Leveraging a Robust Microbial Profile for an MTBE Sorptive Biobarrier

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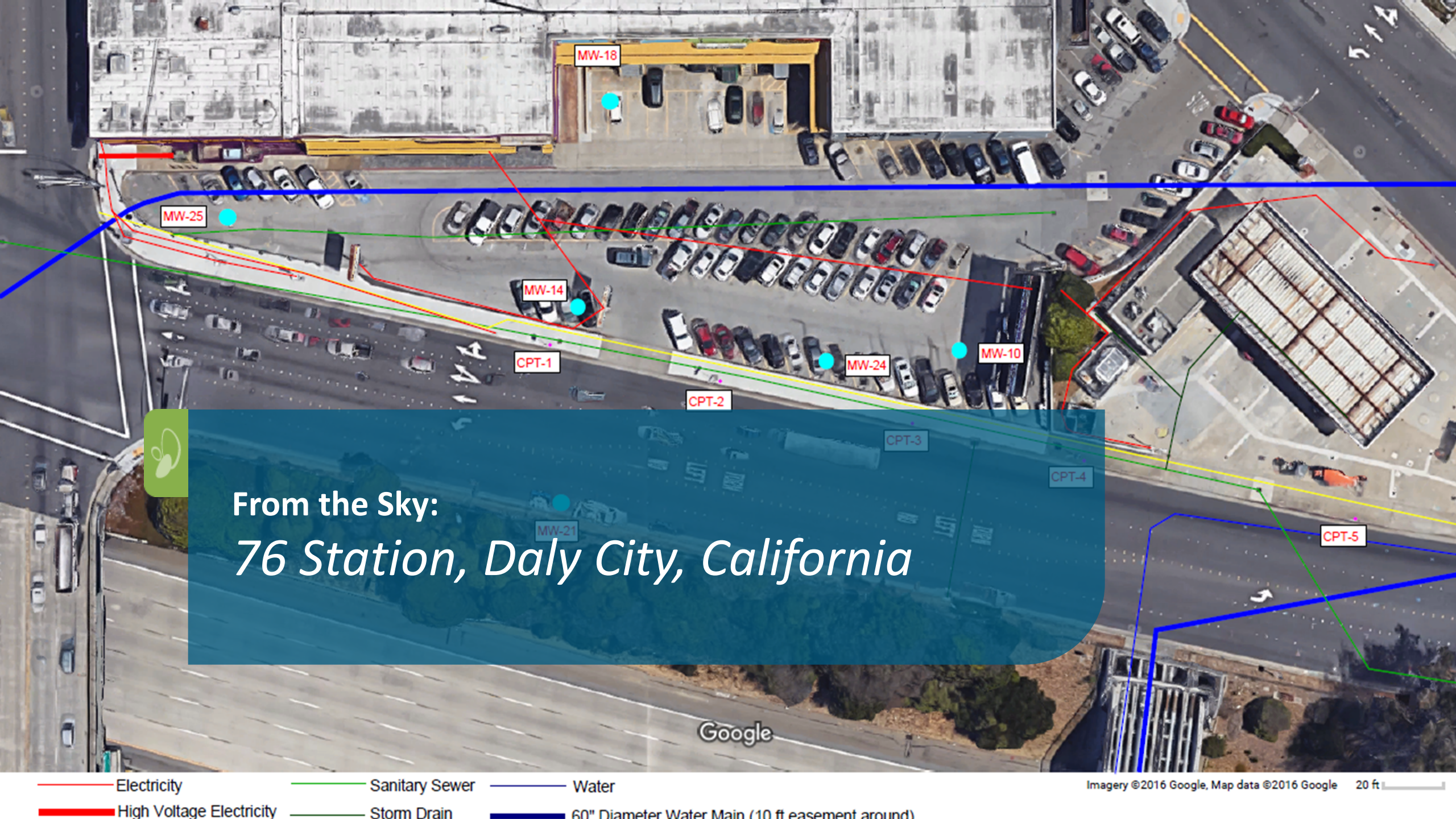

MW-18
MW-25
MW-14
CPT-1
CPT-2
MW-24
MW-10
CPT-3
CPT-4
CPT-5
MW-21
From the Sky:
76 Station, Daly City, California
Google
Electricity
High Voltage Electricity
Sanitary Sewer
Storm Drain
Water
60" Diameter Water Main (10 ft easement around)
Imagery ©2016 Google, Map data ©2016 Google
20 ft

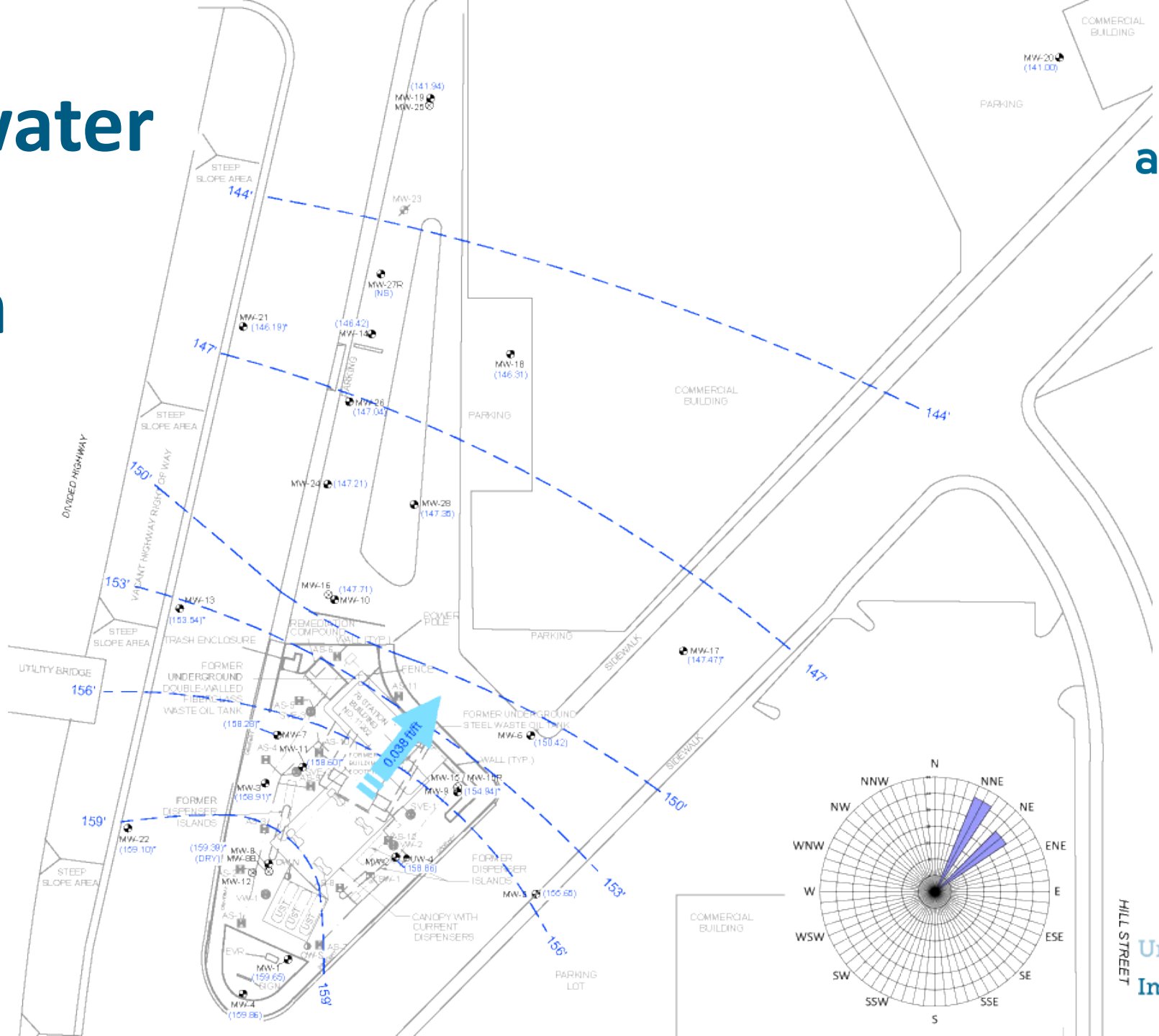
The History

- Operating gas station with prior leaking UST
- Prior remedial efforts to clean up BTEX and TPH-GRO successful using AS/SVE
- Minimal impacts remain on-site. Off-site groundwater is the current focus (<10 lbs. of MTBE mass in groundwater)
- Groundwater table at 32 ft. bgs
- San Mateo County Groundwater Protection Program oversees the site
- Primary concern is a water supply well within 1,000 ft. of the downgradient edge of the plume

The History (continued)

- MNA important polishing on-site
- Site responded well to increased dissolved oxygen
- Plume migration through narrow channels of sand and limited to a 5 ft. vertical horizon – 32 ft. – 37 ft. bgs
- Regulator favored expansion of the AS/SVE system or switch to P&T
- Regulator was skeptical of a sorption technology and even more skeptical of coupling bioremediation
- Logistical issues/high cost of other alternatives persuaded the regulator to approve in situ sorption

Groundwater Flow Direction



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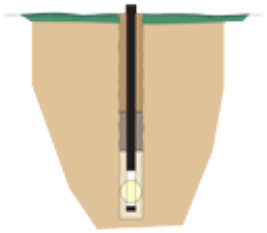
Molecular Biological Tools and Geochemistry

Sample Collection

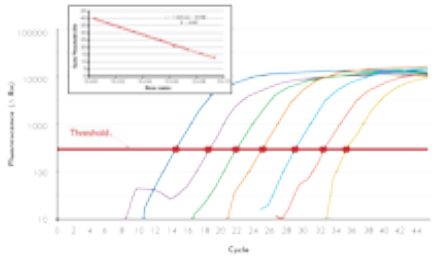


Groundwater, soil, or Bio-Trap® Sampler collected and shipped overnight on ice (4°c)

DNA Extraction

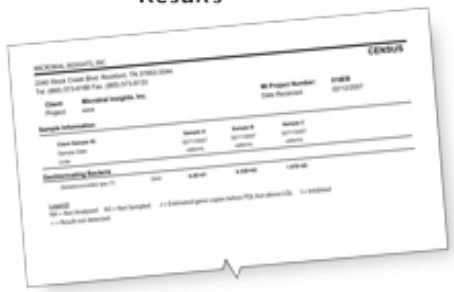
DNA is extracted from samples upon arrival

Amplification



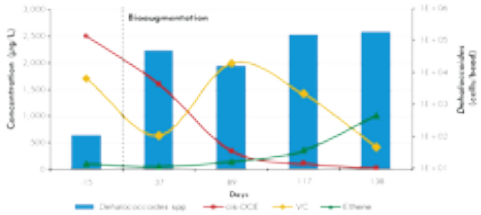
Quantitative Real-Time PCR is used to detect and quantify targets of interest (i.e. *Dehalococcoides* spp.)

Results

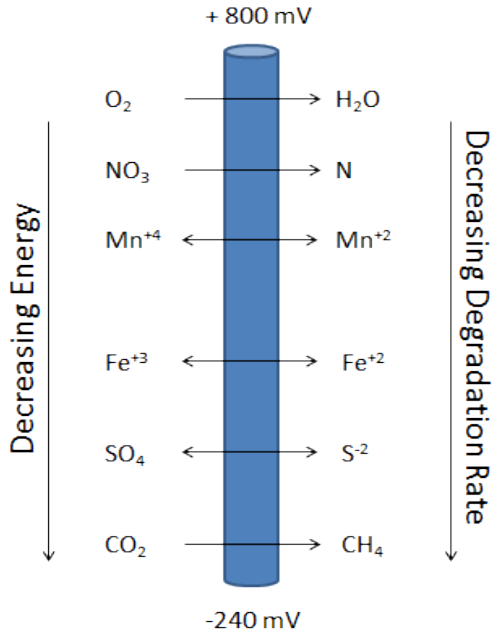


Results are emailed to project contact

Assessment



Results are integrated with other site parameters to evaluate site management decisions



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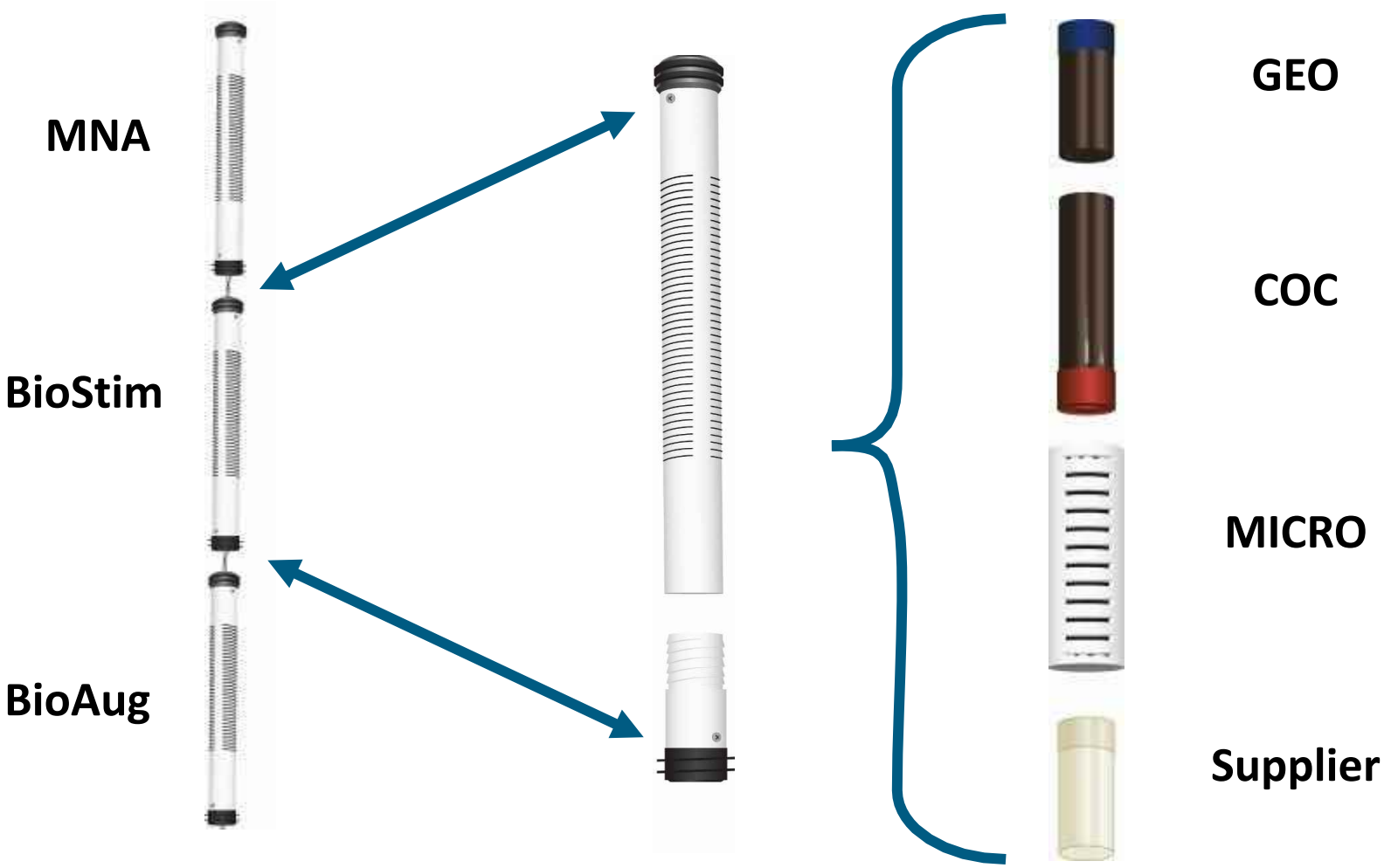
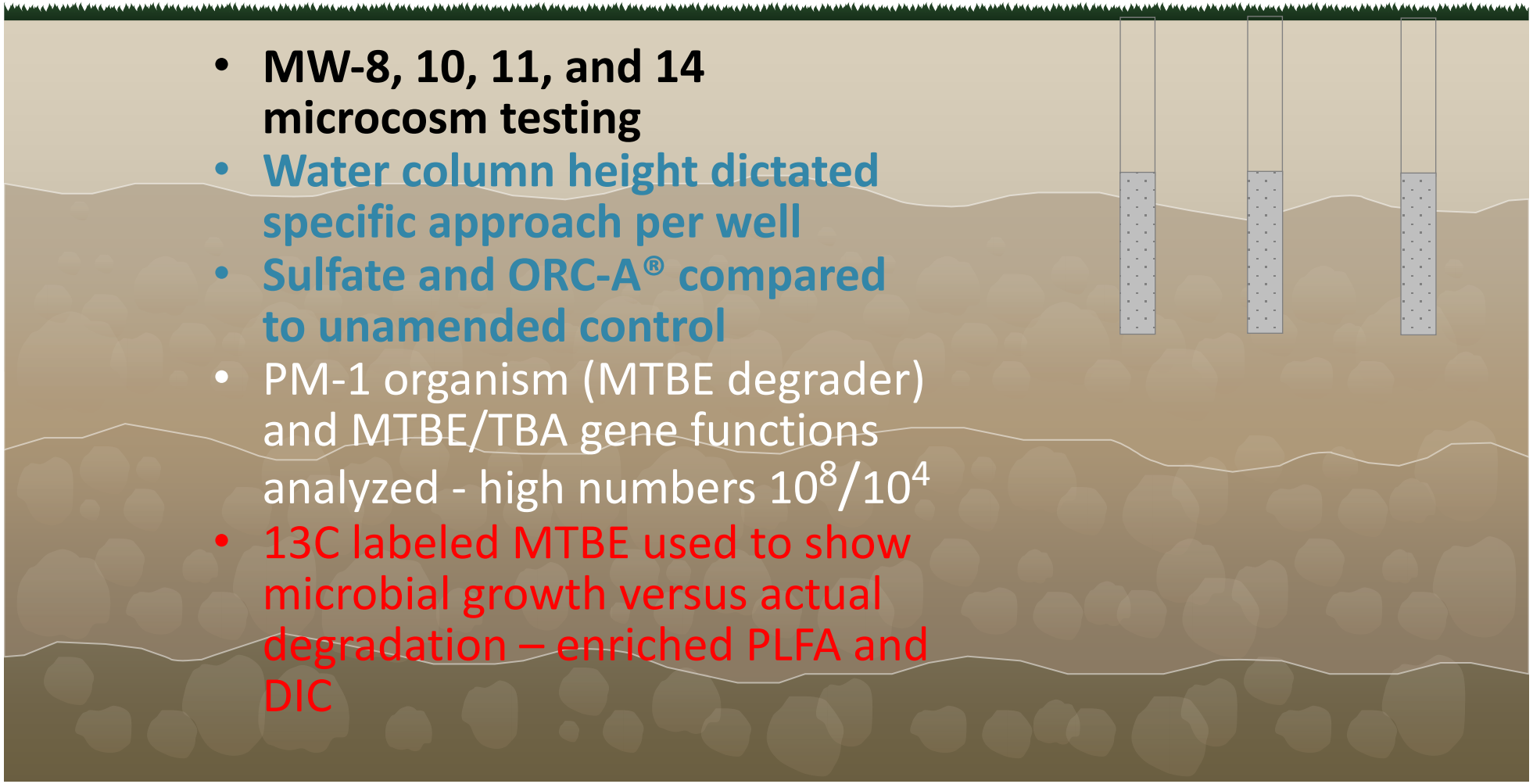
In Situ Microcosms



Microbial Results



- **MW-8, 10, 11, and 14 microcosm testing**
- **Water column height dictated specific approach per well**
- **Sulfate and ORC-A® compared to unamended control**
- PM-1 organism (MTBE degrader) and MTBE/TBA gene functions analyzed - high numbers $10^8/10^4$
- 13C labeled MTBE used to show microbial growth versus actual degradation – enriched PLFA and DIC

The Chemistry

PLUME STOP®
Liquid Activated Carbon

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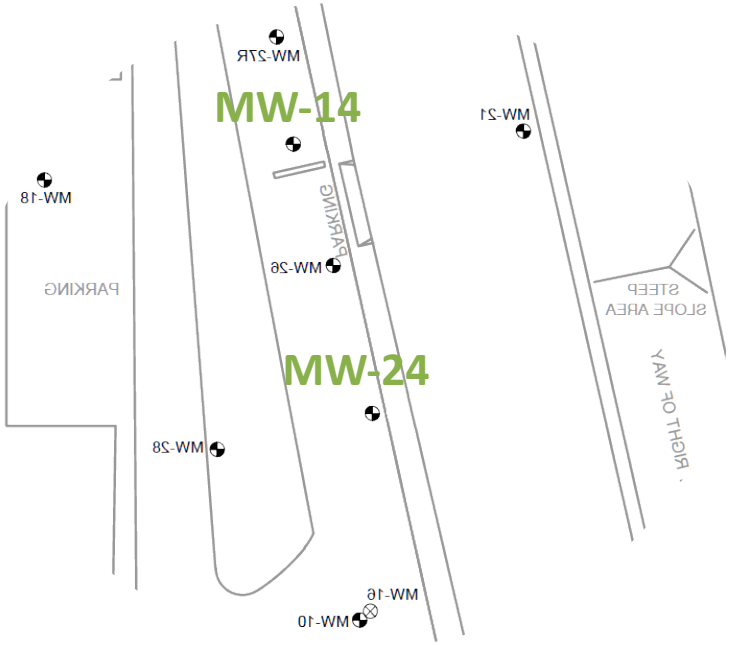
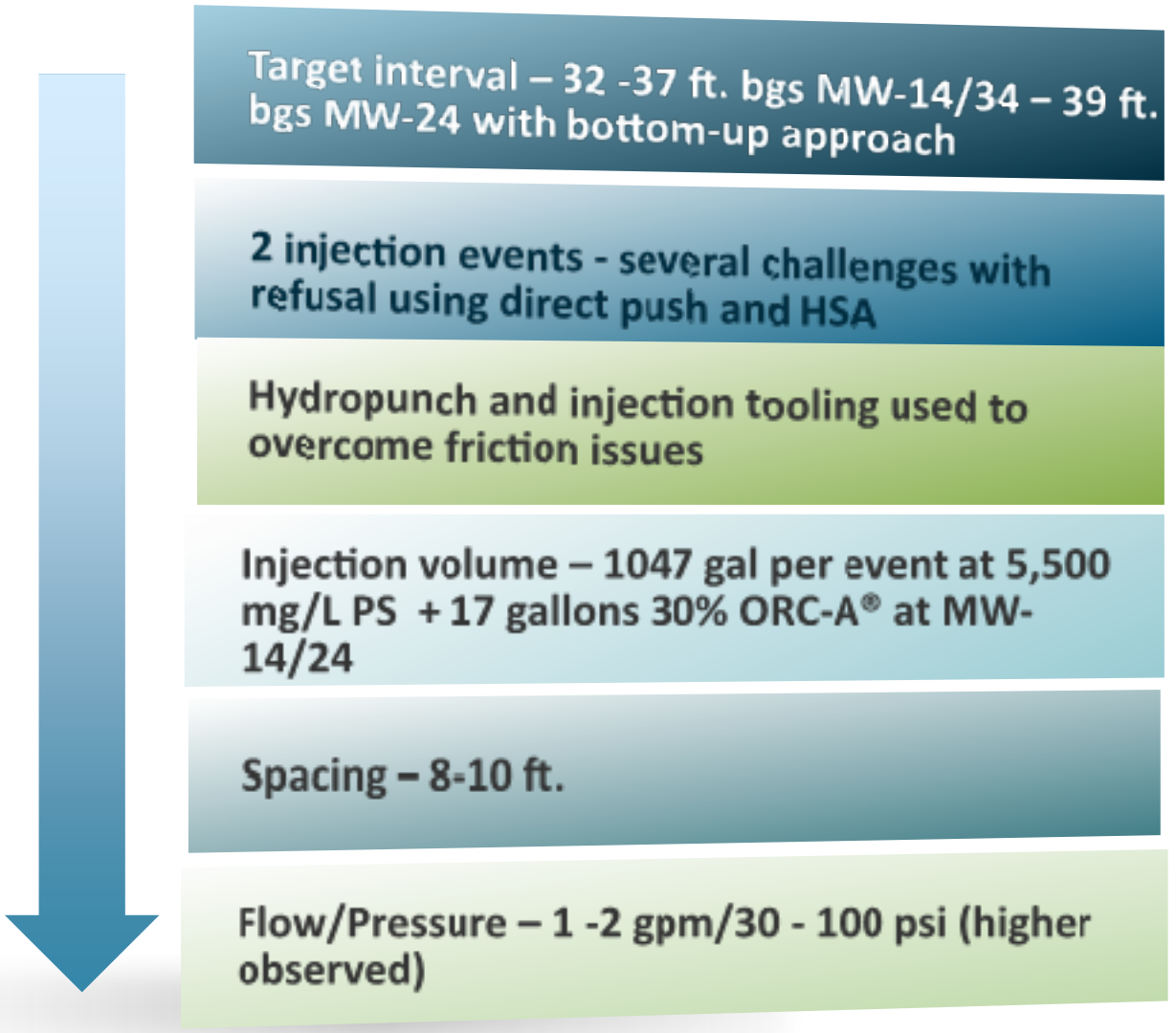
Pilot Test Approach

- Direct push PlumeStop at MW-14 and MW-24 (locations exceeded goal)
- Direct push ORC-A® to enhance biodegradation 30 days later
- Three injection points per well per amendment
- Monitor every two weeks for MTBE/TBA and secondary parameters – geochem/field parameters/microbial (RNA vs DNA)
- Remedial goal – 1 mg/L MTBE



Injection Highlights



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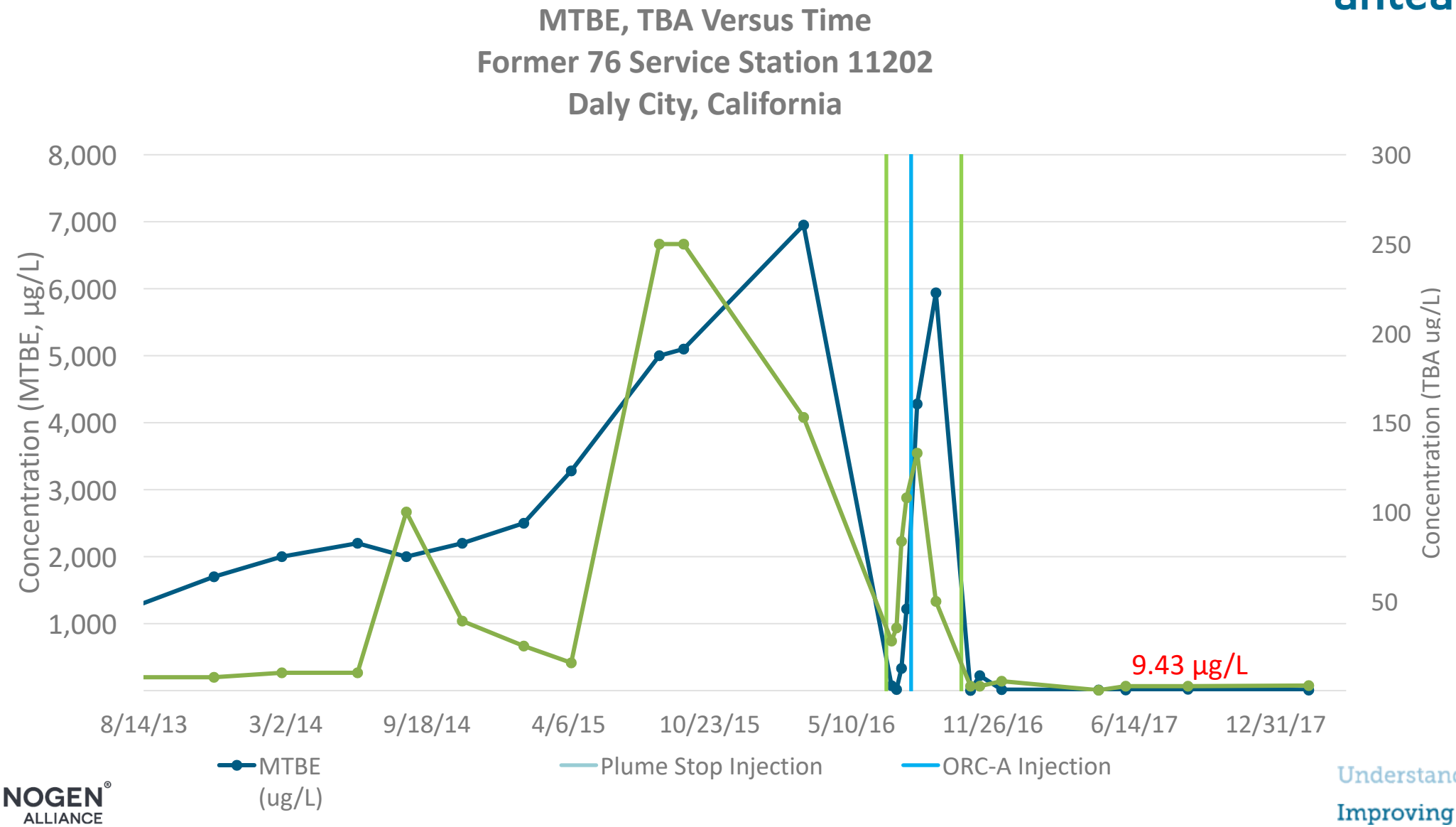
The Results: MW-14



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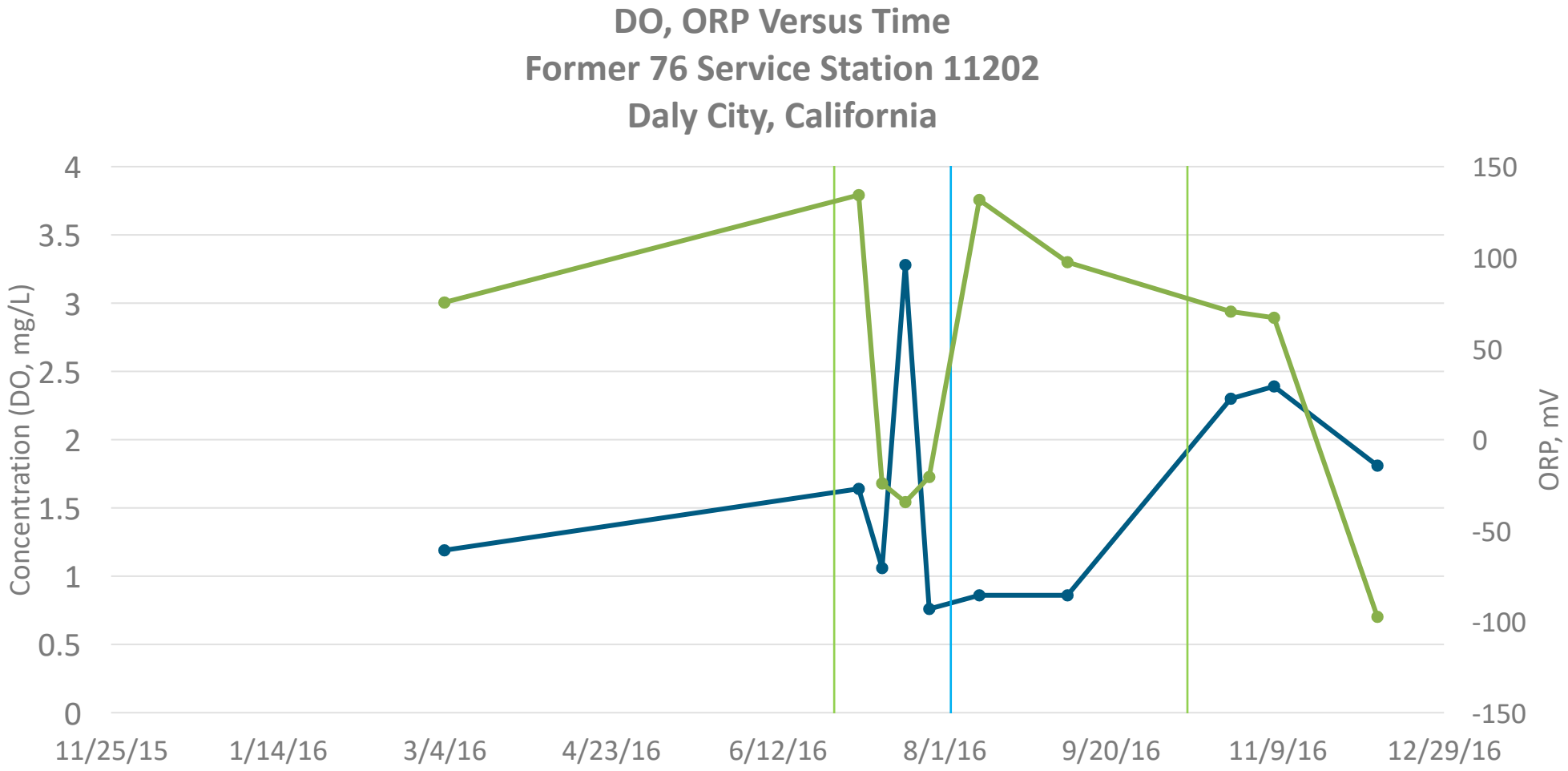
Secondary Results: MW-14



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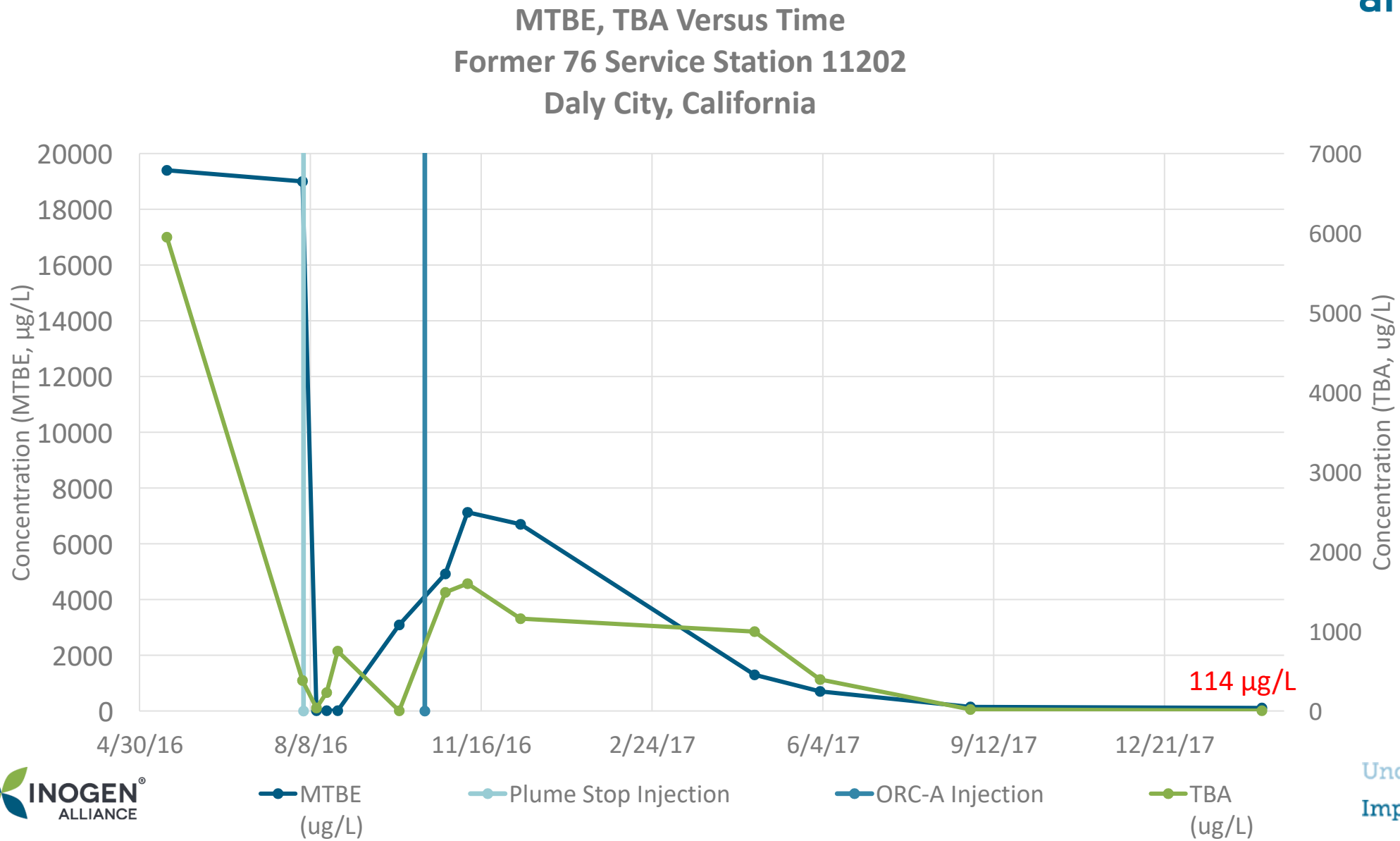
The Results: MW-24



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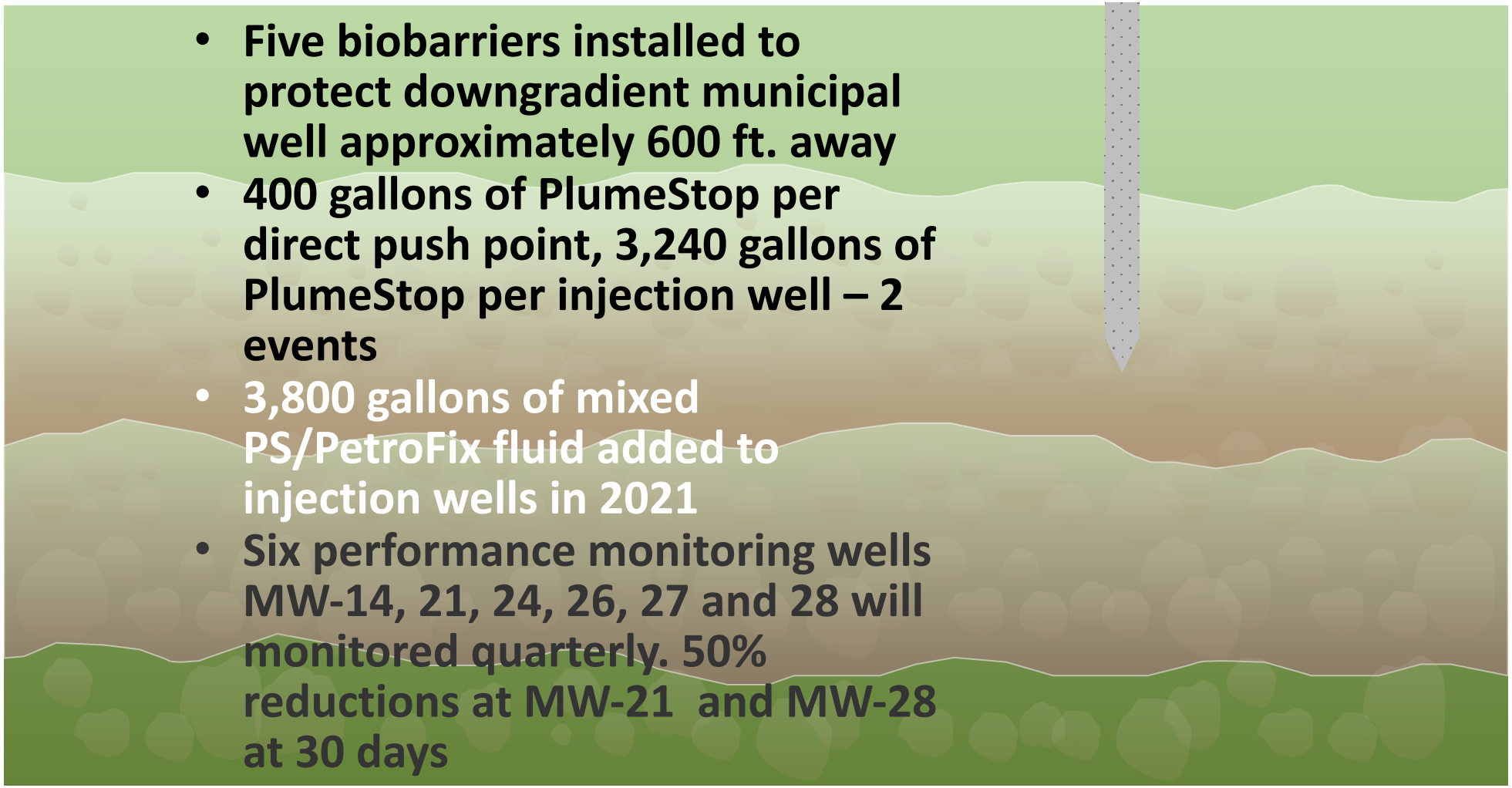
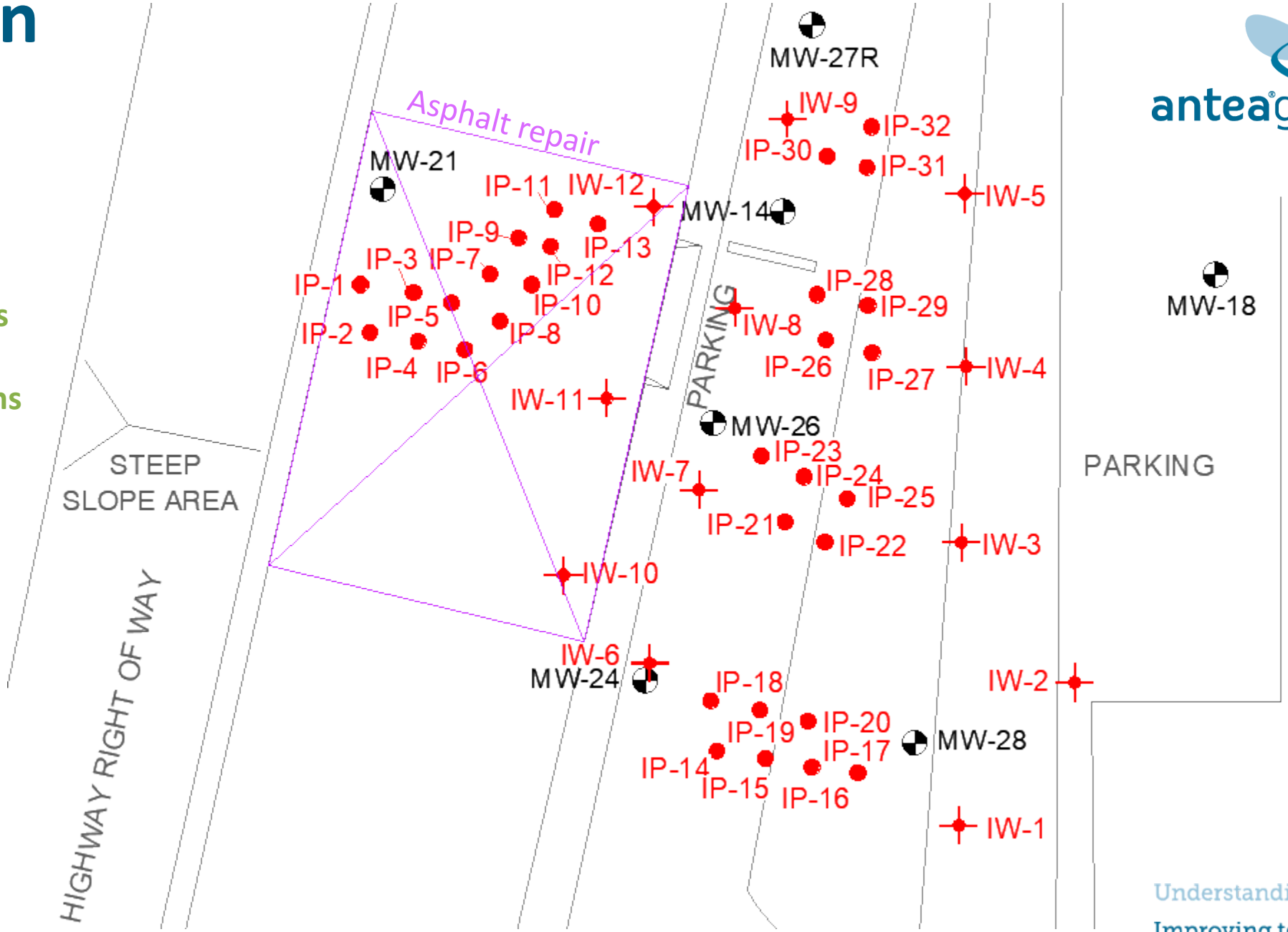
Full Scale Biobarrier Application



- Five biobarriers installed to protect downgradient municipal well approximately 600 ft. away
- 400 gallons of PlumeStop per direct push point, 3,240 gallons of PlumeStop per injection well – 2 events
- 3,800 gallons of mixed PS/PetroFix fluid added to injection wells in 2021
- Six performance monitoring wells MW-14, 21, 24, 26, 27 and 28 will monitored quarterly. 50% reductions at MW-21 and MW-28 at 30 days

Injection Layout 2018

12 injection wells
32 direct push injection locations



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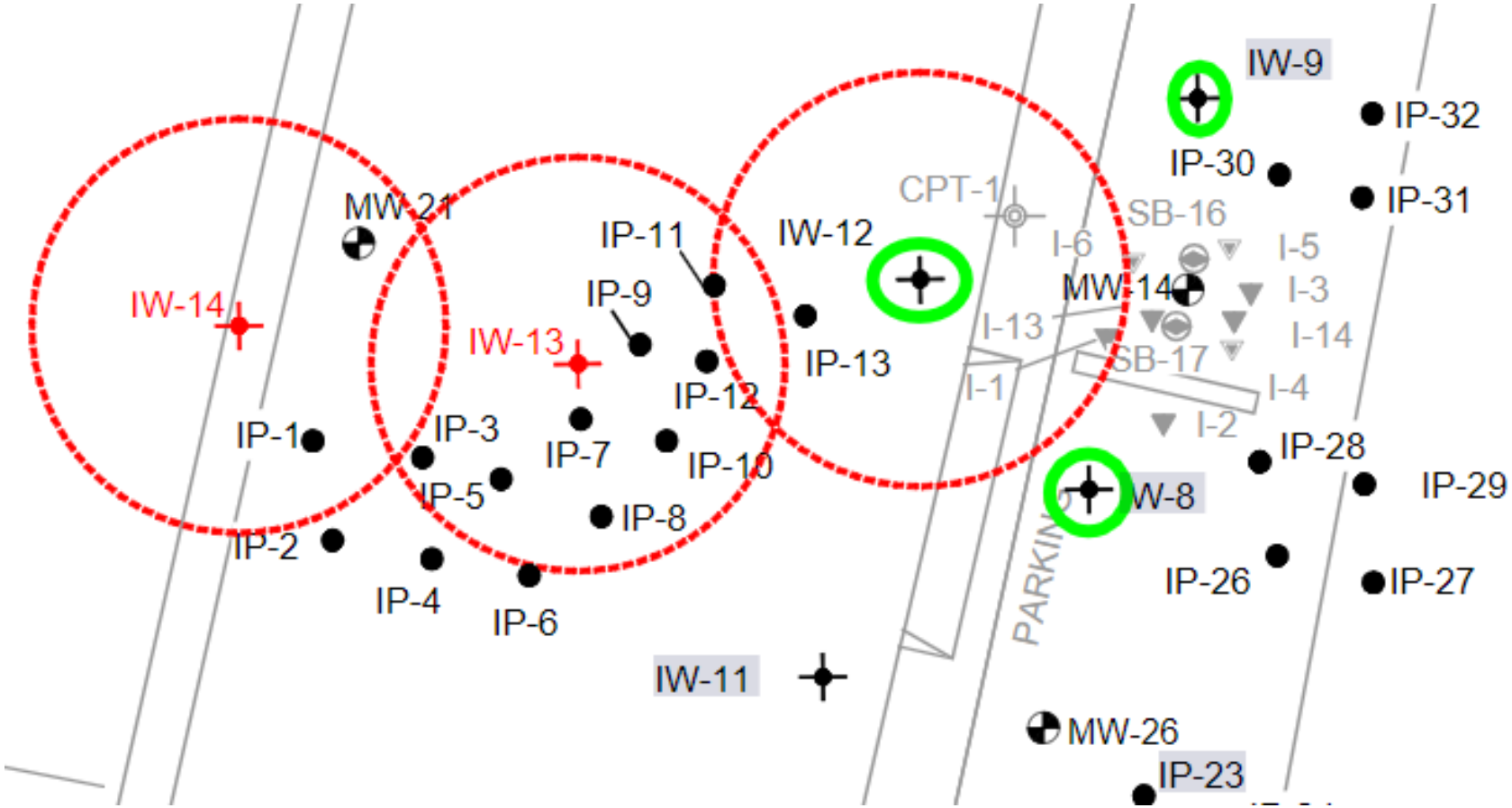
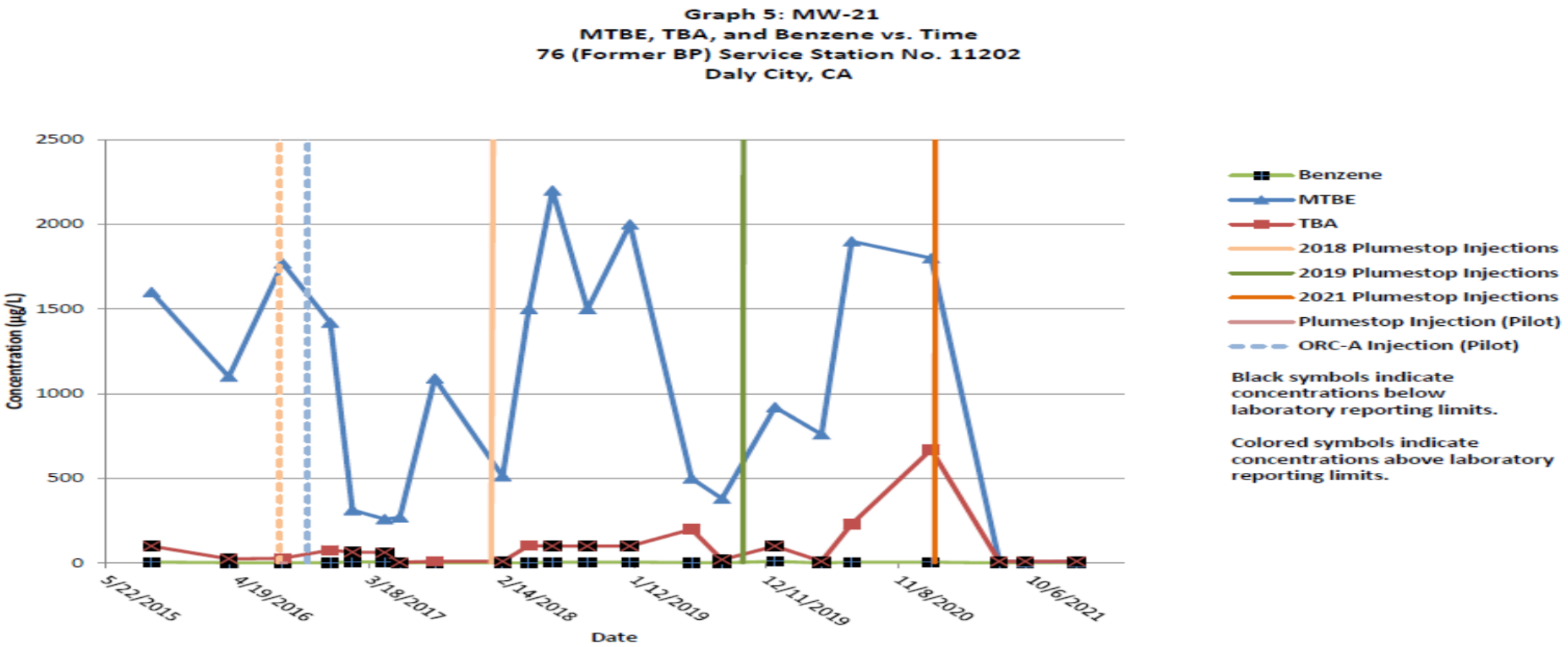
Revised Injection Layout 2021



MW-21 Results



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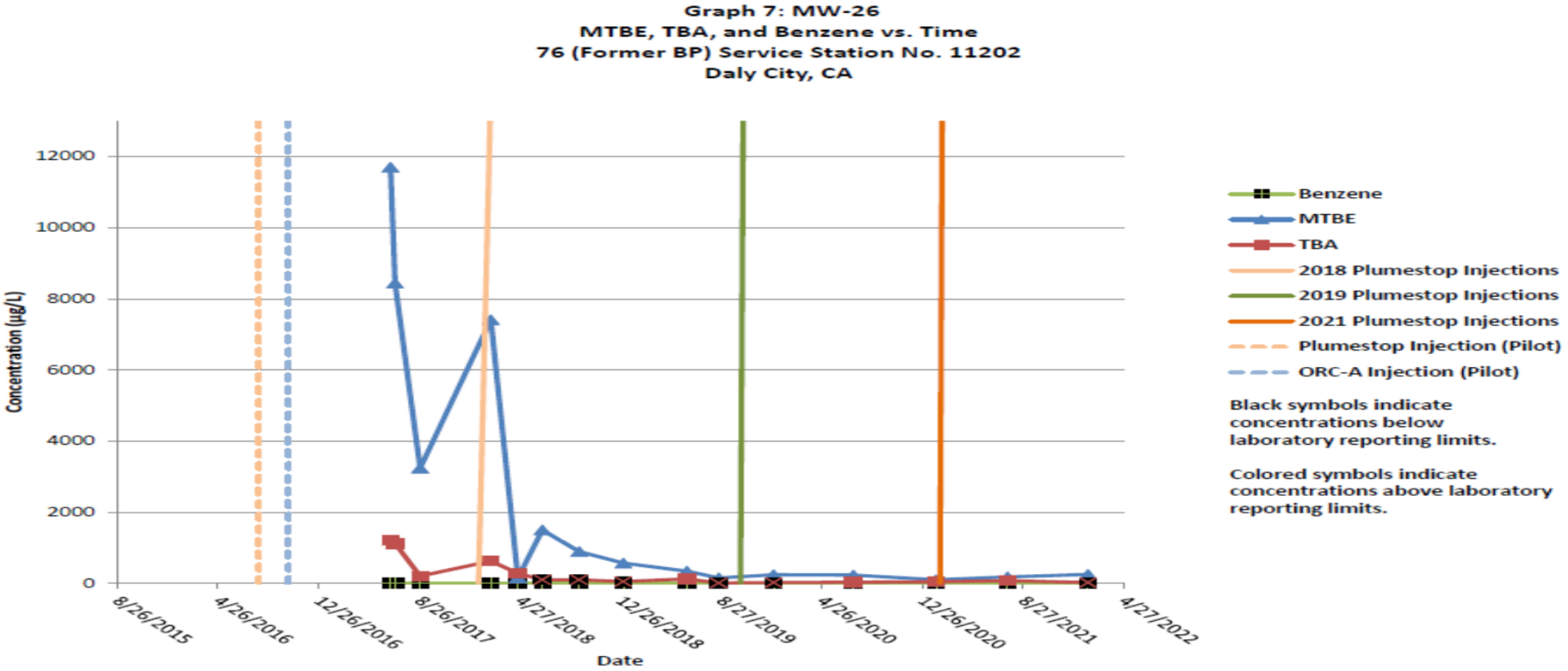
MW-26 Results



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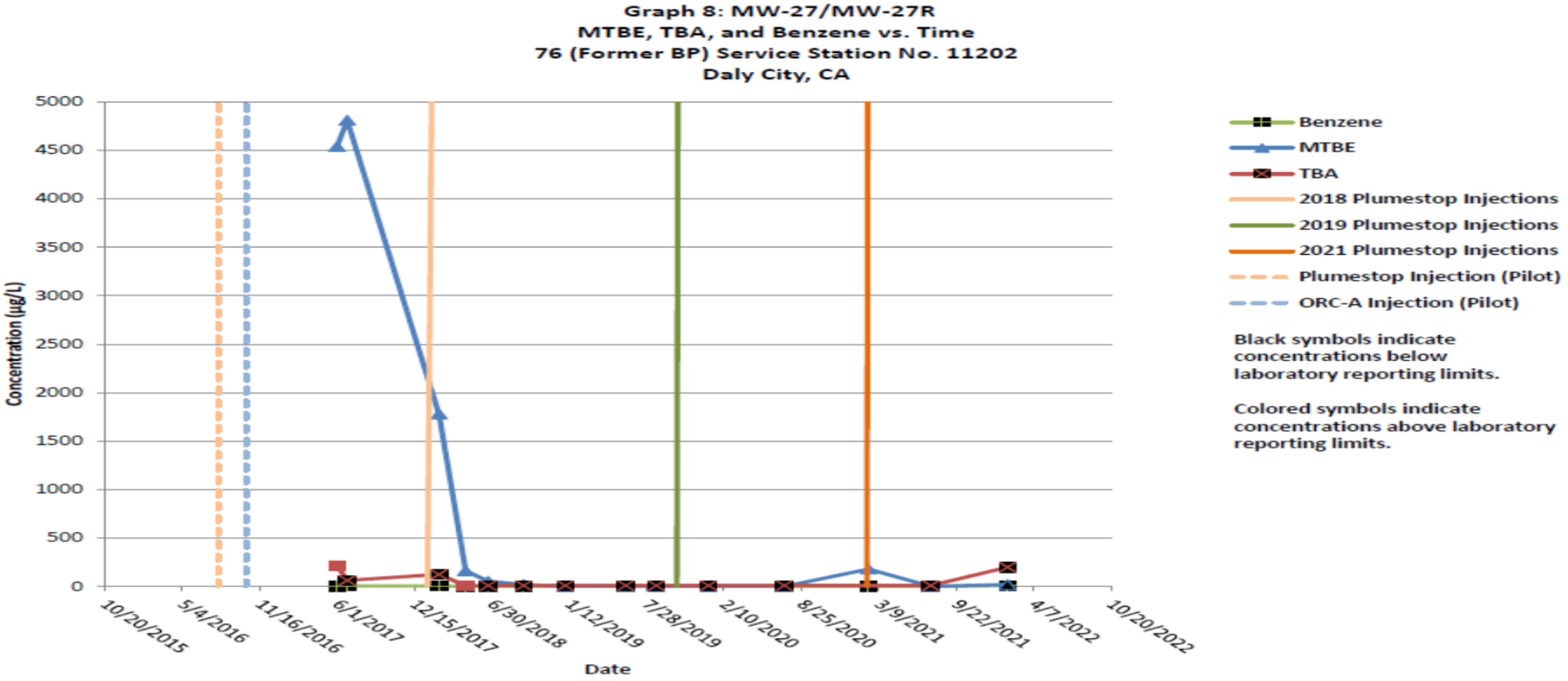
MW-27R Results



Takeaways

- Direct push injection into sand is not always what it appears
- A bioamendment can be an important addition to the carbon-based amendment, but natural conditions can still support biodegradation
- With the right microbiology and conditions, substantial reduction in MTBE/TBA concentrations is possible
- **In situ sorption/biodegradation is efficient when a robust microbial population is present and with a thorough sampling program and Mann Kendall analysis can lead to site closure (2023).**

Injection Challenges:

Night work

Major roadway lane closure

Infrastructure

Sands that compact

Acknowledgements:

Dacre Bush (Antea Group, Long Beach)
Craig Sandefur and Dan Nunez (Regenesis)
Gregg Drilling
Microbial Insights

Thank you

If you have more questions…

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We do more than effectively solve client challenges; we deliver sustainable results for a better future.

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