Innovative Pulsed Ozone Microdiffusion Sparge Approach for Tetrachloroethylene Remediation at an Arizona State Superfund Site

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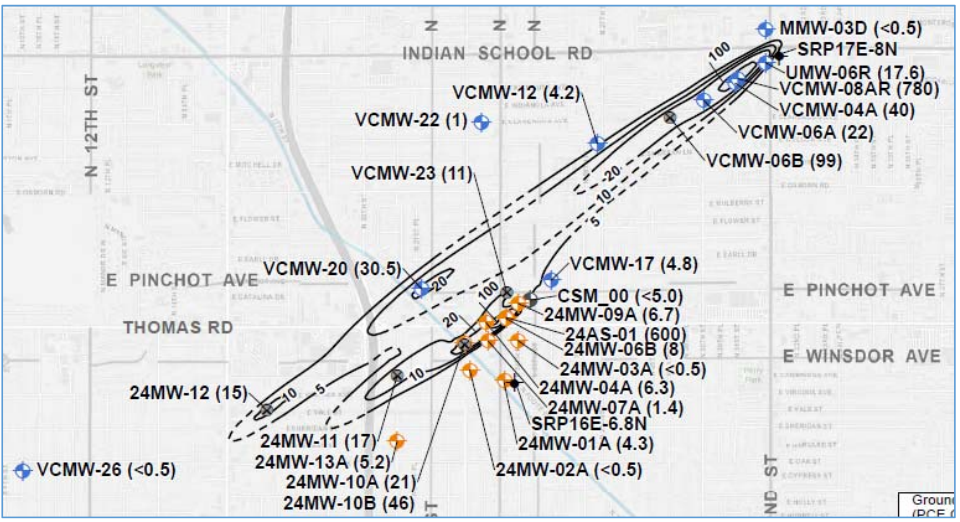
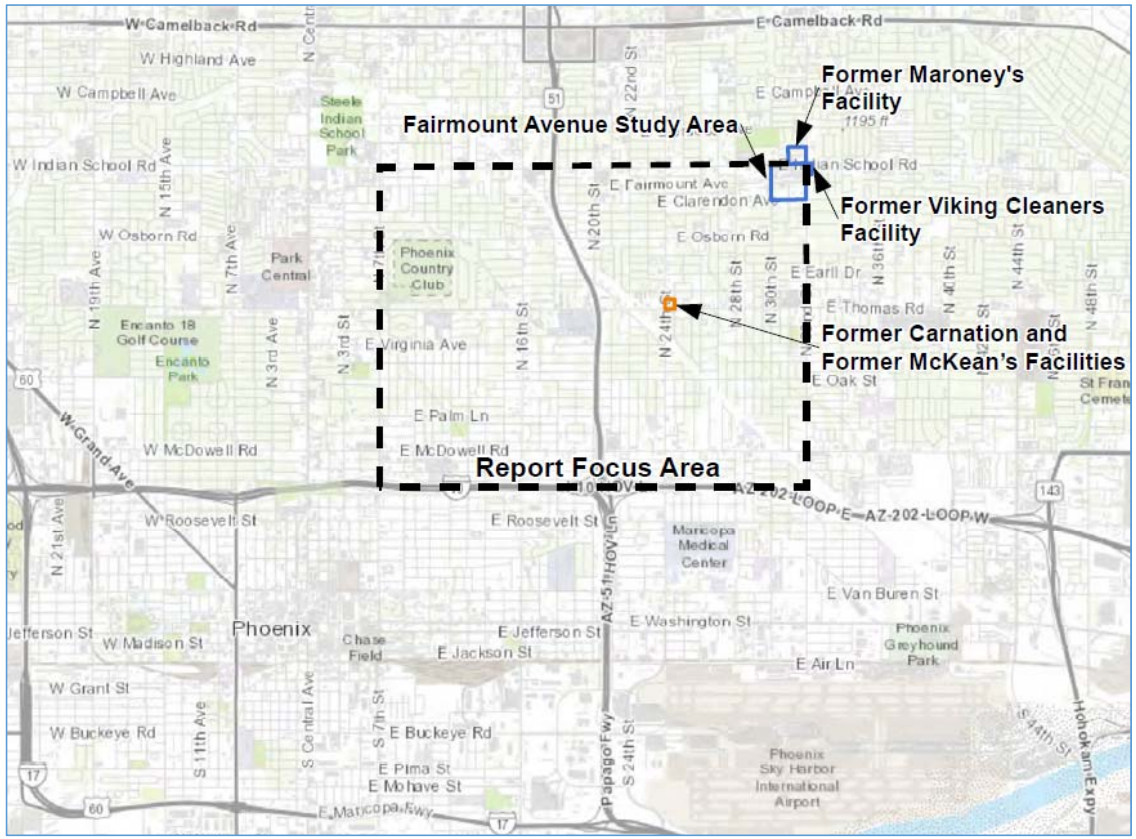
24th St. & Grand Canal WQARF Site

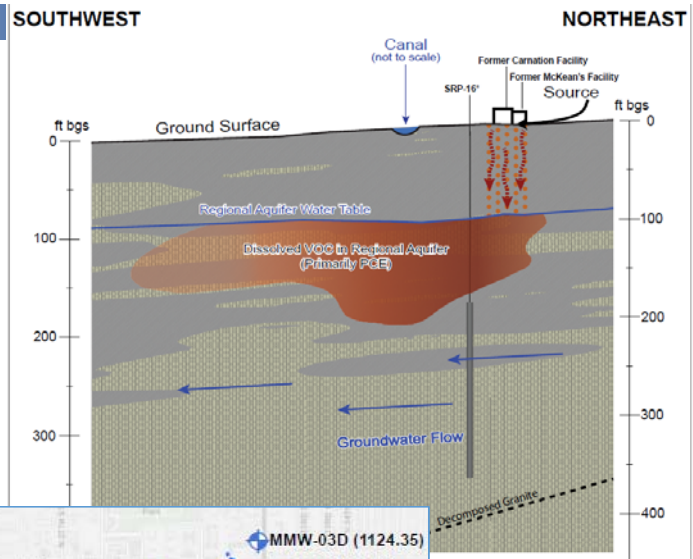
- WQARF = Water Quality Assurance Revolving Fund
  - Arizona's State Superfund Program

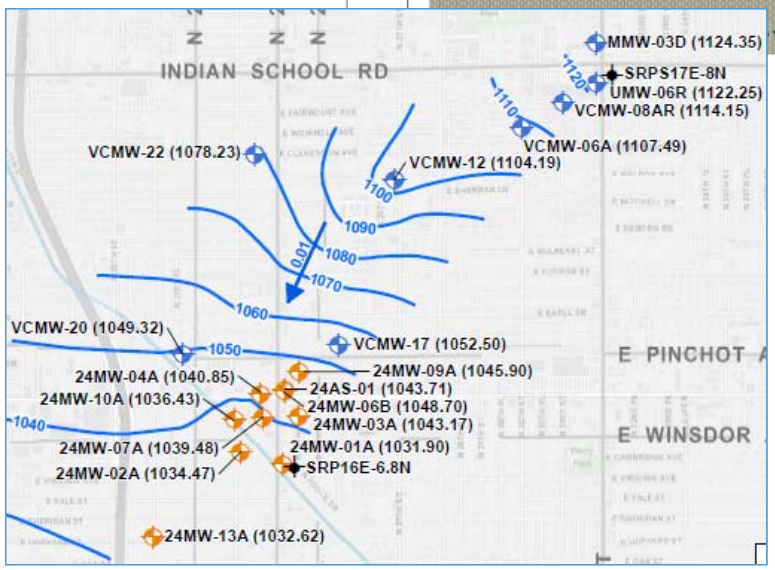




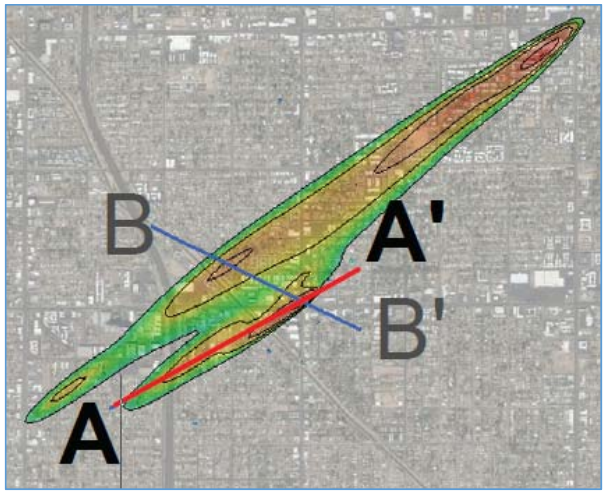
Site Hydrogeology

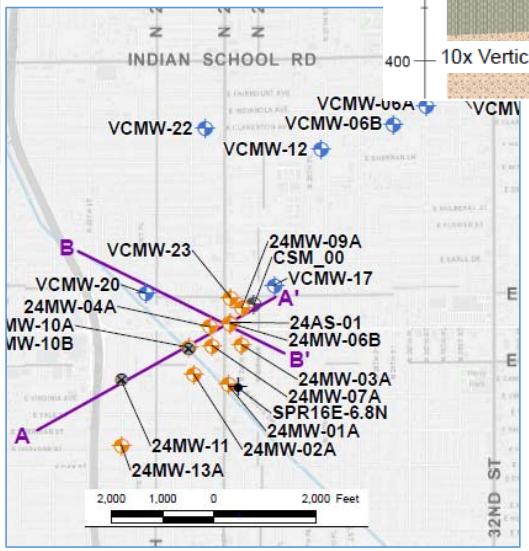
- Most of Phoenix lies in a broad relatively level alluvial valley
- Three hydrogeologic units: Upper, Middle and Lower Alluvial Units
- Site depth to groundwater: ~85 to ~100 ft bgs
- Lithology - intermittent layers of sand, gravel, and silt
- Groundwater flow to the west-southwest
- Groundwater velocity ~70 ft/day

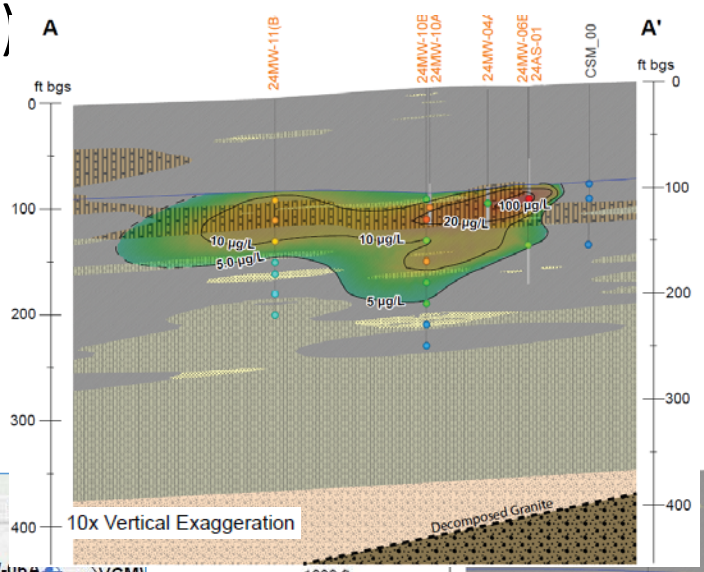


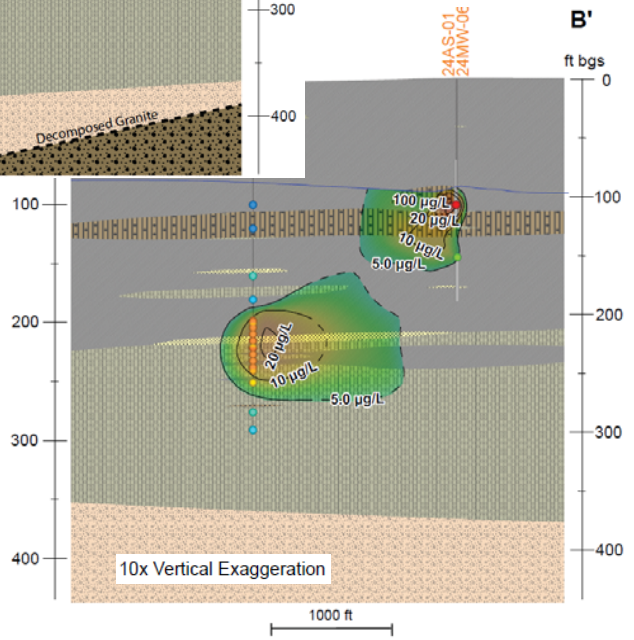


Environmental Visualization System (EVS)



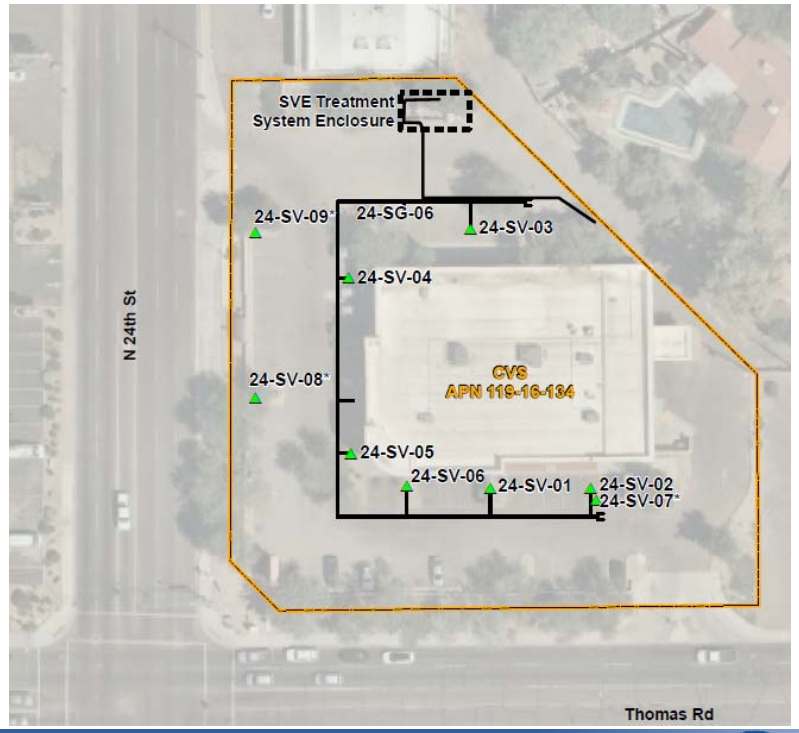




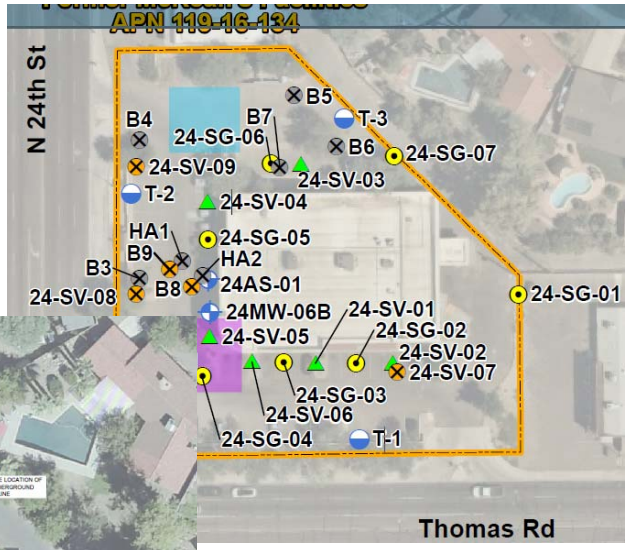


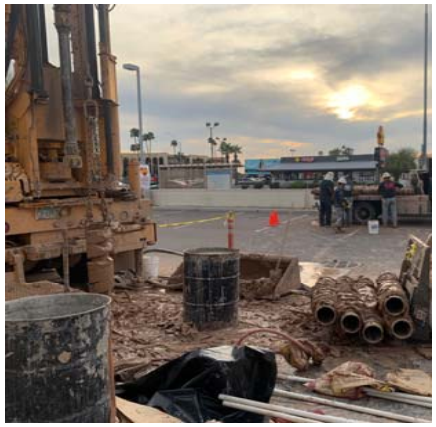
Site Layout

Former soil vapor extraction system



New ozone pilot sparge system



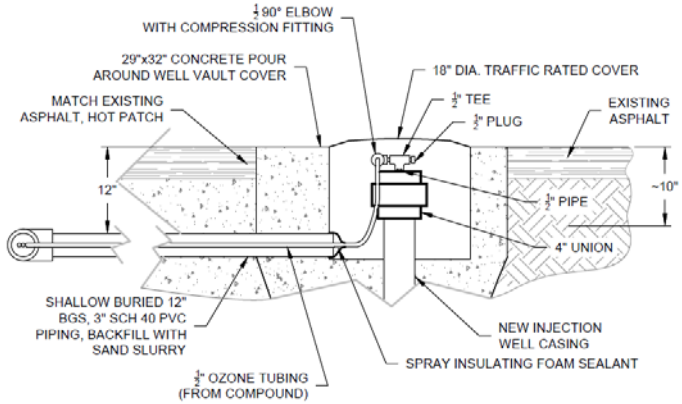


Compound Became a Homeless Shelter

Site location and utilizing previous SVE compound

Intent was to pull ½-in. dia. ozone tubing thru 2-in. dia. SVE PVC lines

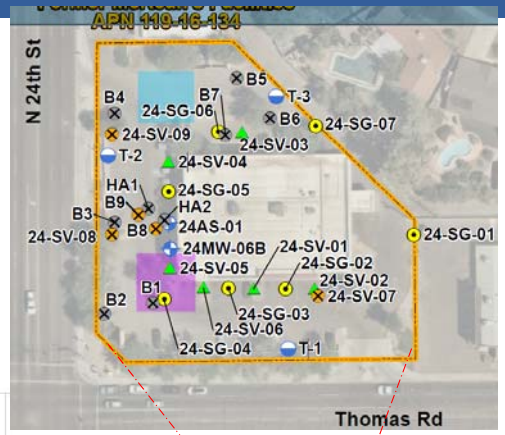

CVS
pharmacy

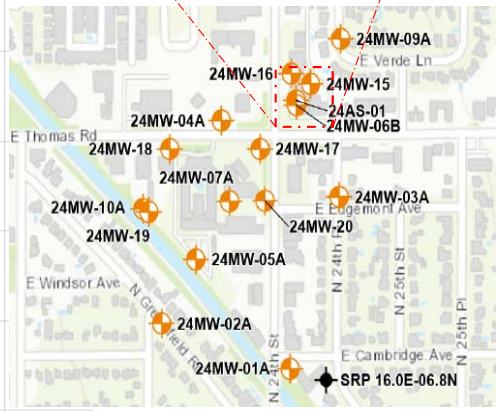

½ 90° ELBOW
WITH COMPRESSION FITTING
29"x32" CONCRETE POUR
AROUND WELL VAULT COVER
18" DIA. TRAFFIC RATED COVER
½" TEE
½" PLUG
MATCH EXISTING
ASPHALT, HOT PATCH
EXISTING
ASPHALT
12"
~10"
½" PIPE
4" UNION
SHALLOW BURIED 12"
BGS, 3" SCH 40 PVC
PIPING, BACKFILL WITH
SAND SLURRY
NEW INJECTION
WELL CASING
SPRAY INSULATING FOAM SEALANT
¼" OZONE TUBING
(FROM COMPOUND)

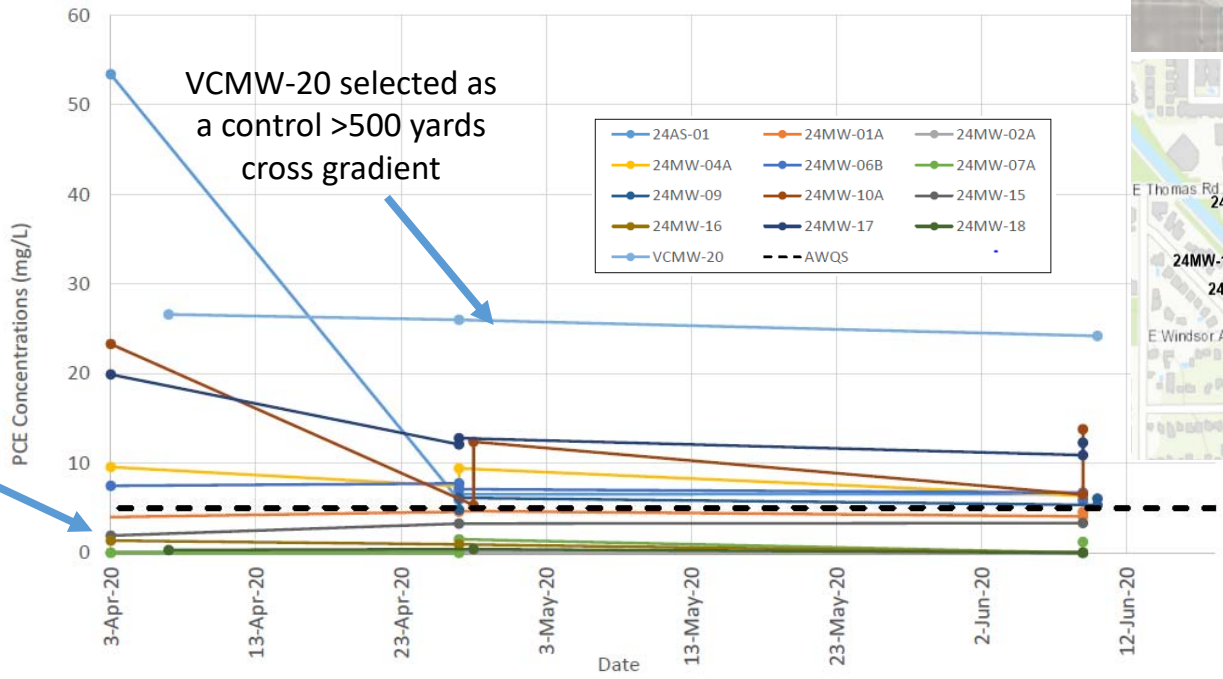

RESI
PERSONAL

Used 50 lbs/day Ozone Sparge Trailer

- PCE in 24AS-01 decreased ~87% from April to June 2020
- All other wells within the 250’ treatment zone saw PCE decrease >20% after initial 6 weeks w/steady decline since
- Ozone detected in monitoring well headspace across the canal
- Significant rise in ORP

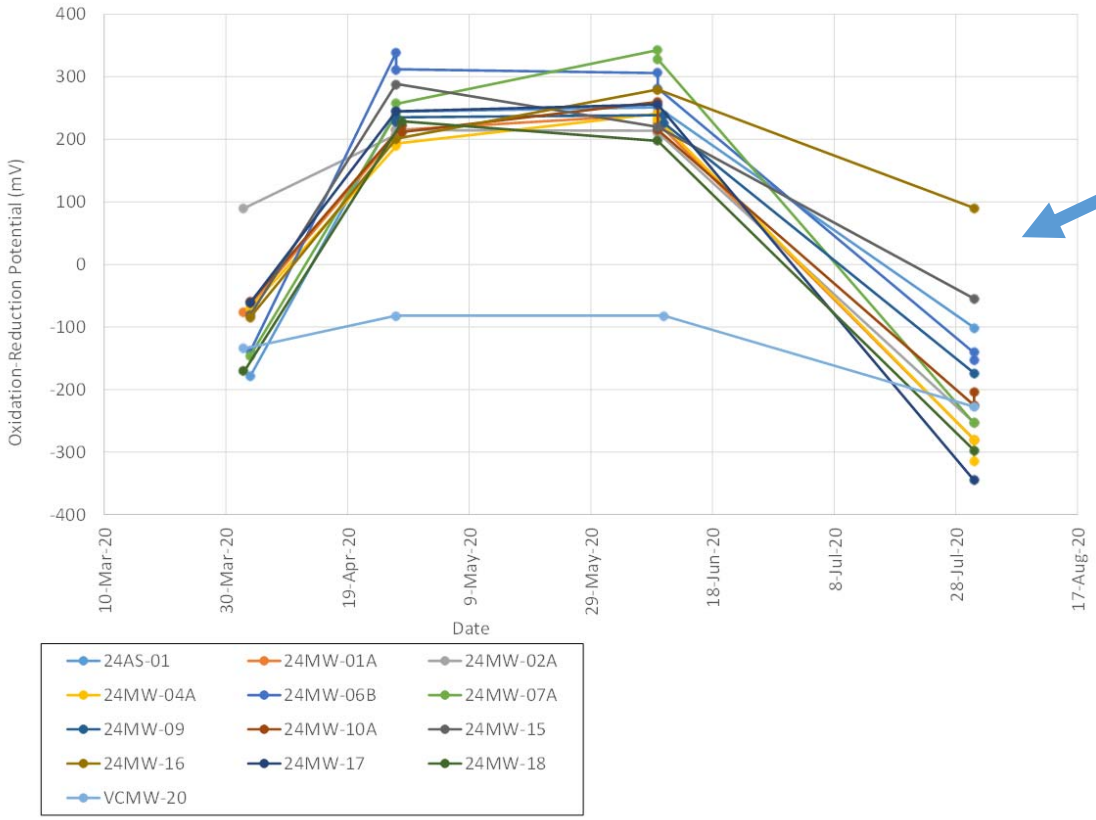




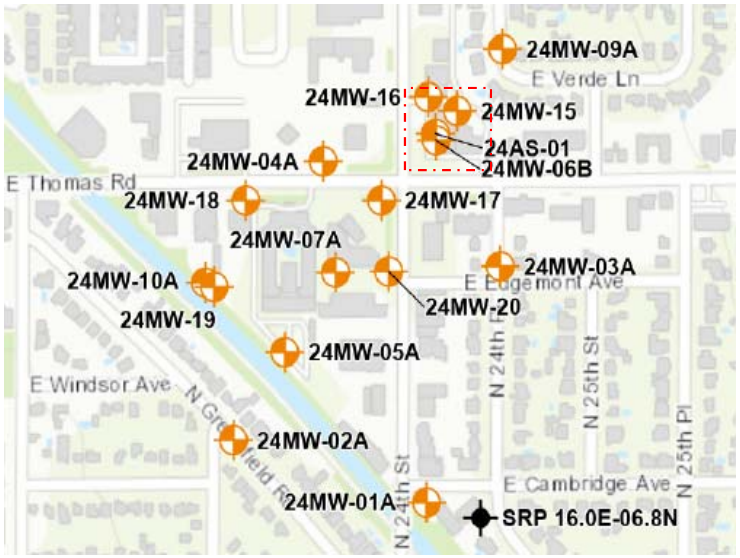


Control wells with <5 ug/l to monitor mixing or contaminant spread during pilot

Groundwater Redox Over Time

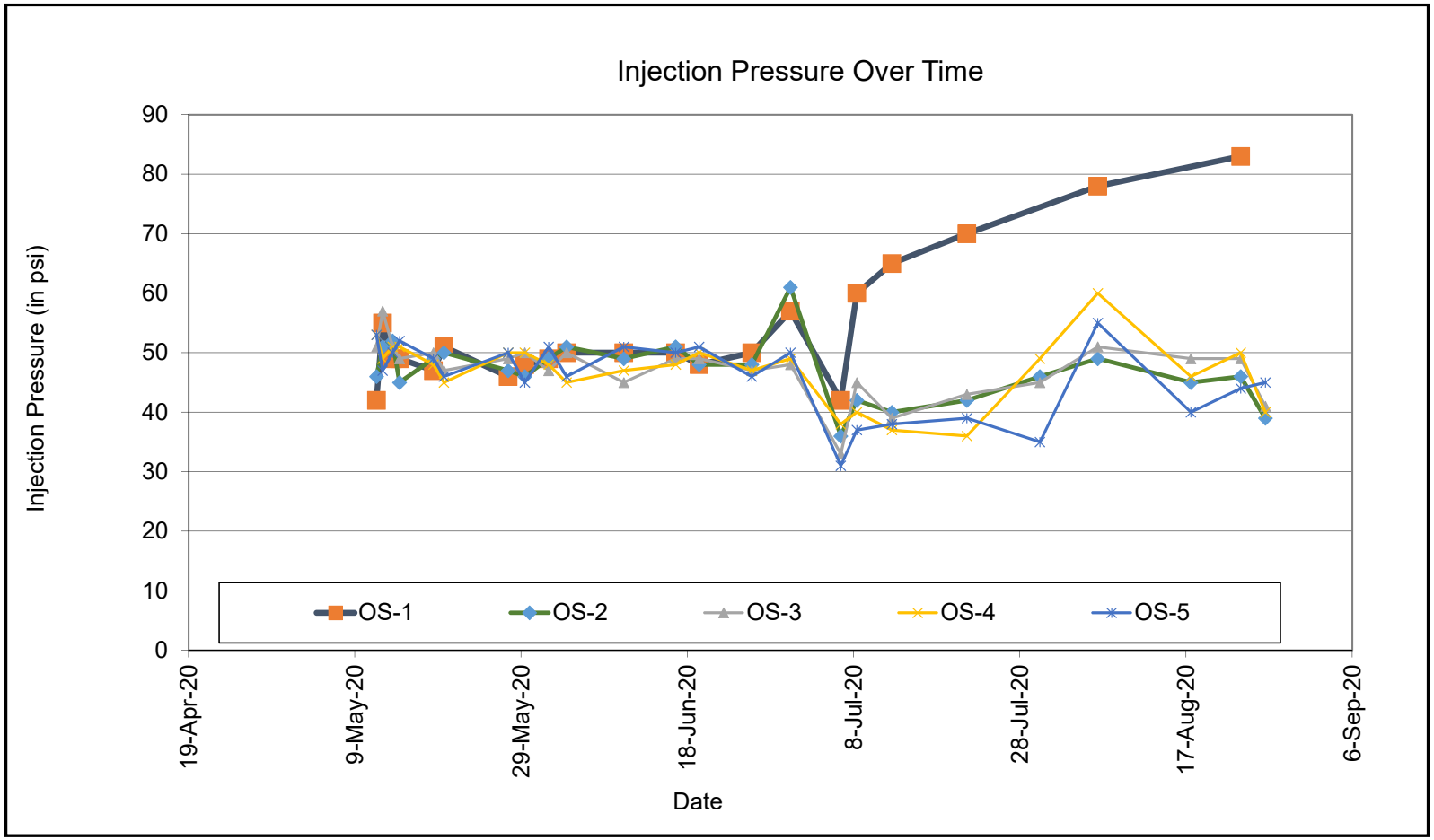


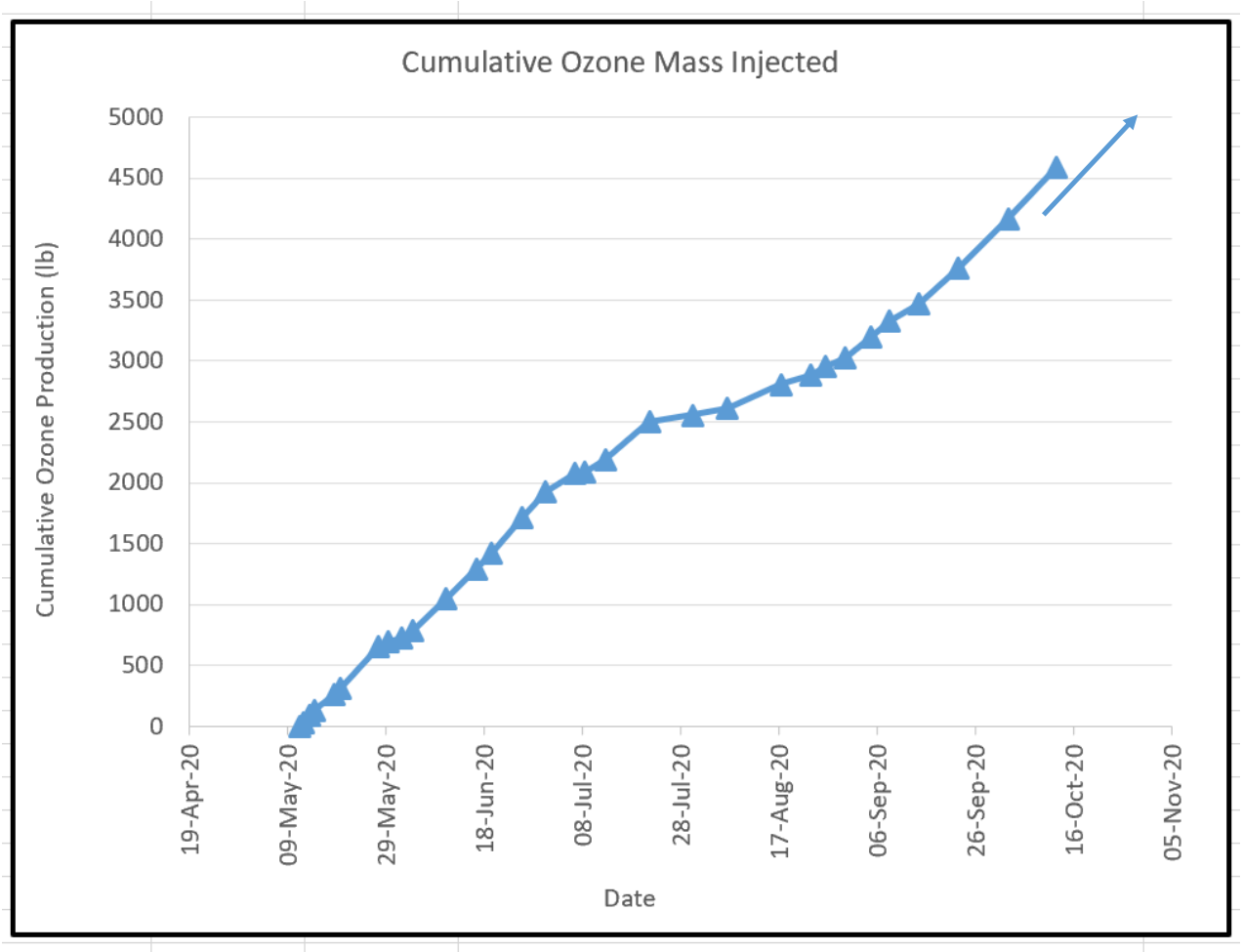
Redox Restored
After 14 Day
System Shut Down



Location	Sample Depth (ft bgs)	Date Sampled	Dissolved Metals (µg/L) Over Time Near Injection Points					
			Chromium	**Copper**	**Manganese**	**Nickel**	**Zinc**	**Uranium**
24AS-01	98	4/27/2020	150	<10.0	<10.0	<10.0	<50.0	58.9
	98 (FD)	4/27/2020	149	<10.0	<10.0	<10.0	<50.0	60.0
	98	6/9/2020	194	<1.00	<5.00	<2.00	<20.0	59.7
	98 (FD)	6/9/2020	201	3.76	<5.00	<2.00	<20.0	64.0
	98	7/31/2020	**0.29**	**<0.0050**	**<0.020**	**<0.0050**	**<0.040**	**0.066**

Metals all reduced to background within 14 days of system shut down


Injection Pressure Over Time
Injection Pressure (in psi)
90
80
70
60
50
40
30
20
10
0
OS-1
OS-2
OS-3
OS-4
OS-5
19-Apr-20
9-May-20
29-May-20
18-Jun-20
8-Jul-20
28-Jul-20
17-Aug-20
6-Sep-20
Date



To date more than 5000 pounds of ozone has been injected into site groundwater

Summary

- EVS-type modeling excellent for refining CSM adequate for advanced and focused remedial approaches
- Pilot testing is critical
- Need to understand O&M requirements of zone sparge systems
- Frequent monitoring and understanding of changes in groundwater chemistry
- Able to achieve dissolve-phase ozone 400+ ft downgradient
- Up to 80% reduction in 6 weeks
- Expand to Full Scale and remediate with 2 years!

Thank You!