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Performance and Refresh of a Full Scale Biowall System Designed to Treat Chlorinated Solvents in Groundwater

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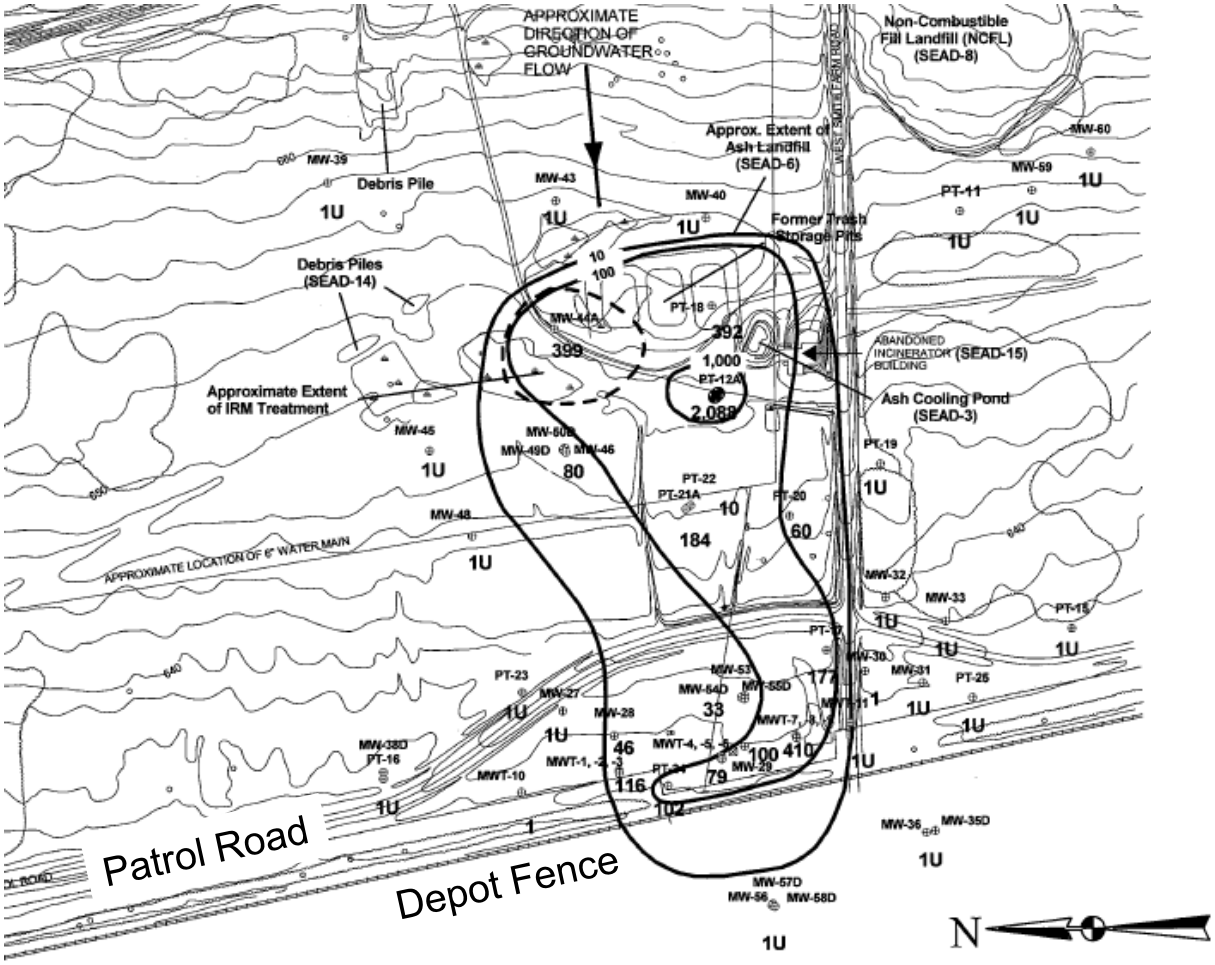
04.10.18

Overview

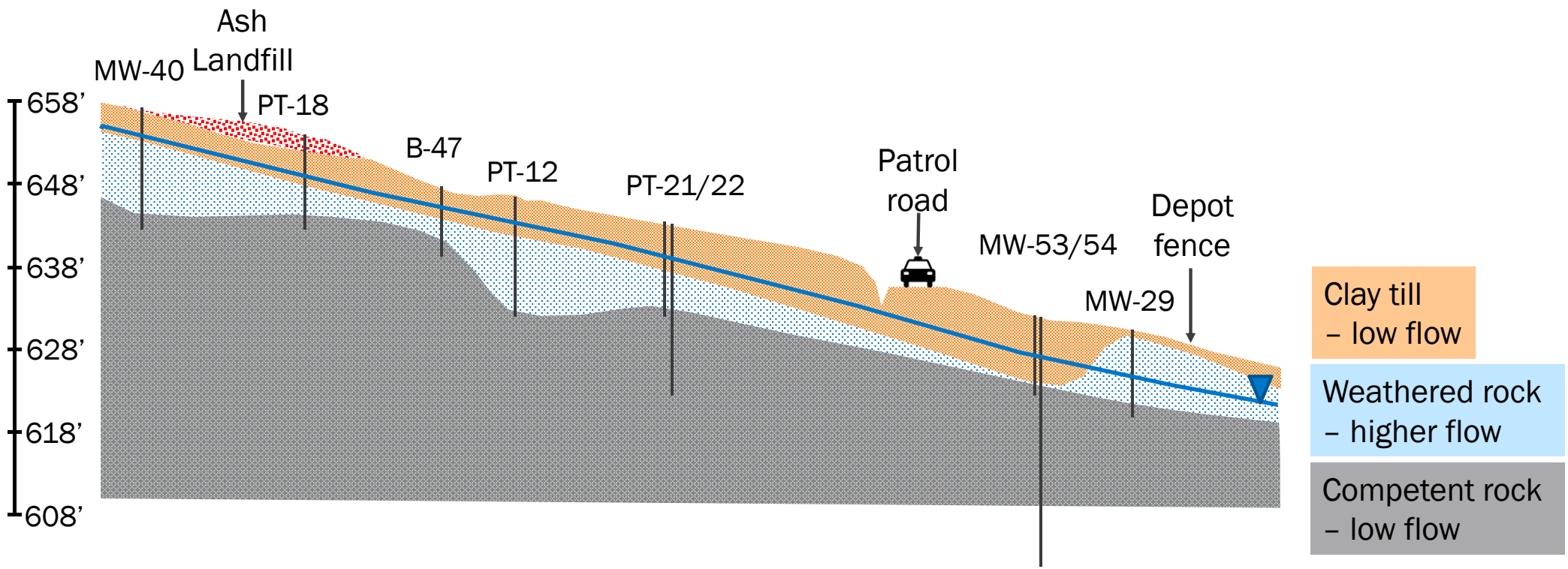
- Seneca Army Depot Ash Landfill Site Summary
- Biowall System Installation and Performance
- Evidence of Biowall Depletion
- Biowall System Refresh
- Post System Refresh Performance
- Conclusions

Seneca Army Depot Ash Landfill Site Summary

- Disposal area for incinerator ash
- Primary CoCs are chlorinated solvents and metals
  - Metals are limited to source area soils
  - Groundwater plume extends 1200’ past the depot fence and onto private property
- Natural geochemistry is oxic and destructive MNA is very limited
- Groundwater flow is to the west at ~40 ft/yr

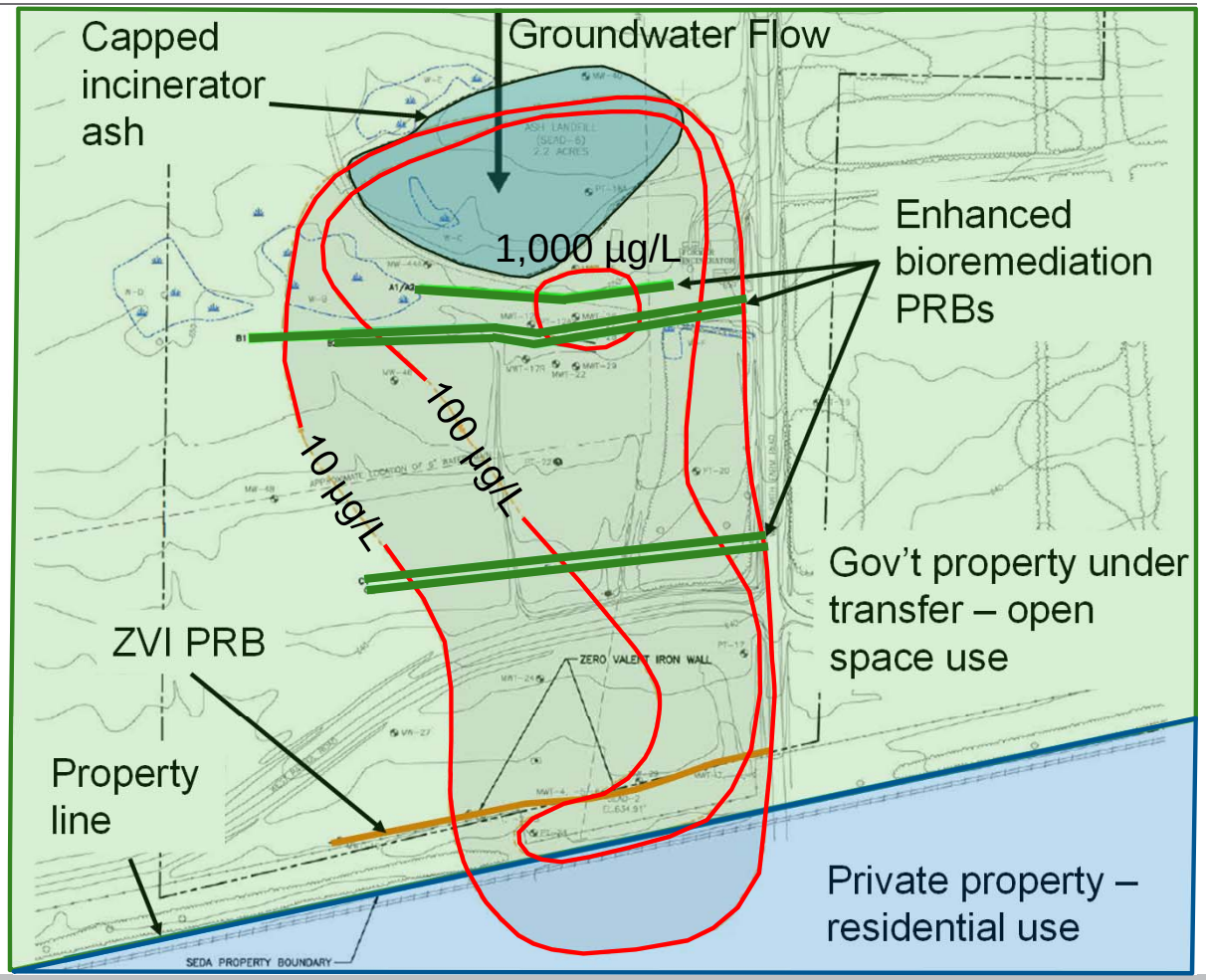


Seneca Army Depot Ash Landfill Site Summary



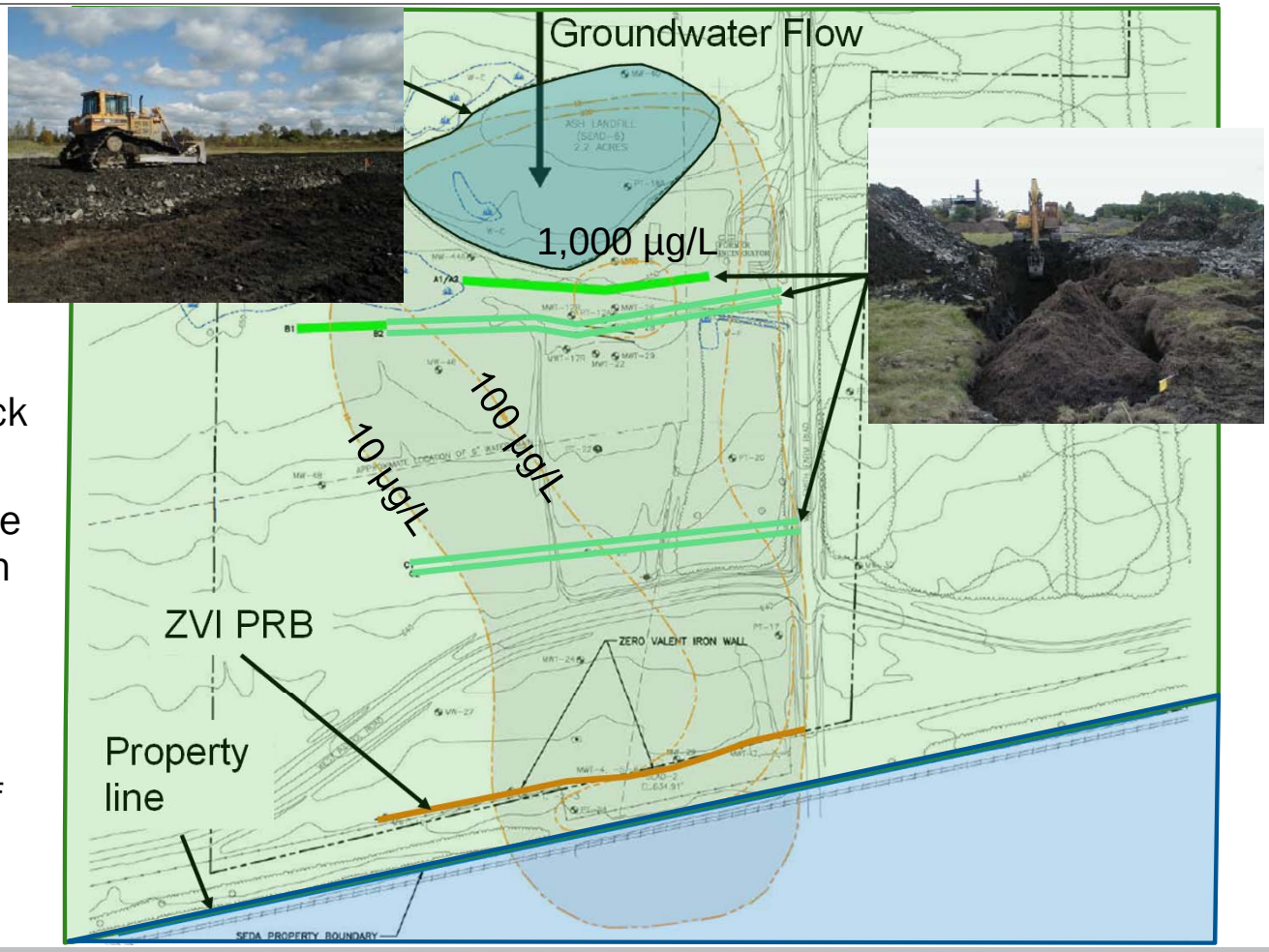
Seneca Ash Landfill Site Use Driven Remedy

- Onsite – Future use open space
  - Remaining incinerator ash capped to eliminate potential direct contact risk
  - Enhanced bioremediation permeable reactive barriers to collapse plume over time
  - Zero valent iron PRB just upgradient of property line to eliminate mass flux offsite
- Offsite – Private property assumed to be residential use
  - Long term monitoring

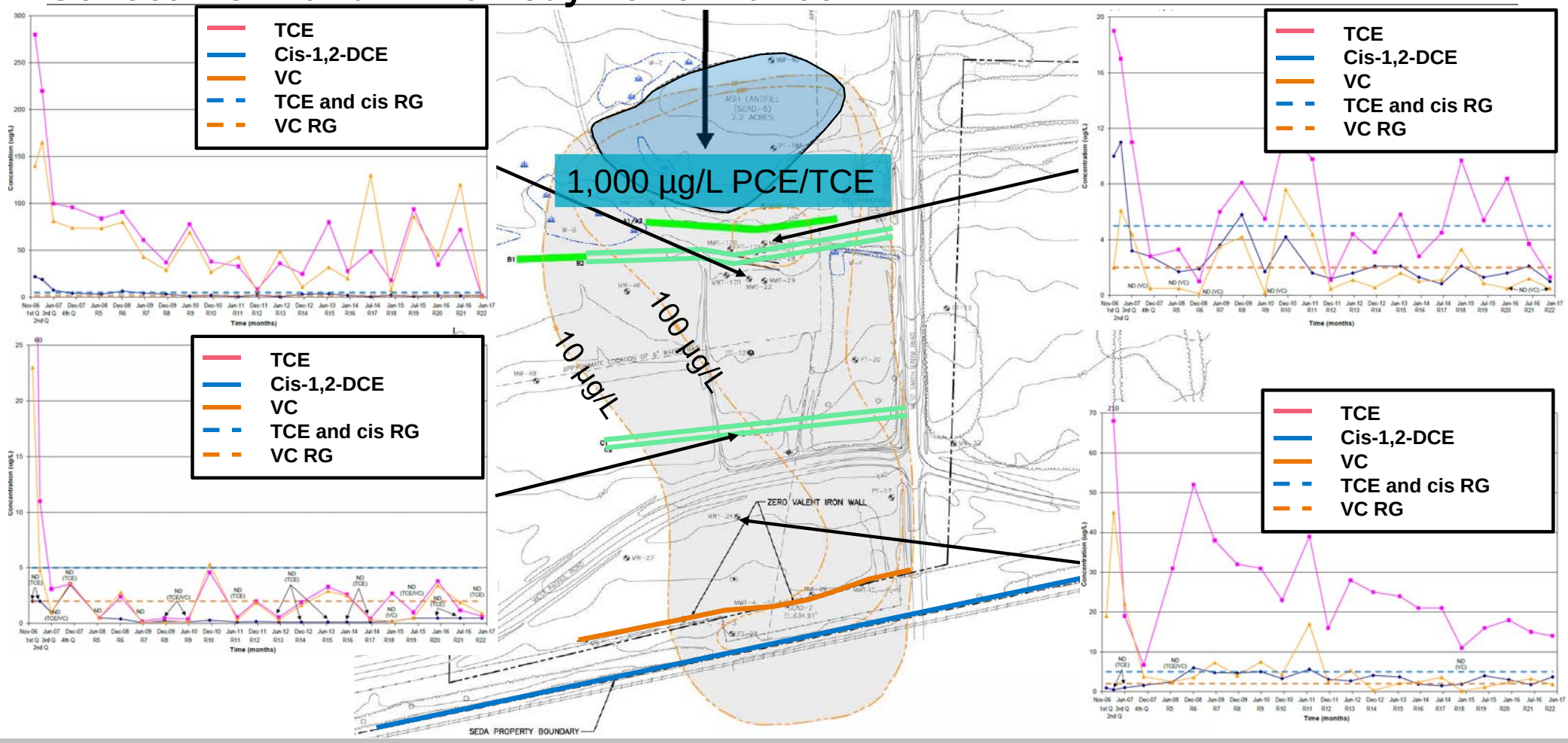


Seneca Ash Landfill Remedy Installation

- Remaining incinerator ash capped with vegetative cover
- ~6,000 linear feet of biowall were installed in 2006
  - Biowalls installed ~8-10 years of travel time apart
  - Biowalls keyed into competent rock to provide complete treatment
  - Biowall backfill consisted of coarse sand and bark mulch sprayed with soybean oil
- ~600 linear feet of ZVI PRB installed
  - Backfill consisted of 50/50 mix of coarse sand and granular ZVI

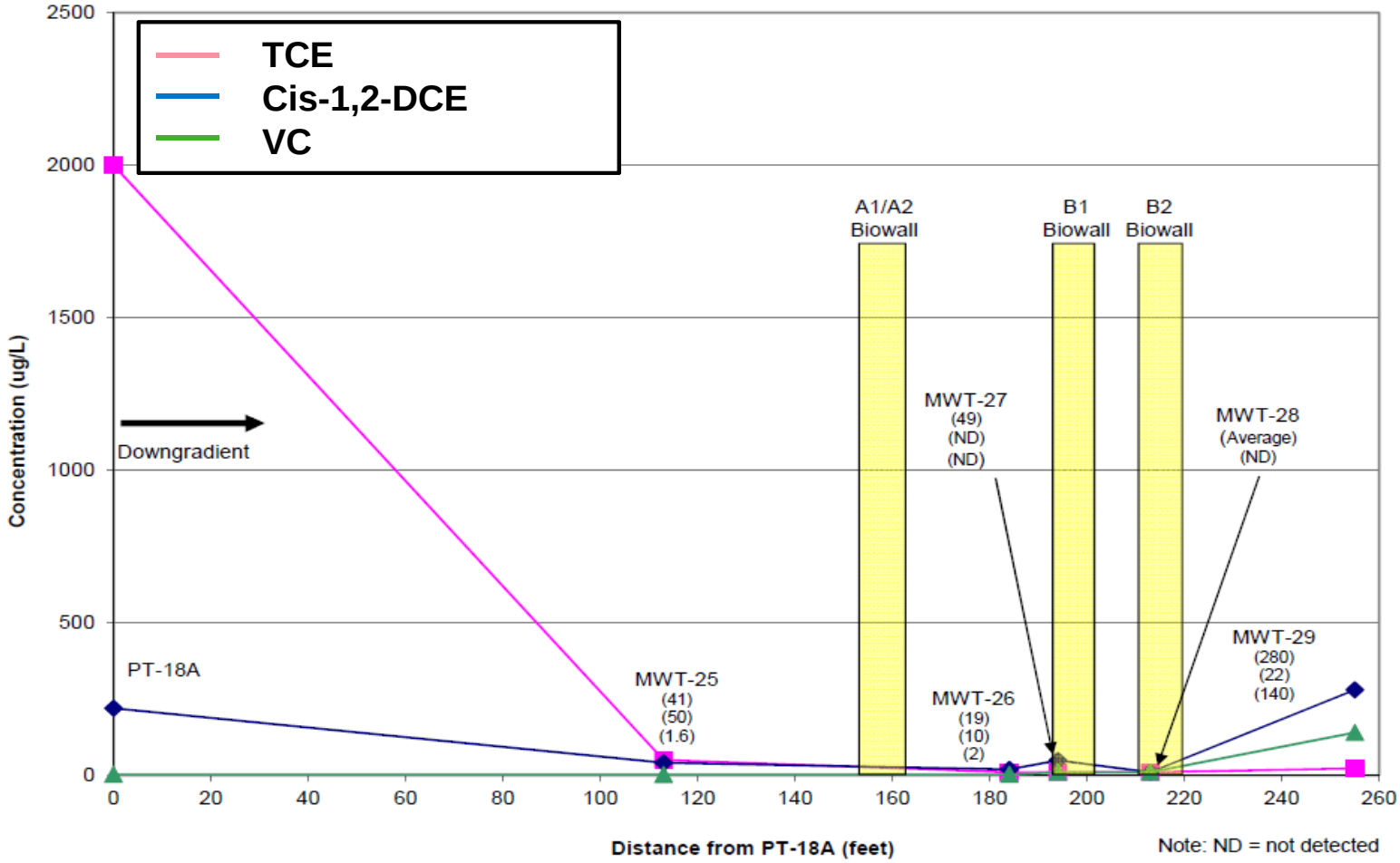


Seneca Ash Landfill Remedy Performance



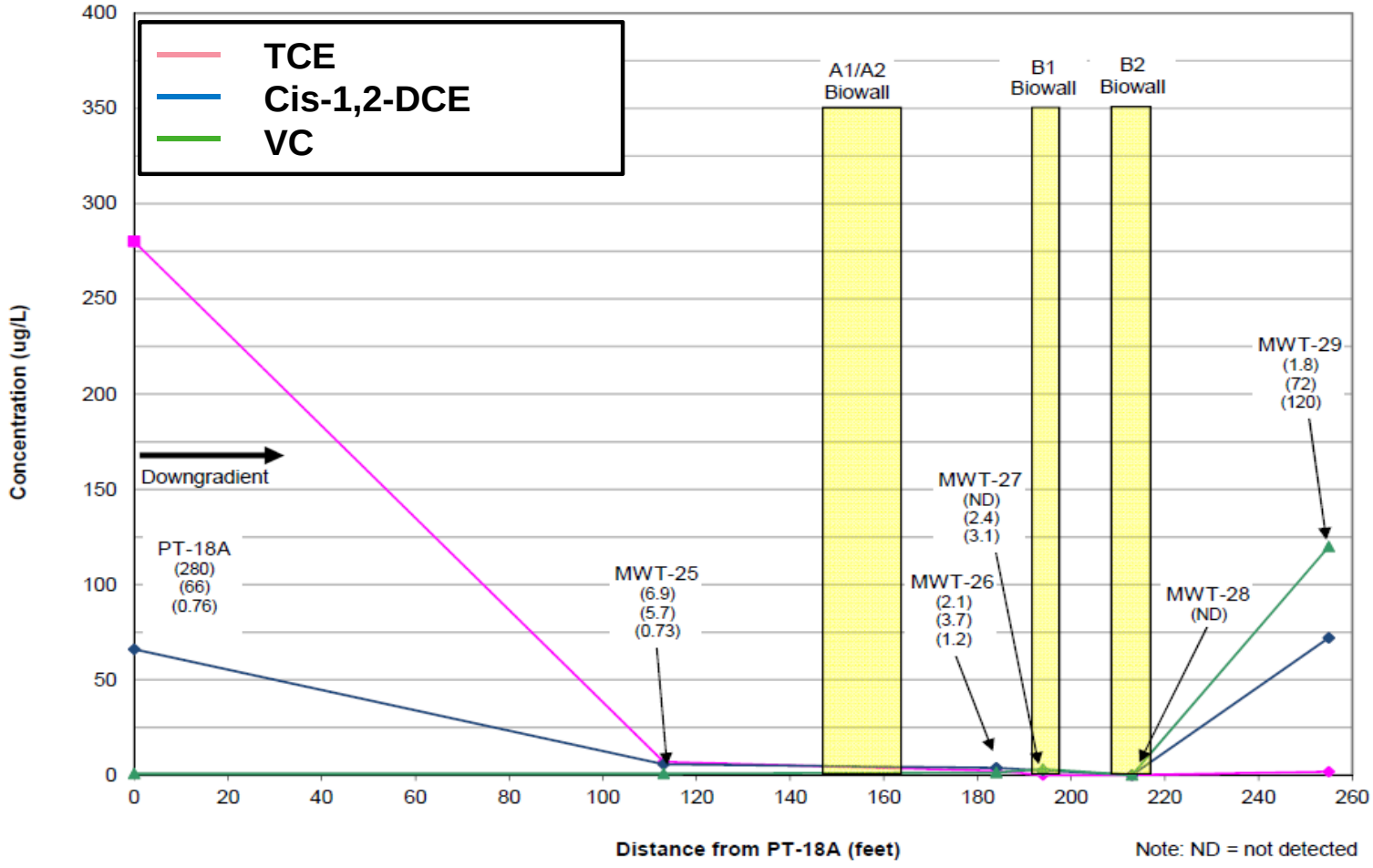
Seneca Ash Landfill Remedy Performance

- Biowall system performance circa 2009 (28 months post installation)

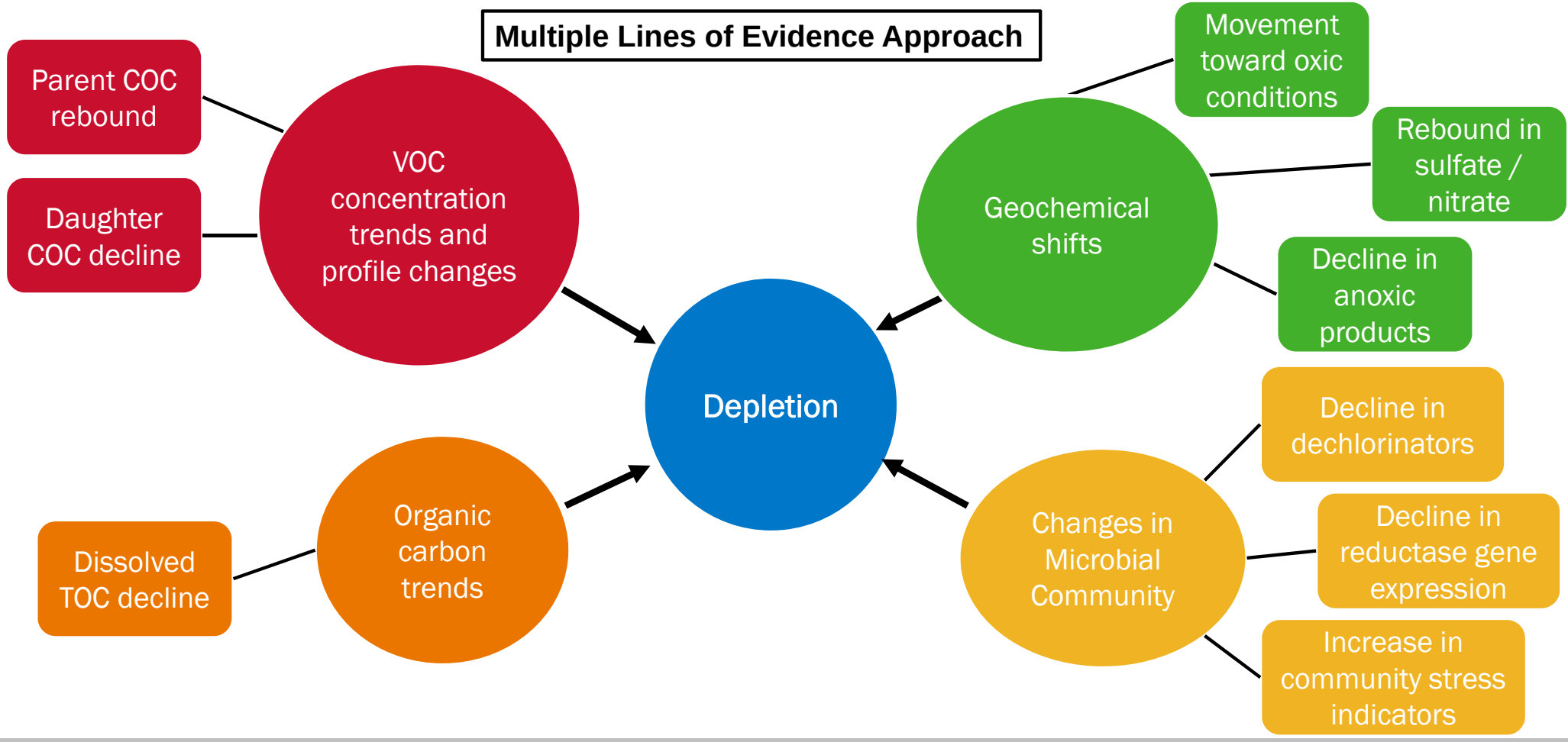


Seneca Ash Landfill Remedy Performance

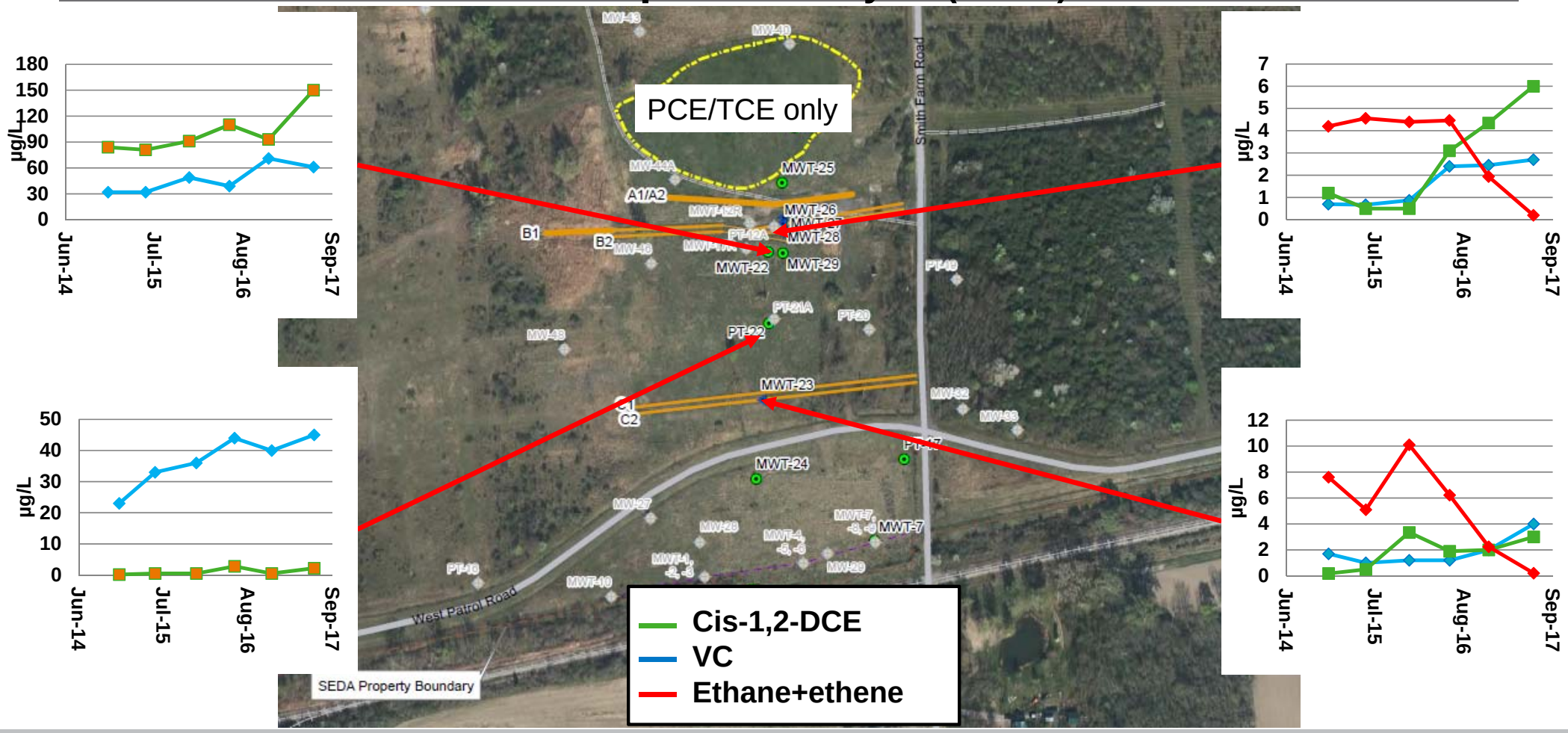
- Biowall system performance circa 2017 (10 years post installation)



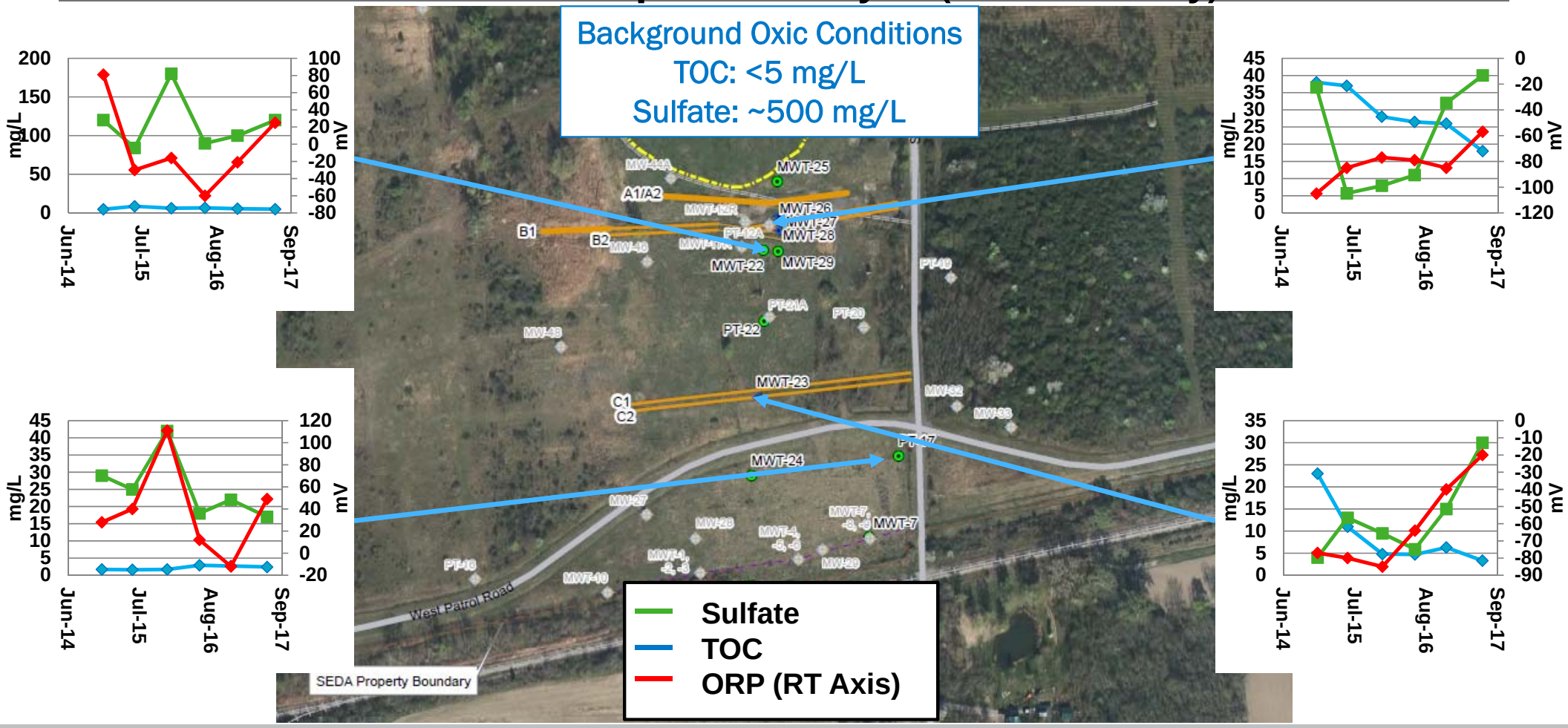
Seneca Ash Landfill Biowall Depletion Analysis



Seneca Ash Landfill Biowall Depletion Analysis (VOCs)



Seneca Ash Landfill Biowall Depletion Analysis (Geochemistry)



Seneca Ash Landfill Biowall Substrate Refresh

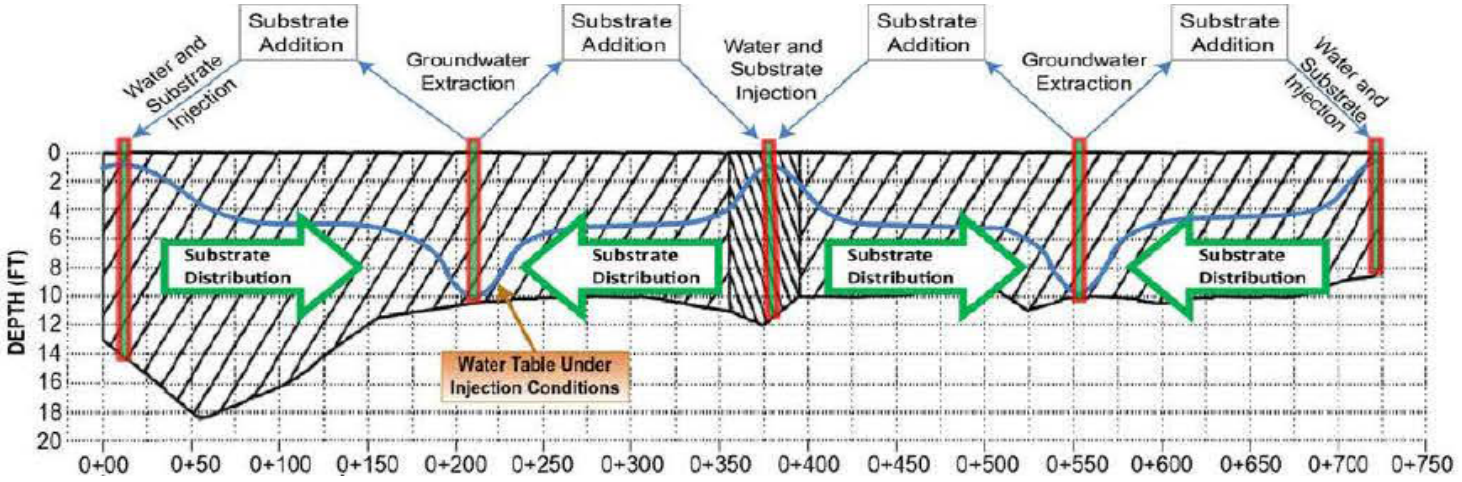
A volumetric Approach to Refresh

Section	Length	Average Width	Number Wells	Range Saturated Thickness	Assumed Saturated Thickness	Total Volume	Pore Volume at 18%	Injection Volume (one pore volume)	Percent Oil Saturation	Neat Oil Volume	Neat Oil Volume	Neat Oil Weight	Percent pH Buffer Saturation	pH Buffer Volume	pH Buffer Weight
Units	feet	feet	each	feet	feet	cubic ft	cubic ft	gallons	percent	cubic ft	gallons	lbs	percent	gallons	lbs
A1/A2	375	12	5	5 - 9	8	36,000	6,480	48,470	5.5%	356	2,666	20,794	1.5%	727	8,725
B1/B2	140	15	2	2 - 5	4.5	9,450	1,701	12,723	5.5%	94	700	5,458	1.5%	191	2,290
B1(1)	535	10	8	2 - 5	4.5	24,075	4,334	32,415	5.5%	238	1,783	13,906	1.5%	486	5,835
B2(2)	540	10	8	2 - 5	4.5	24,300	4,374	32,718	5.5%	241	1,799	14,036	1.5%	491	5,889
C1	560	6	7	4 - 7	6.5	21,840	3,931	29,405	5.5%	216	1,617	12,615	1.5%	441	5,293
C2	560	6	7	4 - 7	6.5	21,840	3,931	29,405	5.5%	216	1,617	12,615	1.5%	441	5,293
								185,137				79,424			33,325
							Injection Rate (gpm)	10							
							Injection Time (hours)	309							
							Injection Days (8.5 hour/day)	36							

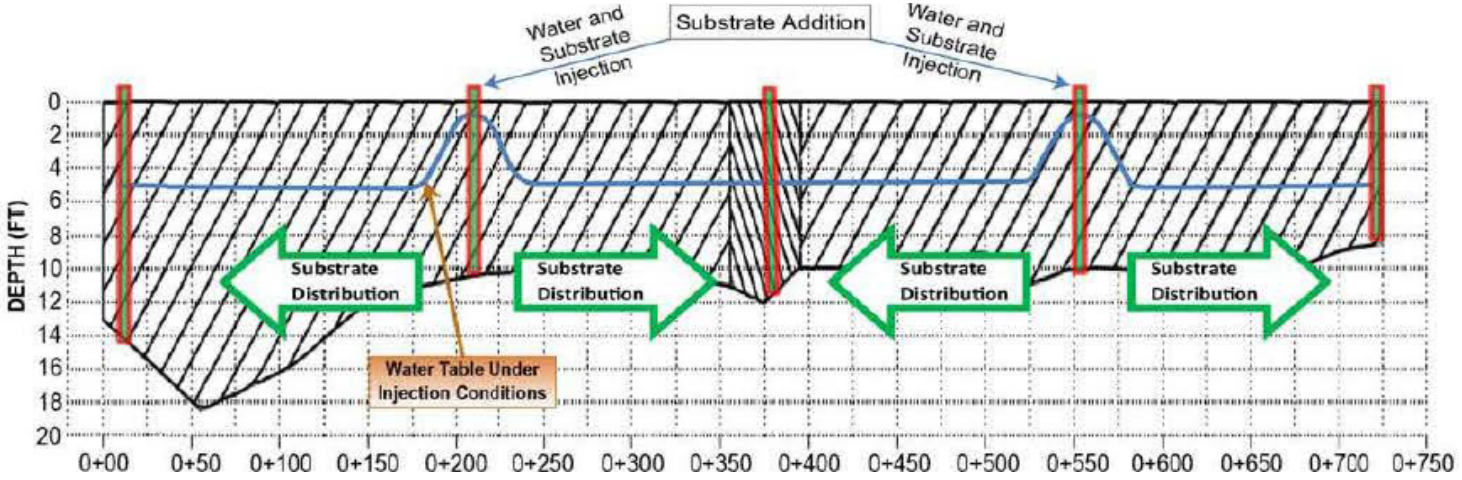
- PRB specific refresh volumes designed to replace 110% of calculated saturated pore volume
- Substrate and pH buffer calibrated to achieve and maintain pH neutral anoxic conditions

Seneca Ash Landfill Biowall Substrate Refresh

Refresh Step 1

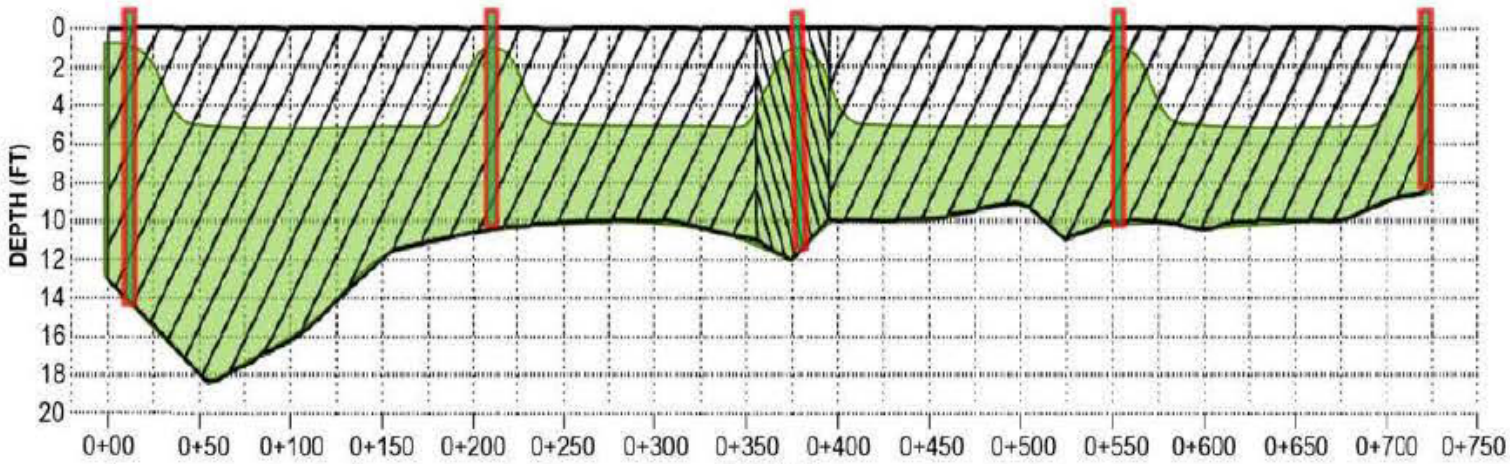


Refresh Step 2



Seneca Ash Landfill Biowall Substrate Refresh

Final refresh substrate distribution

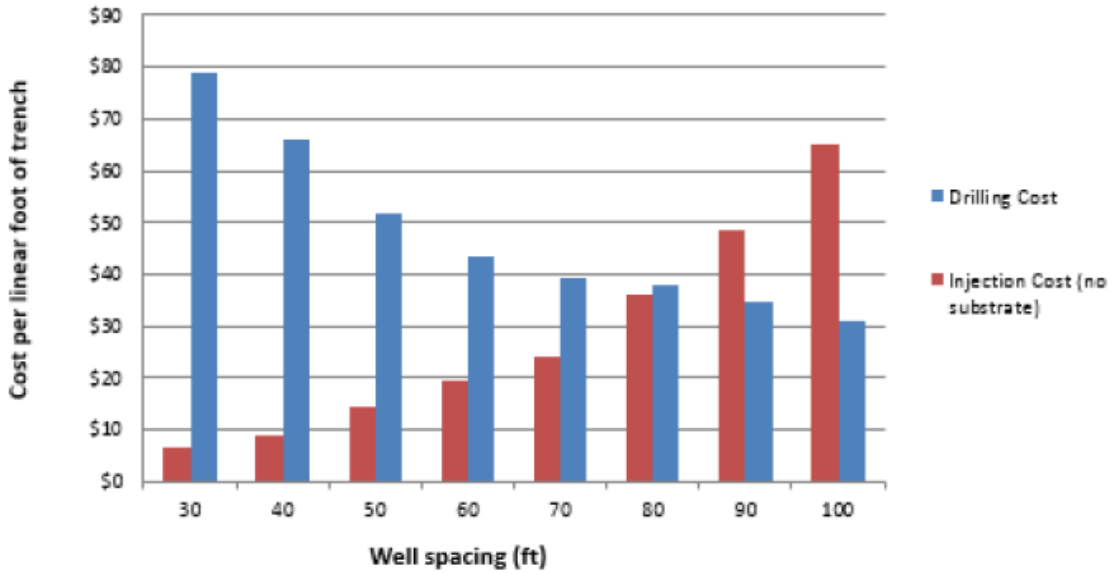


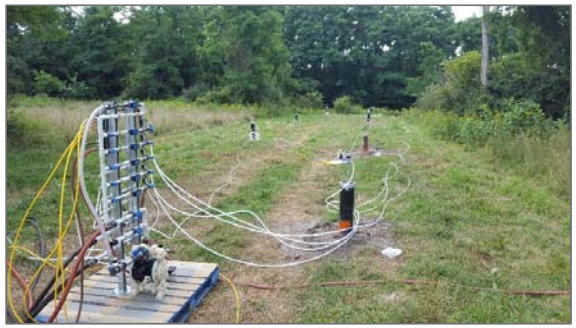
- Final substrate distribution refreshed carbon content throughout each PRB resulting in complete reactive zone spanning the plume
- Some substrate distributed laterally into surrounding soils

- Hydraulic mounding during refresh leaves additional substrate mass above the mean water table for use during high water

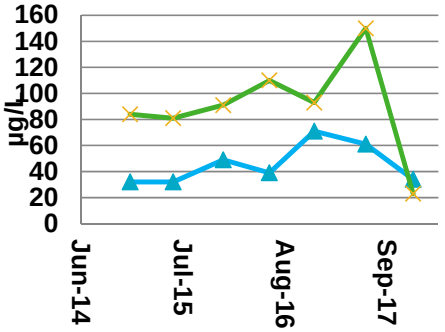
Seneca Ash Landfill Biowall Substrate Refresh

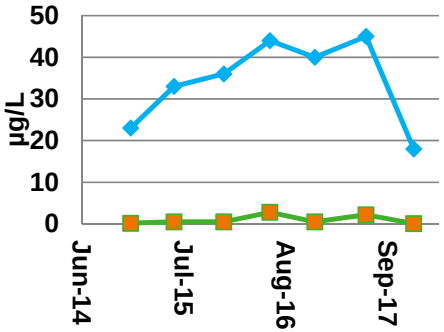
- Substrate refresh was optimized by balancing drilling costs against injection time
- Achievable injection location and biowall specific substrate distribution was considered
- Hydraulic mounding was minimized to prevent daylighting of substrate onto the ground surface

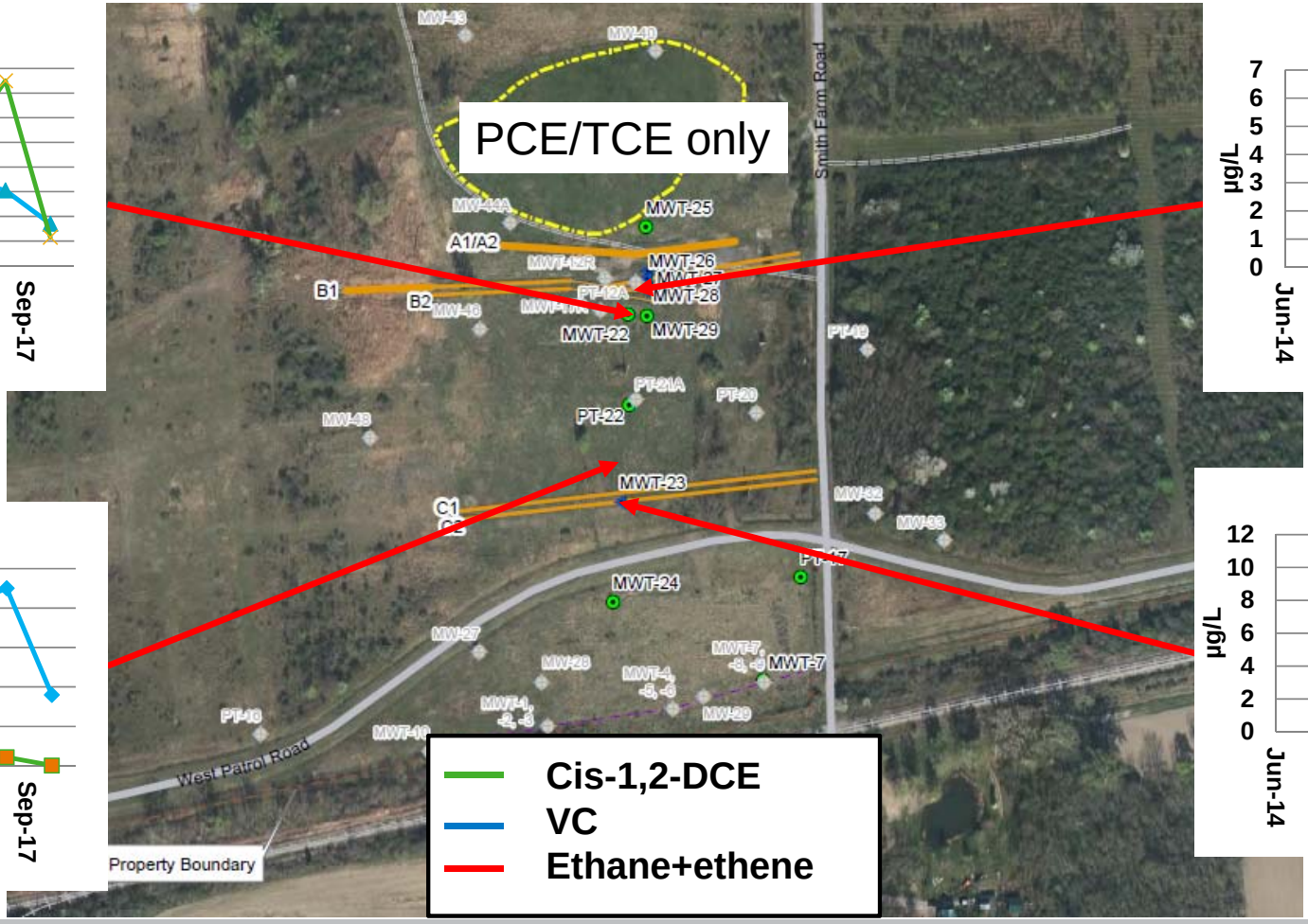


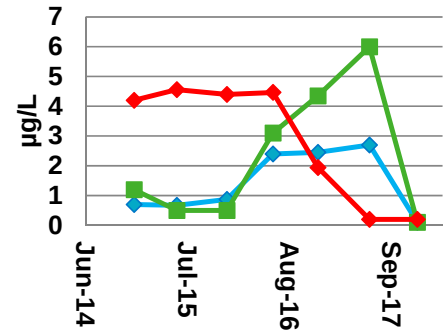


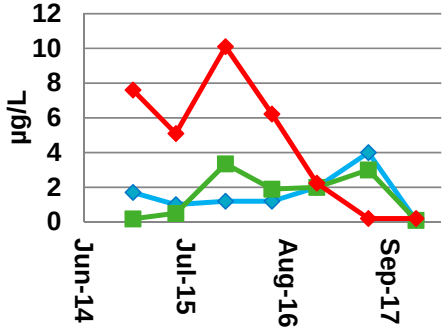
Seneca Ash Landfill Performance Data 3-Months Post Refresh (VOCs)



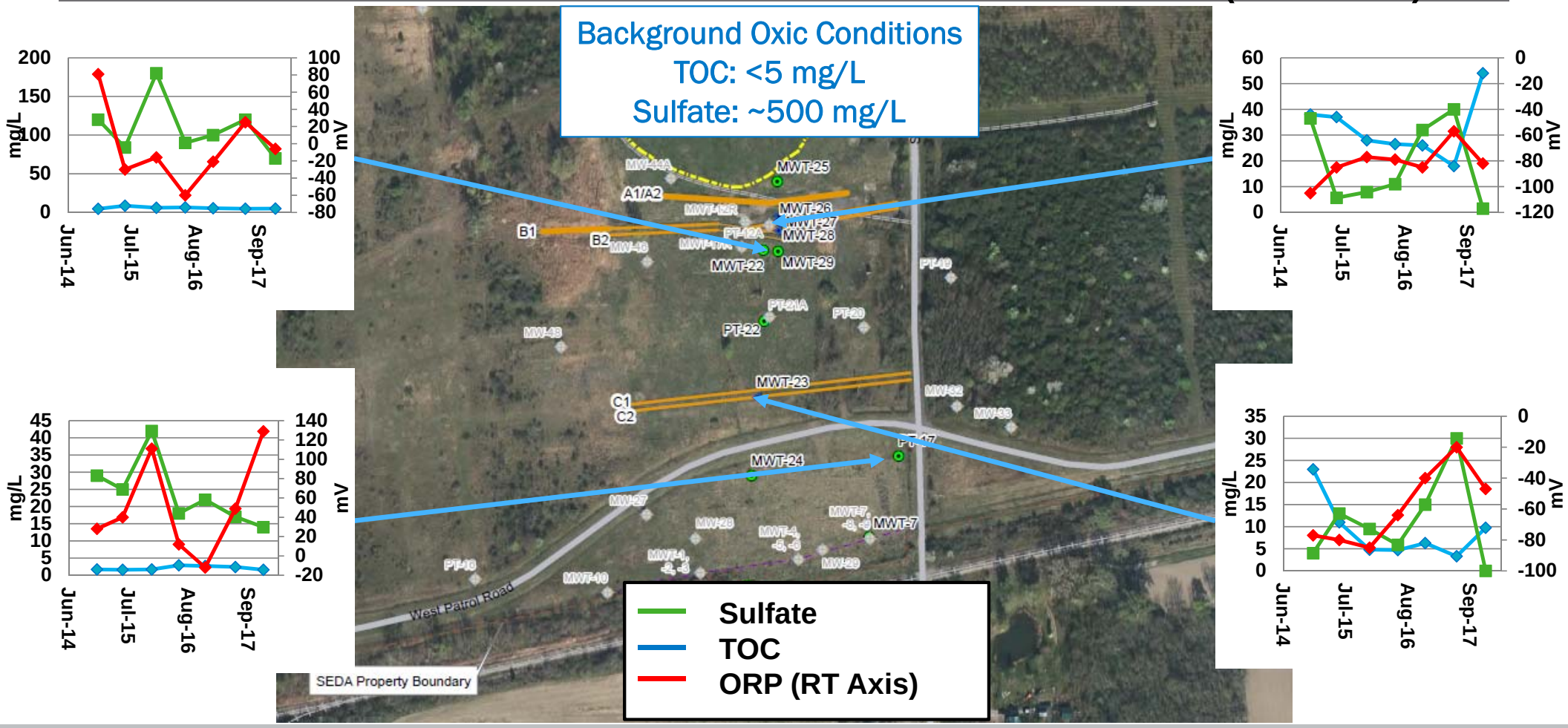








Seneca Ash Landfill Performance Data 3-Months Post Refresh (Geochem)



Summary and Conclusions

- The biowalls installed in 2006 performed well for 10+ years before refresh was needed
  - Anoxic pH neutral conditions were maintained in the biowalls over range of flow conditions
  - Complete dichlorination of incoming PCE/TCE mass through year 10
  - Plume was significantly reduced
  - Mass flux toward the property line and the safety net ZVI wall strongly reduced
- Evidence of depletion included:
  - Reversing geochemical trends
  - Re-appearance of parent compounds (PCE/TCE)
  - “Accumulation” of dichlorination intermediate products
  - Decline in ethene concentrations

Summary and Conclusions

- Biowalls were efficiently refreshed in 2017 using a mix of soybean oil and pH buffer emplaced through recirculation
  - Recirculation methods improved distribution within biowalls and reduced costs
  - Refresh injection wells left in place to reduce future refresh costs
- Biowall system performance has been re-established based on first round of performance data (3 months post refresh)
- Biowall system is expected to continue to perform for 6-8 years post-refresh

Acknowledgements

- United States Army Corps of Engineers – Huntsville District
- Former Seneca Army Depot
- United States Army Corps of Engineers – New York District

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