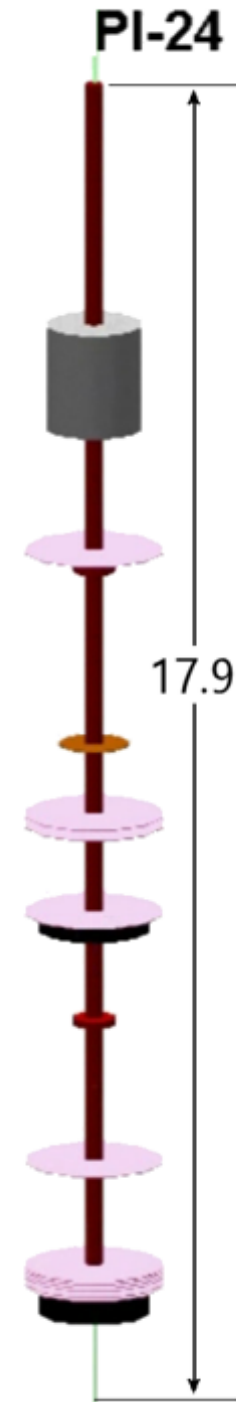
(>Mean + 1 Standard Deviation)

 TVPH



Observed Carbon Types

- Suspect Carbon
- Specks
- Spots
- Smears
- Even Distribution
- Heavy Distribution
- Vertical Seams
- Horizontal Seams



Carbon

Carbon
Observation
Well



Carbon Observations

Even Distribution

Heavy Distribution

Horizontal Seam

Smear

Specks

Spot

Suspect Carbon

Vertical Seam

Mineral

Mineral

Carbon
Observation
Well



Carbon Observations

Even Distribution

Heavy Distribution

Horizontal Seam

Smear

Specks

Spot

Suspect Carbon

Vertical Seam

PI-

PI-19

PI-19

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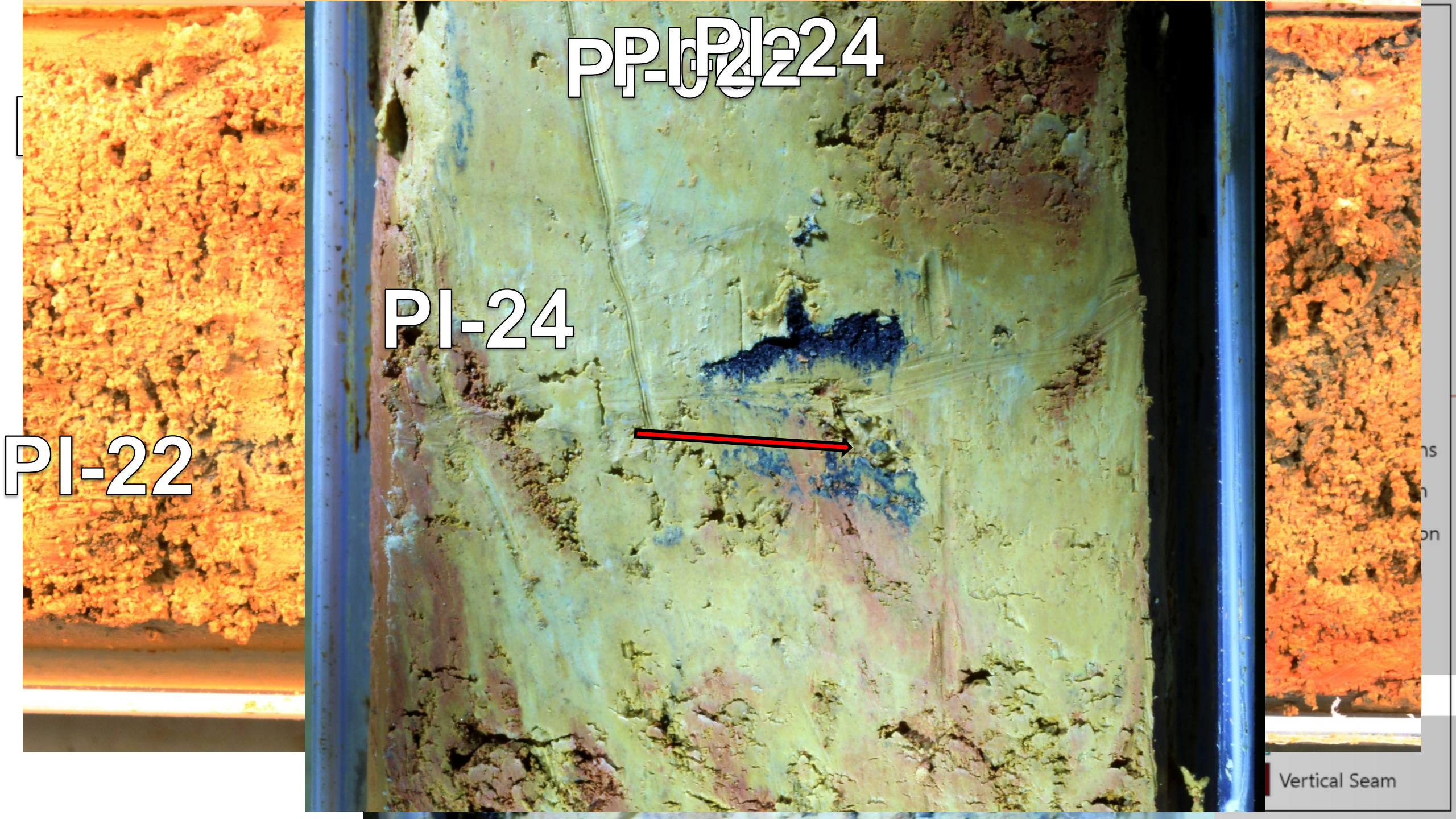
tribution

Distribution

ntal Seam

t Carbon

Seam



PI-24

PI-24

PI-22

Vertical Seam

PI

PI-08

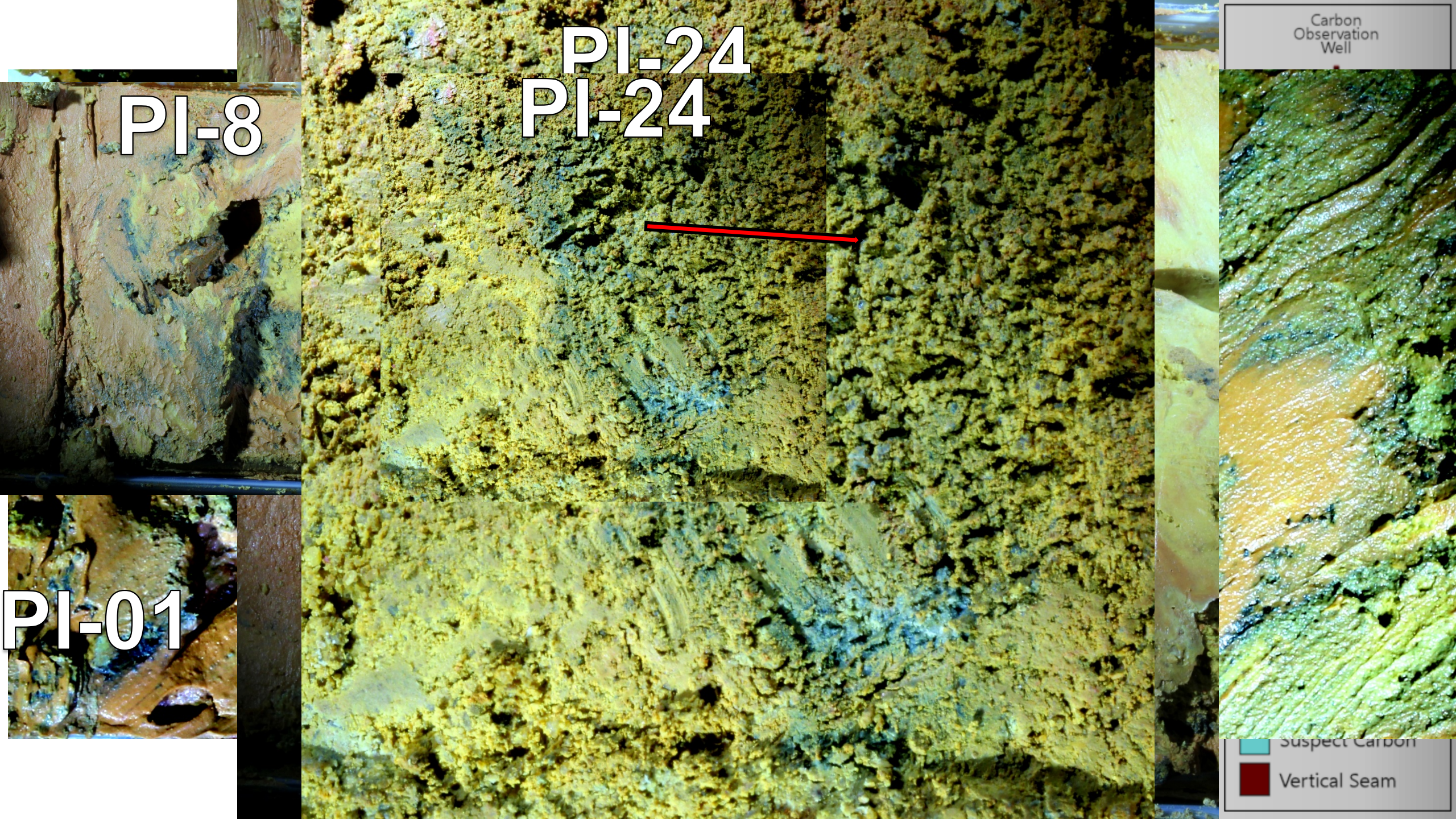
Carbon
Observation
Well

20X Magnification

PI-08

20X

ot
spect Carbon
rtical Seam



PI-8

PI-24
PI-24

PI-01

Carbon
Observation
Well

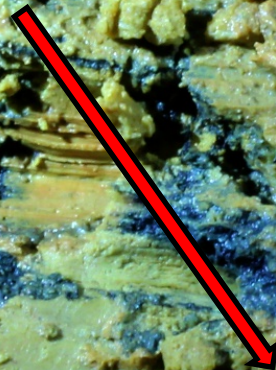
Suspect Carbon
Vertical Seam

PI-24

PI-24

PI-24

PI-24



PI-18

PI-18

PI-24

PI-26

Carbon
Observation
Well



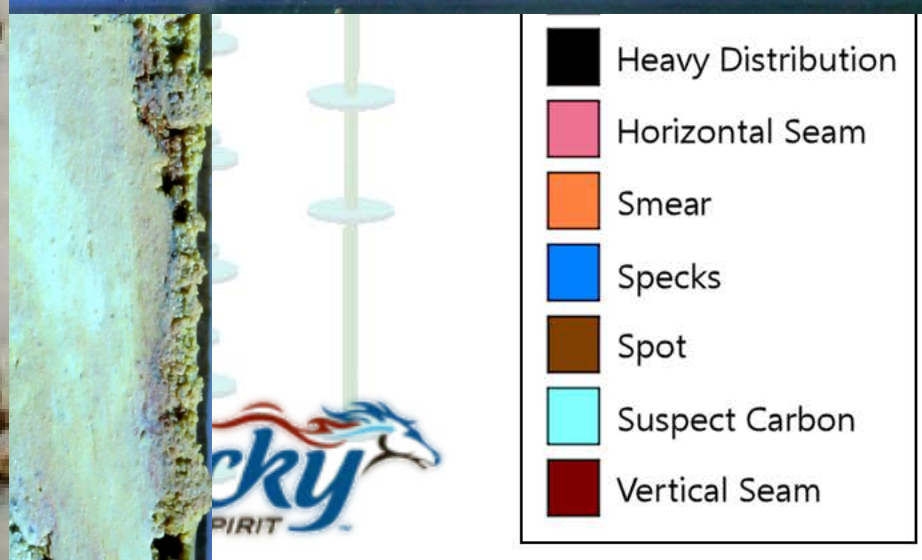
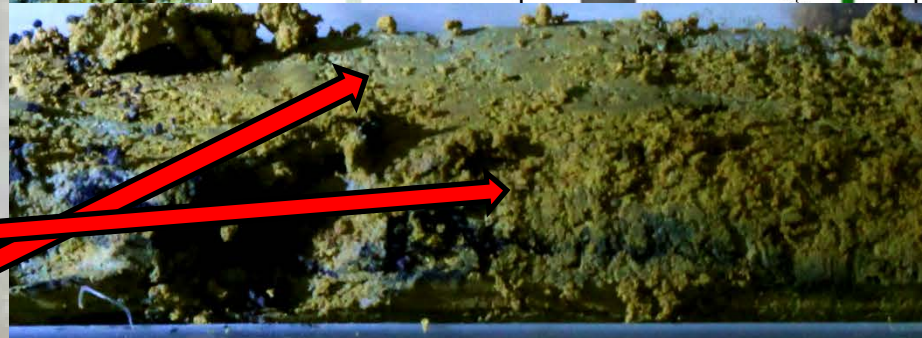
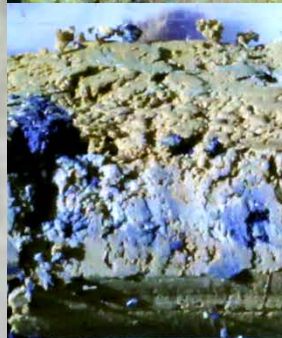
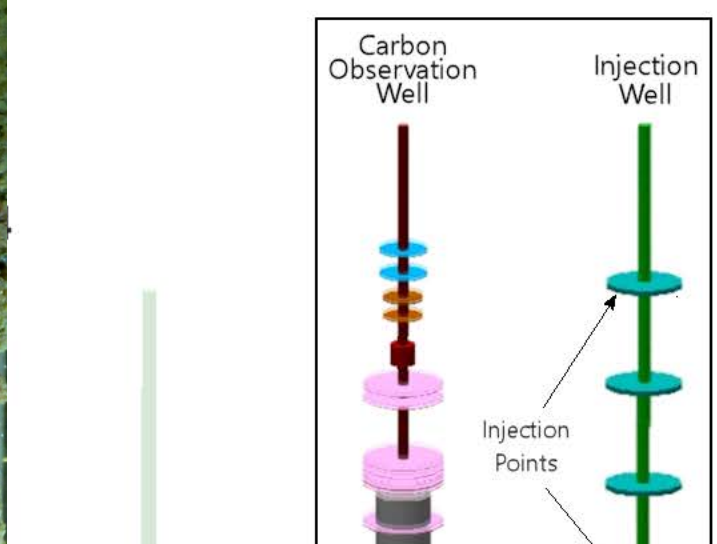
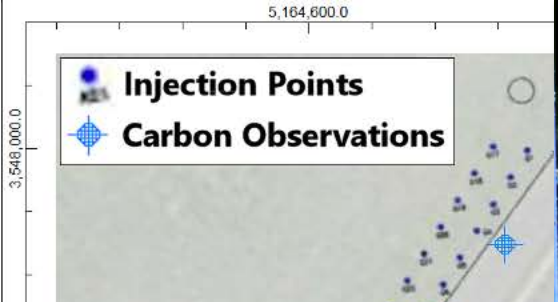
PI-26

MW-08

MW-08







- Heavy Distribution
- Horizontal Seam
- Smear
- Specks
- Spot
- Suspect Carbon
- Vertical Seam



PI-10

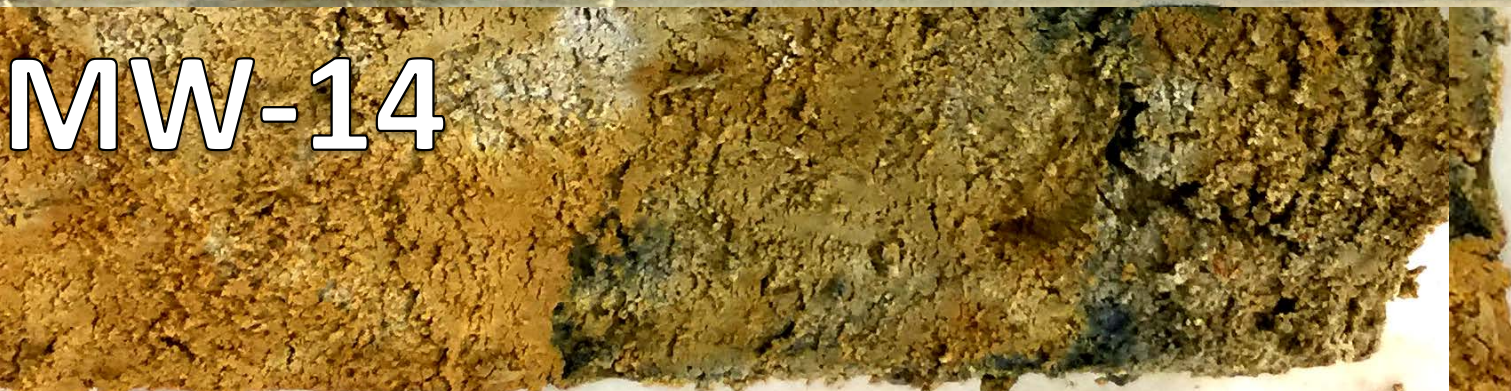
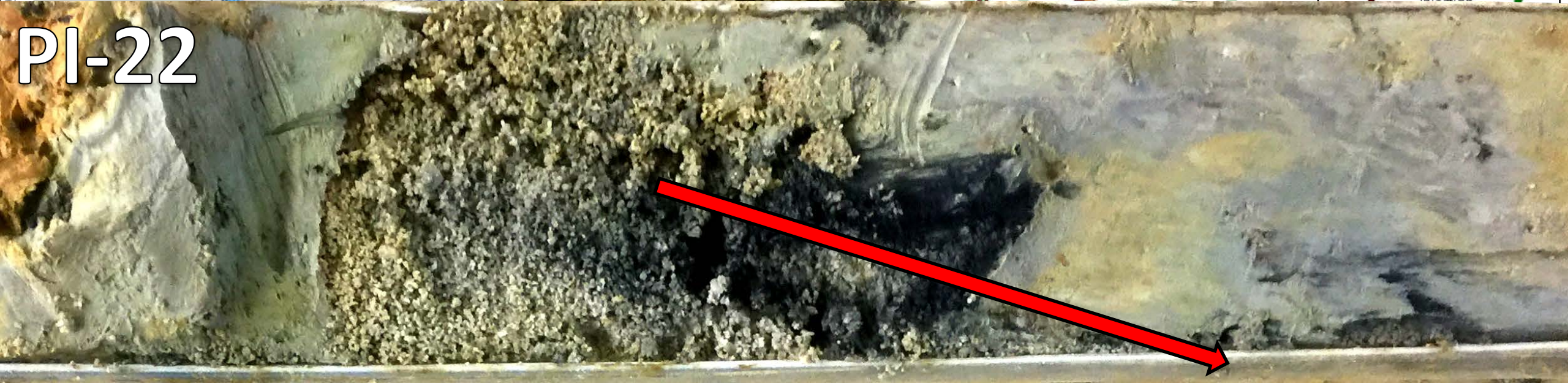
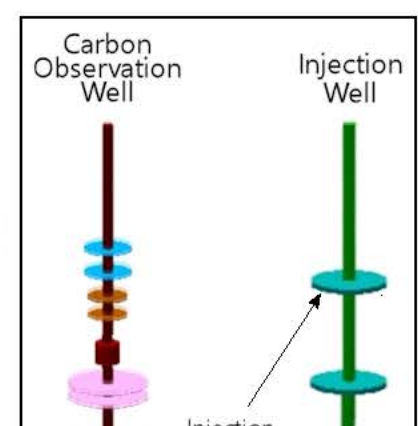
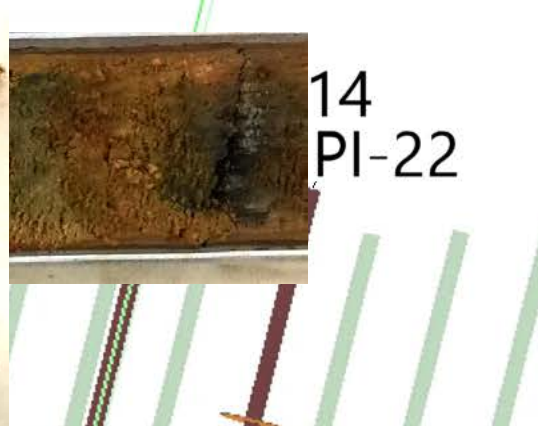
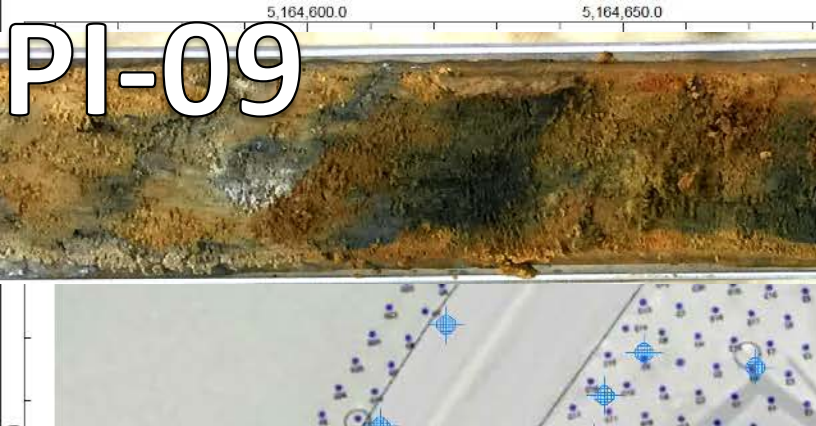
PI-28

PI-19

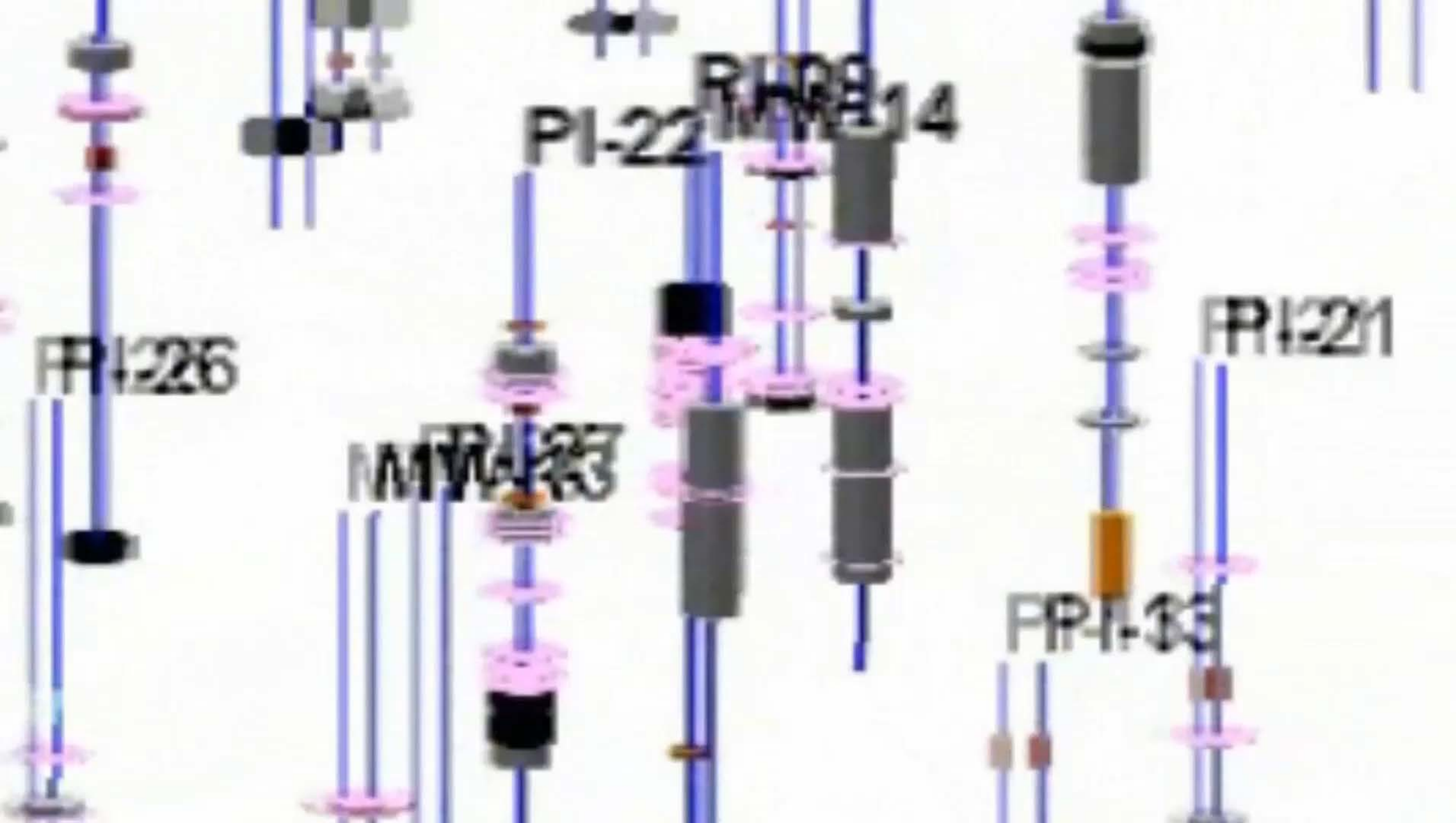
PI-31

PI-11





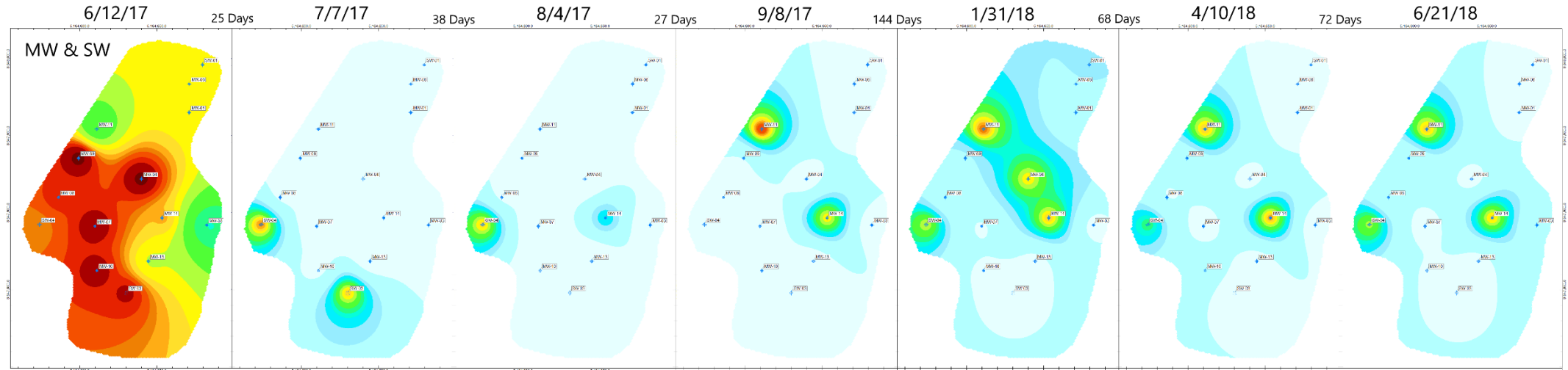




Quantification of Carbon Sightings

Carbon Count by # of Inclusion within 40 Cores by Depth		6-8 FT	8-10 FT	10-12 FT	12-14 FT	14-16 FT	Sum of Inclusions per Category	Percent of Total Sightings
Carbon Present	X≥1	32	32	31	26	29	150	55%
% by Interval	%	80%	80%	77.50%	65%	72.50%		
	X≥2	14	20	15	7	18	74	27%
	%	35%	50%	37.50%	17.50%	45%		
	X≥3	4	9	5	3	11	32	12%
	%	10%	22.50%	12.50%	7.50%	27.50%		
	X≥4	2	3	1	0	4	10	3%
	%	5%	7.50%	2.50%	0	10%		
	X≥5	1	1	1	0	1	4	1%
	%	2.50%	2.50%	2.50%	0	2.50%		
Visual Carbon: Sum of Cores		6-8 FT	8-10 FT	10-12 FT	12-14 FT	14-16 FT	Total	
TOTAL Sightings per depth for all cores:		53	65	53	36	65	272	
% OF TOTAL:		19%	24%	19%	13%	24%		

- Top Chart Summary
 - Each core had between 65 to 80% probability of visually demonstrating carbon (Row data)
 - 55% of all inclusions were single inclusions
- Bottom Chart Summary
 - Each of the 5 intervals demonstrated between 13 to 24% of the total carbon identified (20% would be equality)



Benzene Levels

Top Row:

MW-1,2,3,4,5,6,7,8,9,10,11,13,14,15 &
SW-1,2,3,4

Middle Row:

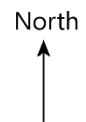
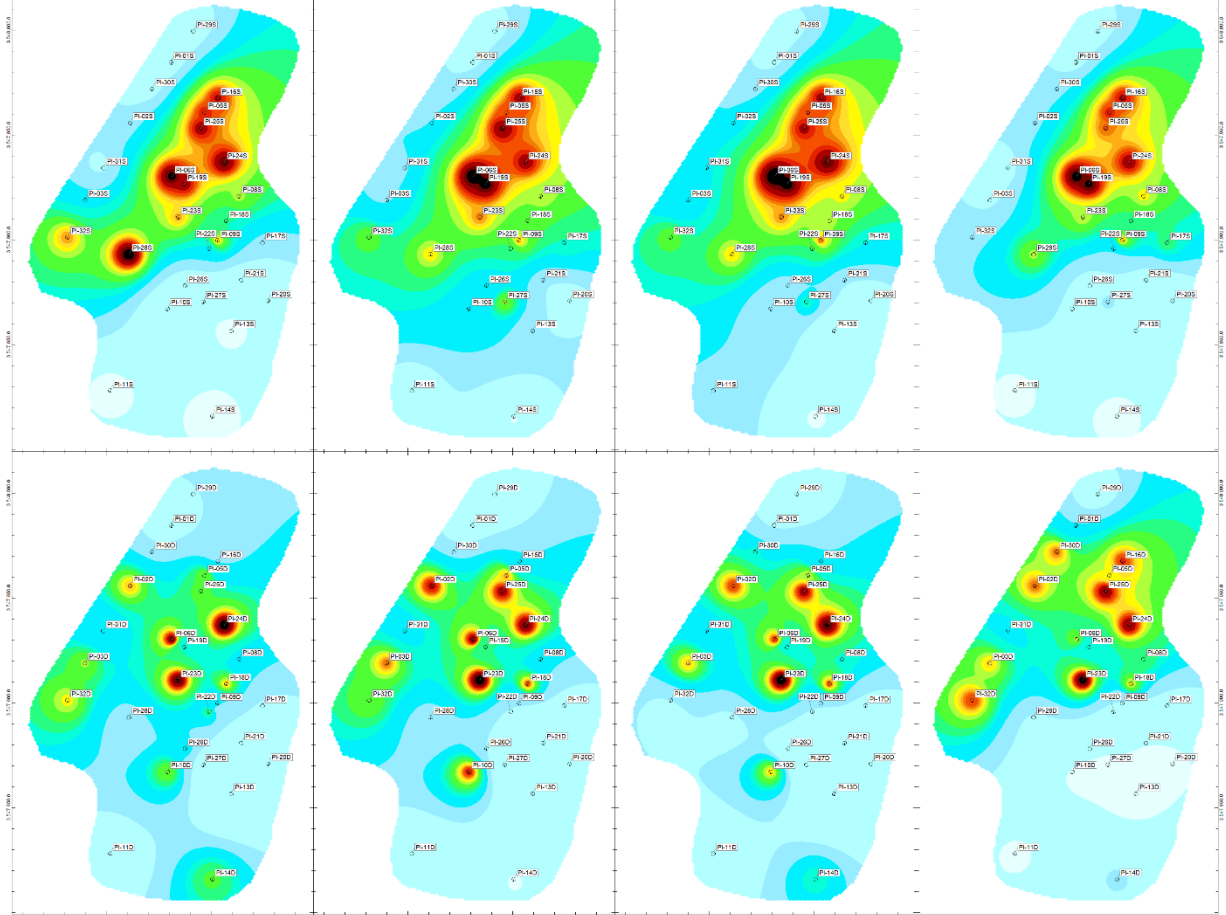
PI-1,2,3,5,6,8,9,10,11,13,14,15,16-32 Shallow

Bottom Row:

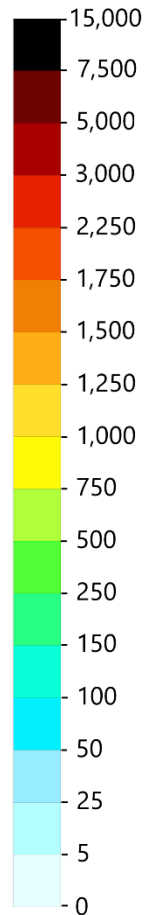
PI-1,2,3,5,6,8,9,10,11,13,14,16-32 Deep

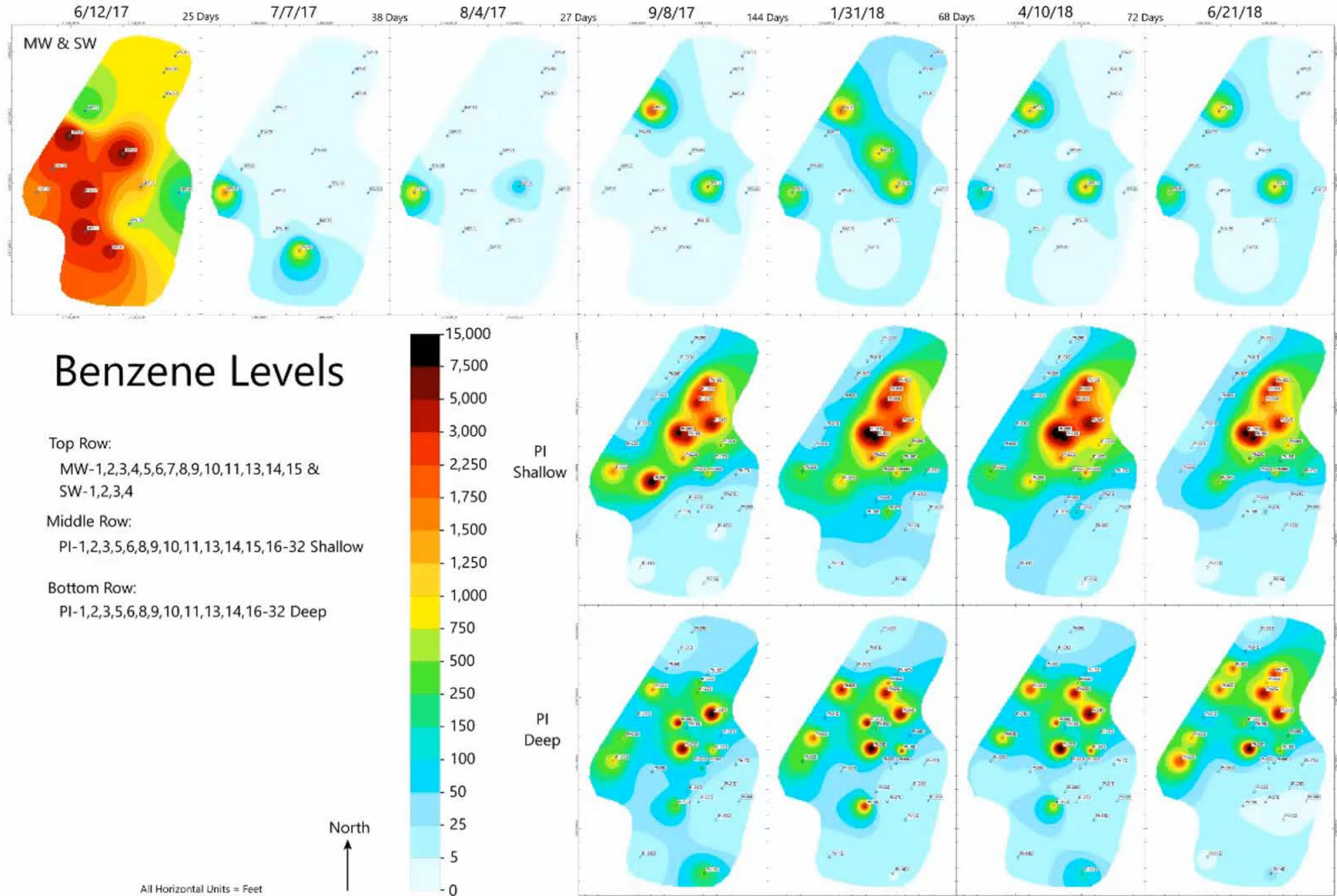
PI
Shallow

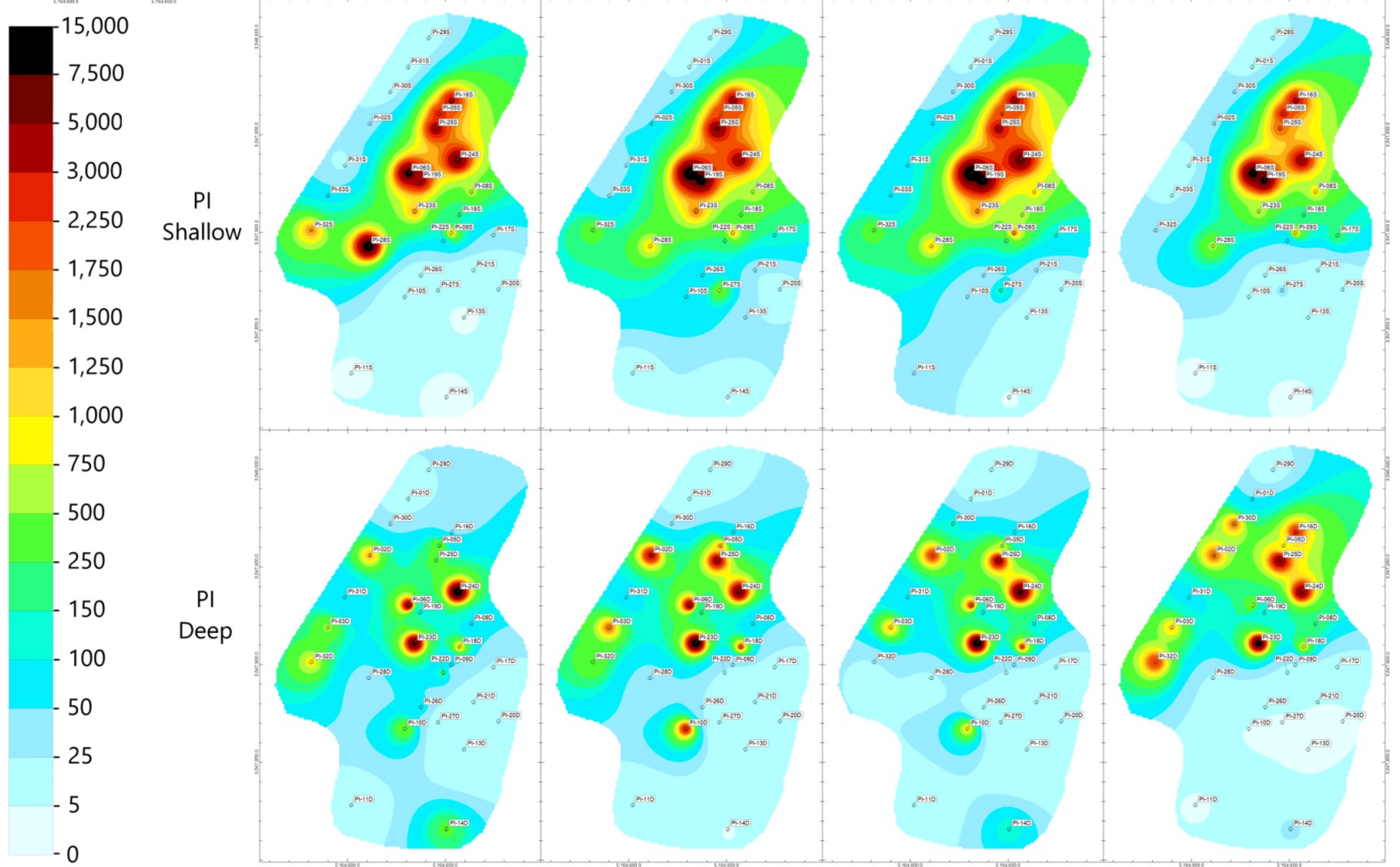
PI
Deep

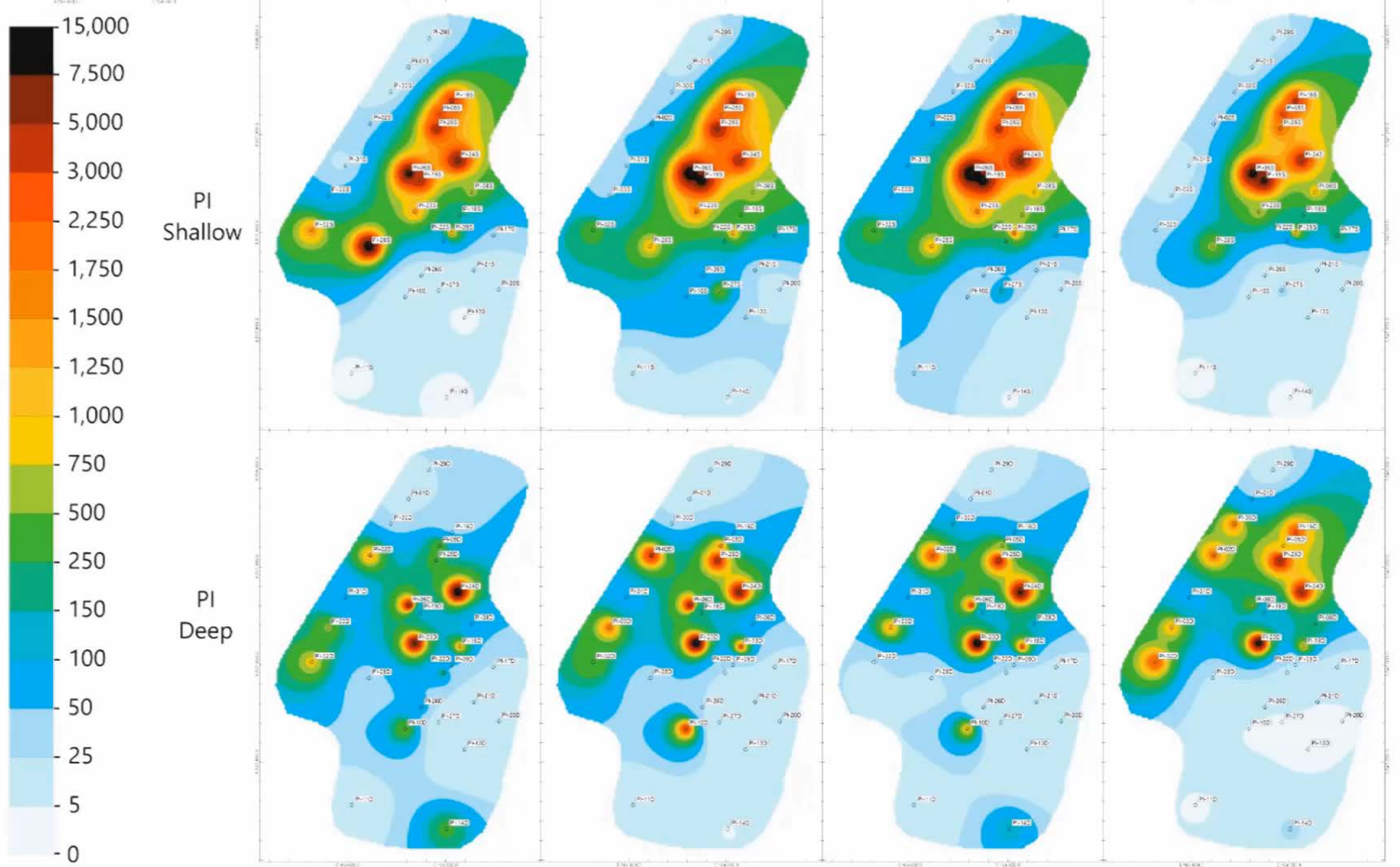


All Horizontal Units = Feet



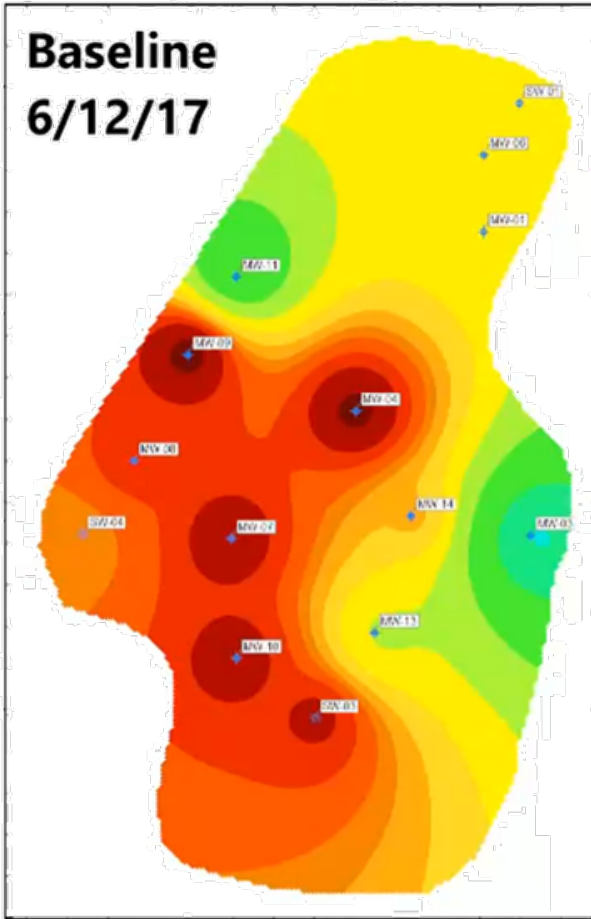




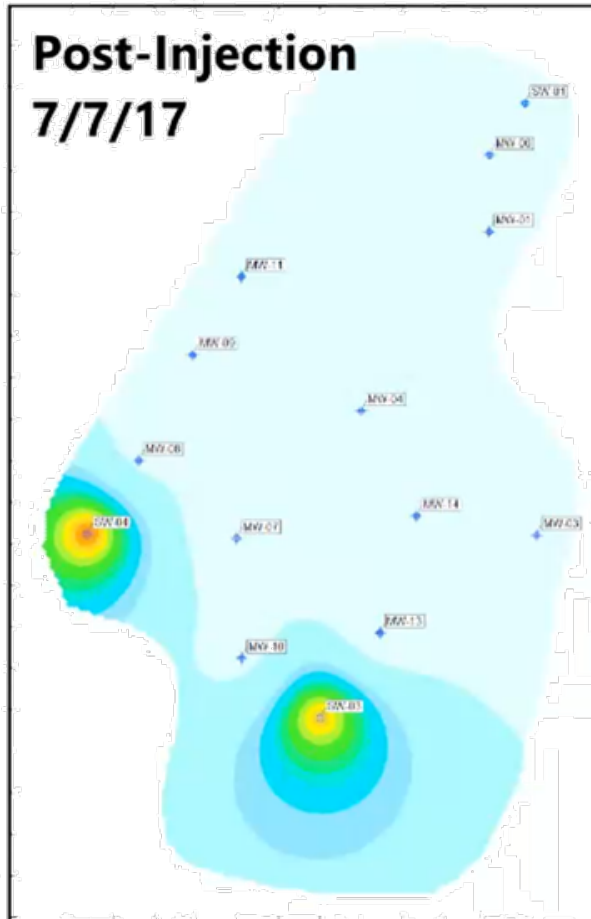


Benzene Comparison

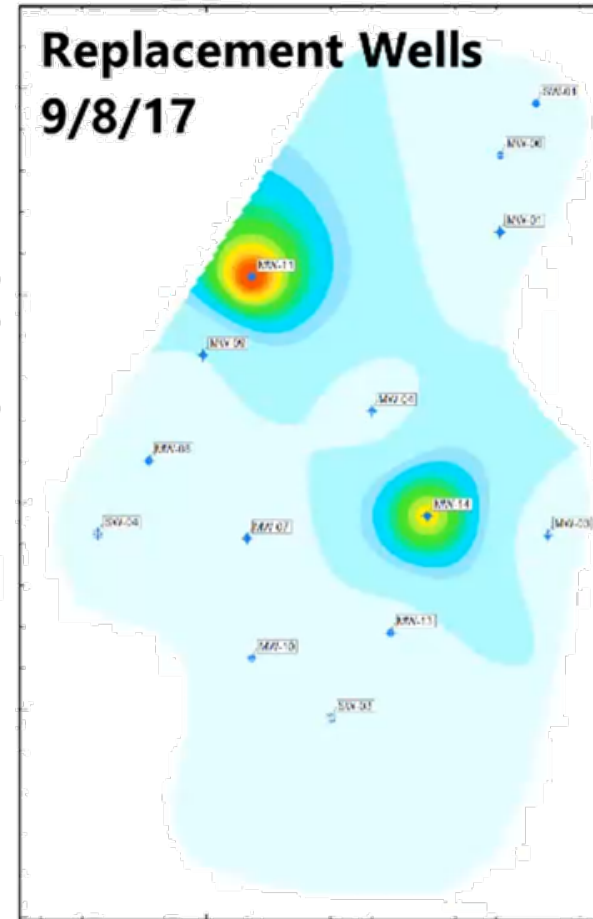
Baseline
6/12/17



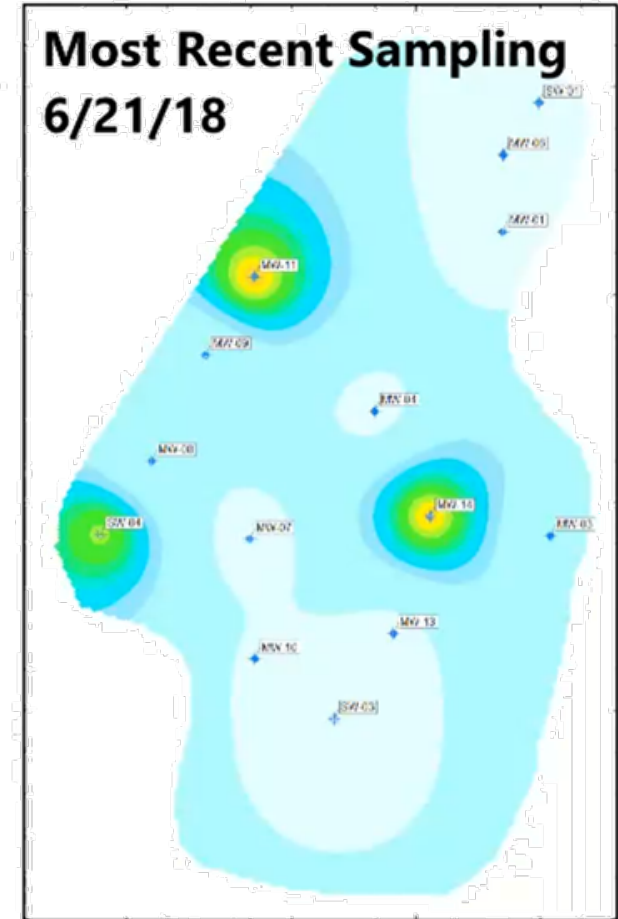
Post-Injection
7/7/17



Replacement Wells
9/8/17



Most Recent Sampling
6/21/18



Summary

- Distribution of carbon by observation types
 - Vocabulary as a means of sharing & communicating results
- Distribution statistics indicate that carbon inclusion occurrence is predictable but inclusion types varied greatly
- Observations indicate that carbon often tracks the interface between different soil textures
- Monitoring well results
 - Results vary by well type, i.e., 2", 10ft screened vs 1", 5ft screened Shallow & Deep
 - The intentionally remaining contamination impacts both well types (Positive Control)
 - The area to the southwest, outside the immediate influence of the remaining source, appears significantly improved.



Questions

I appreciate the work of those who contributed to this presentation either in its development or by executing the on the ground work at the Gossers site. 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 or entities:

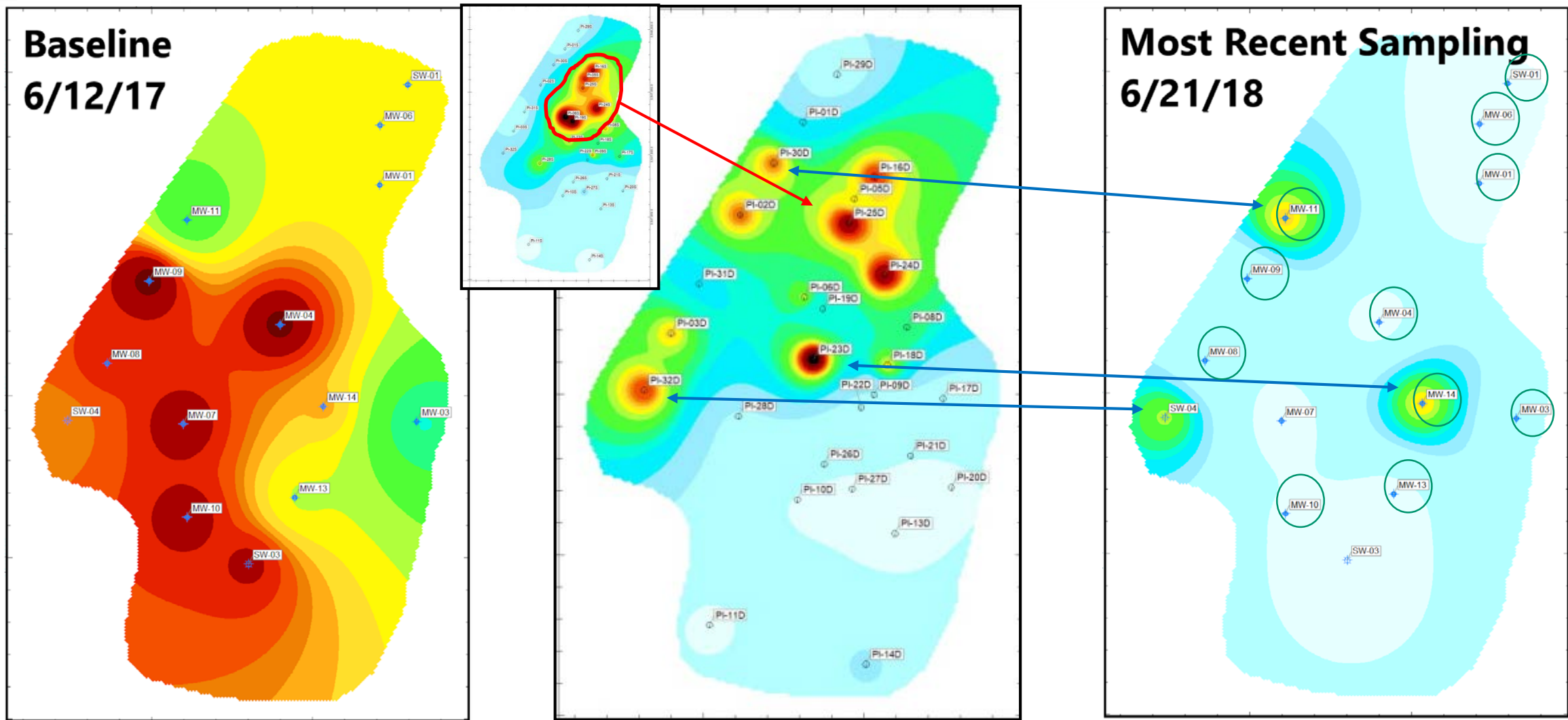
Alvin Campbell Gossers Project Manager KY DWM UST Branch



HINKLEMEYER
ENVIRONMENTAL SERVICES, LLC

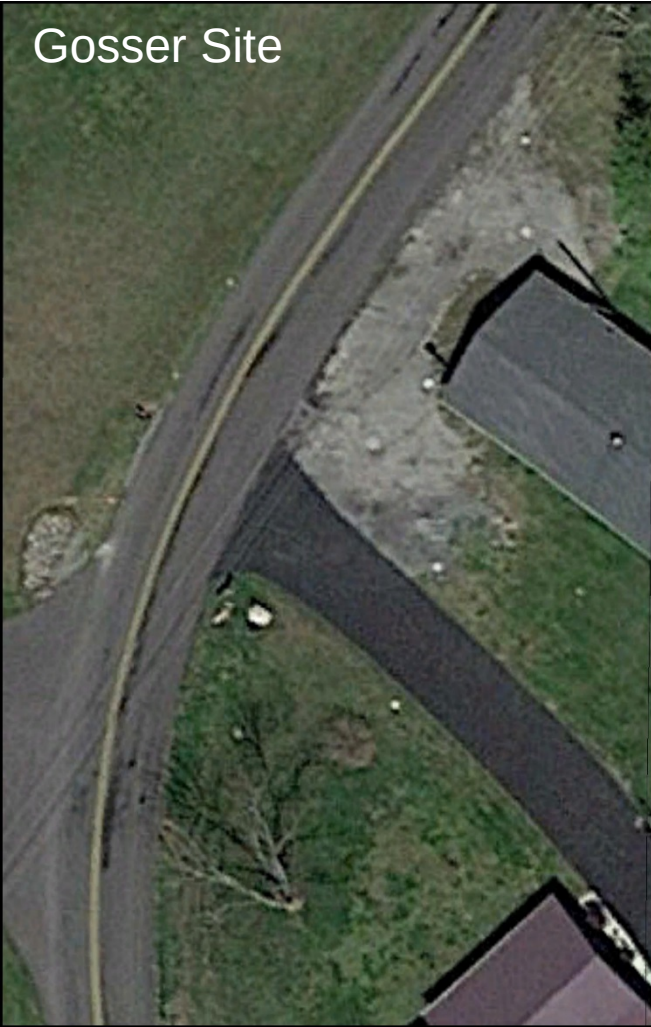


Comparison of Present State of Groundwater

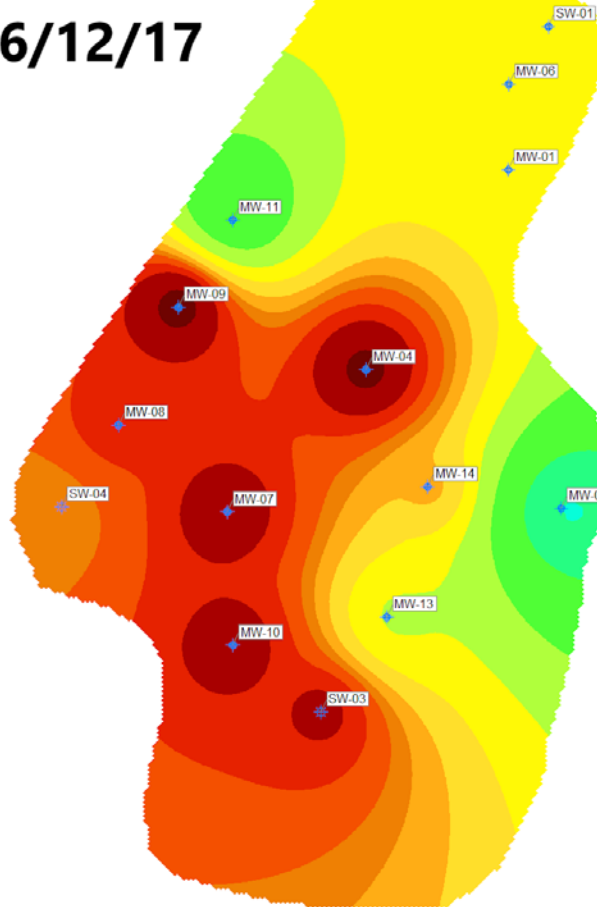


Questions?

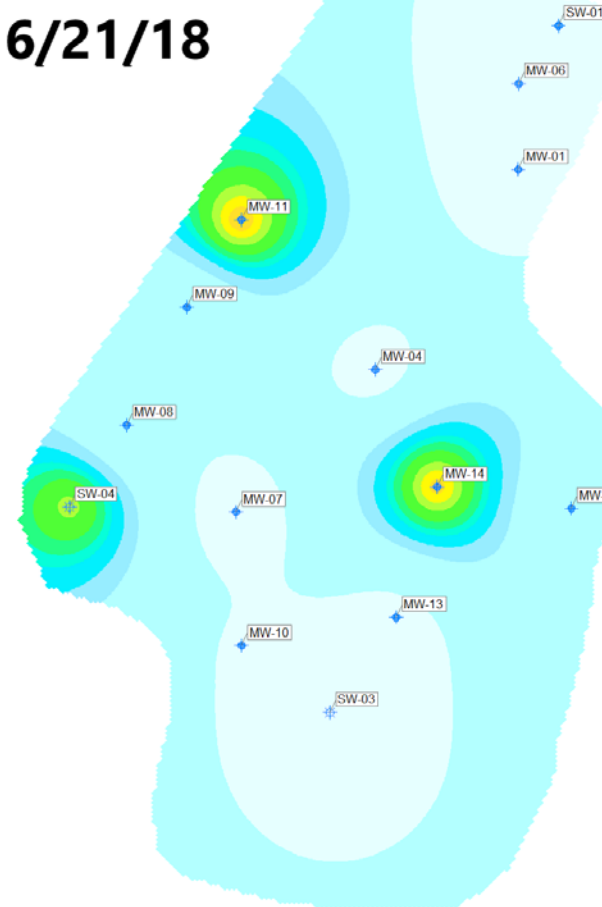
Gosser Site



**Baseline
6/12/17**



**Most Recent Sampling
6/21/18**



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