In Situ Thermal Hydrolysis of 1,2-Dichloroethane (EDC) in Fine-Grained Soil: Pilot Test

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Michael Singer/KNV

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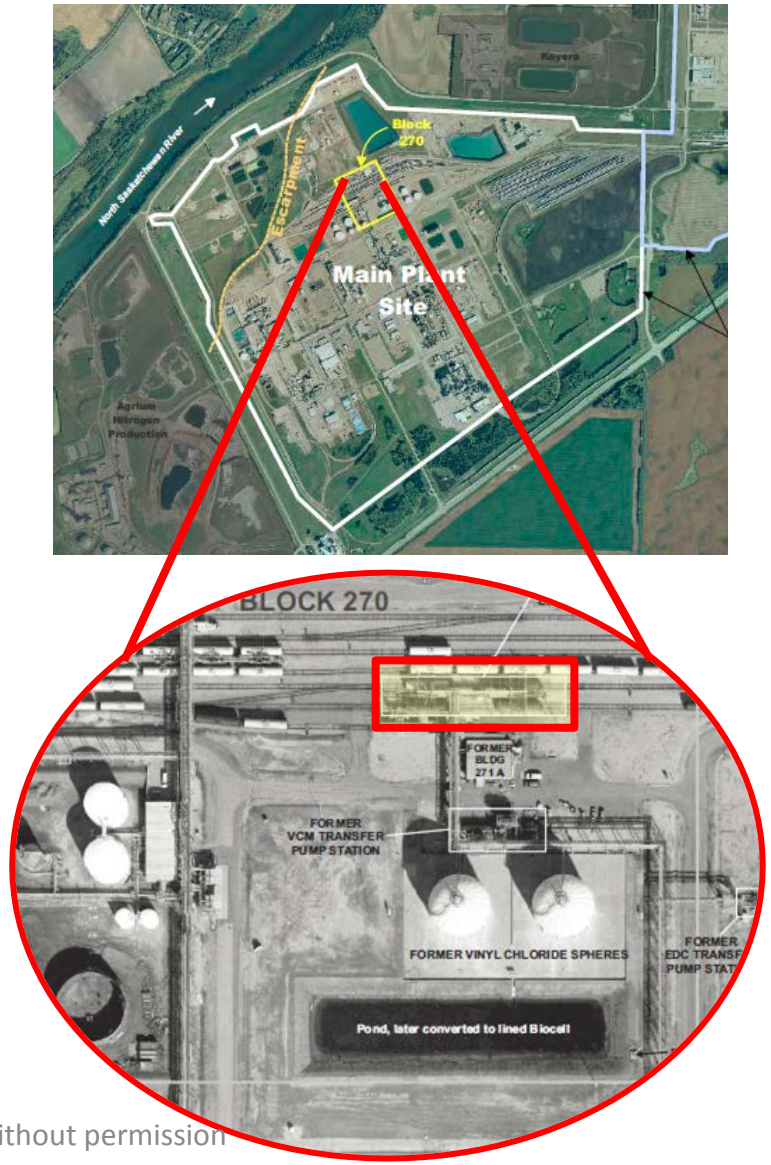
Agenda

- Site Background
- Hydrolysis of EDC
- Pilot Study Approach
- Heating History and Issues
- Sampling Results
- Summary and Conclusions

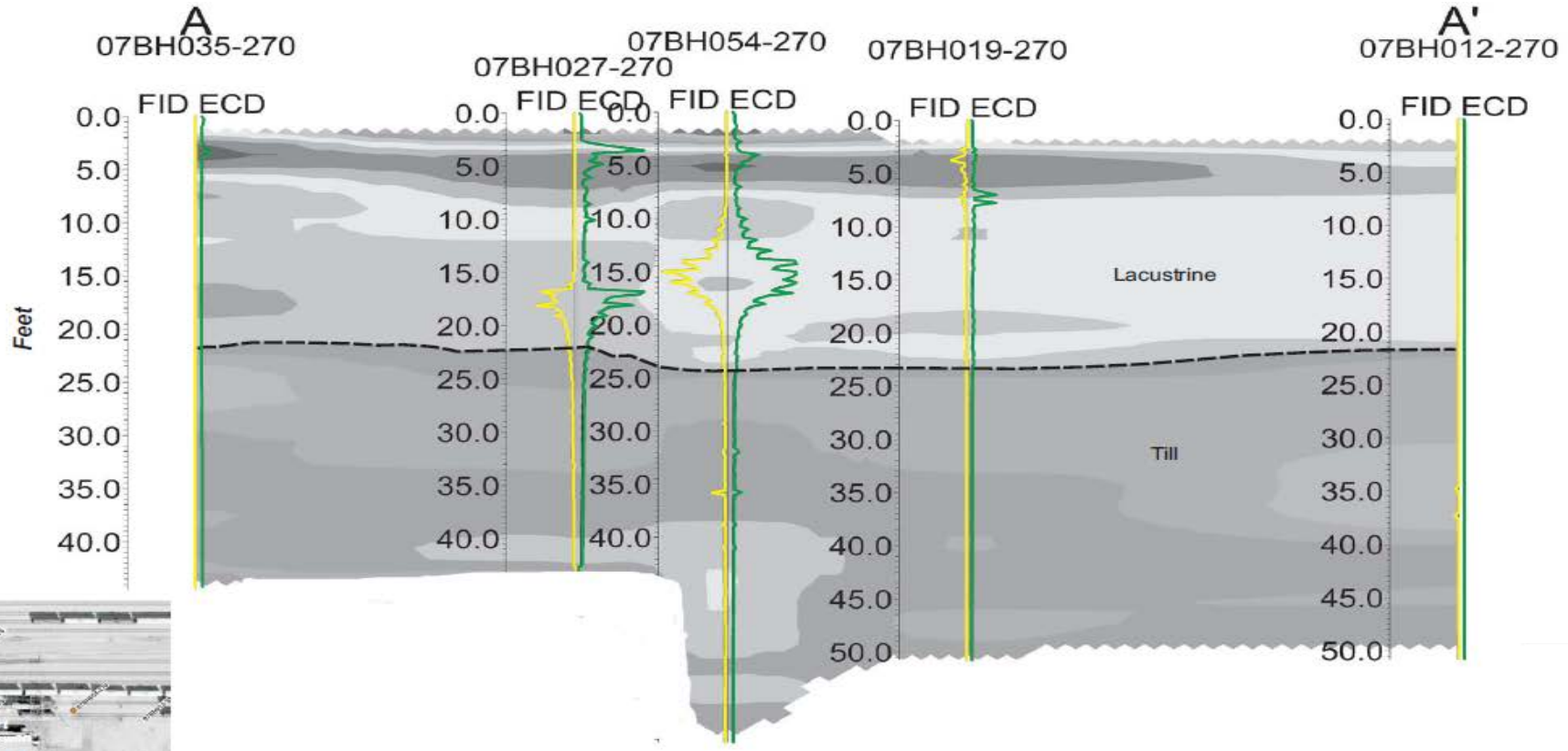
Site Background

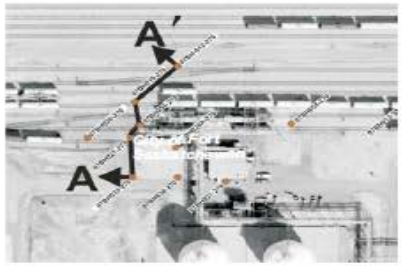
Why the need for the project

- Elevated EDC in soil and groundwater due to historical operations (former EDC product rail loading facilities)
- Limited Access – cannot disrupt operational rail lines

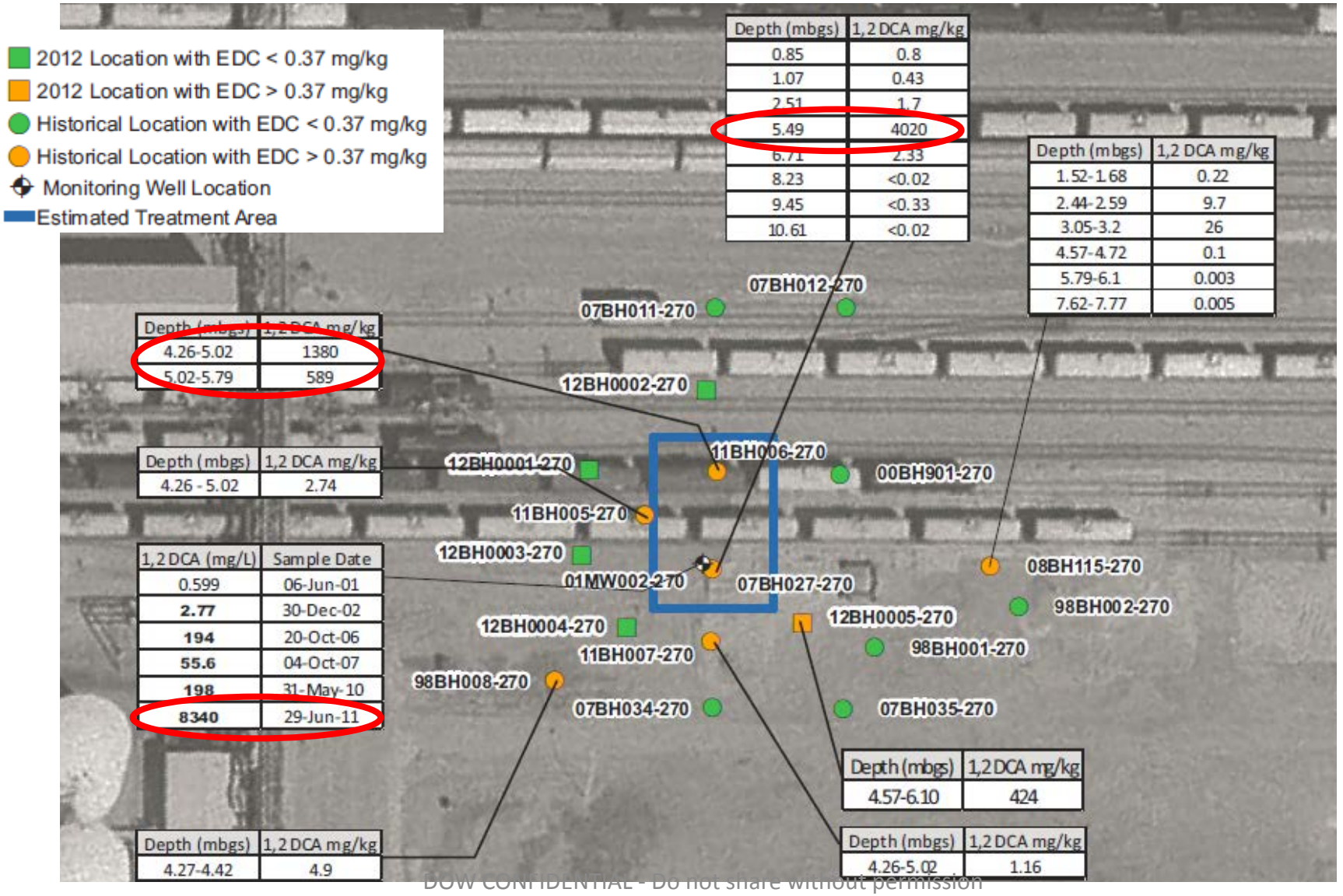


Site Geology





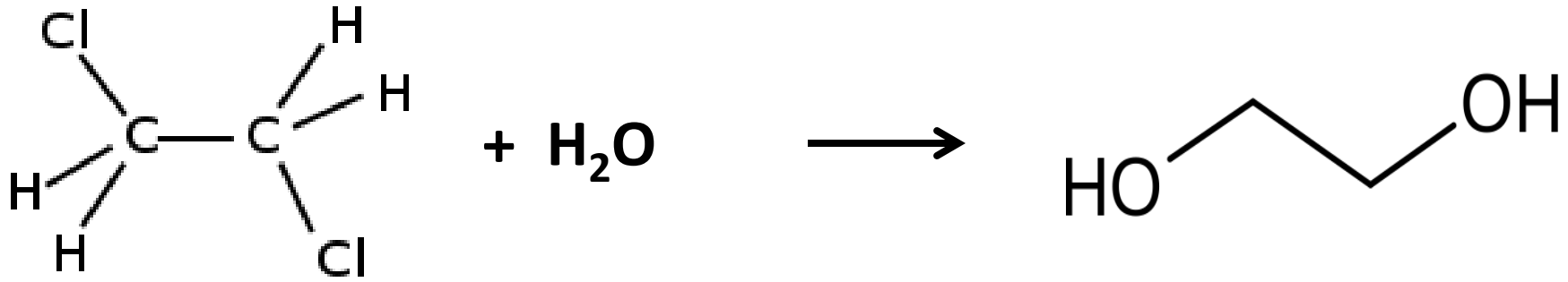
Extent of Contamination



Hydrolysis of 1,2-dichloroethane

EDC Transformation

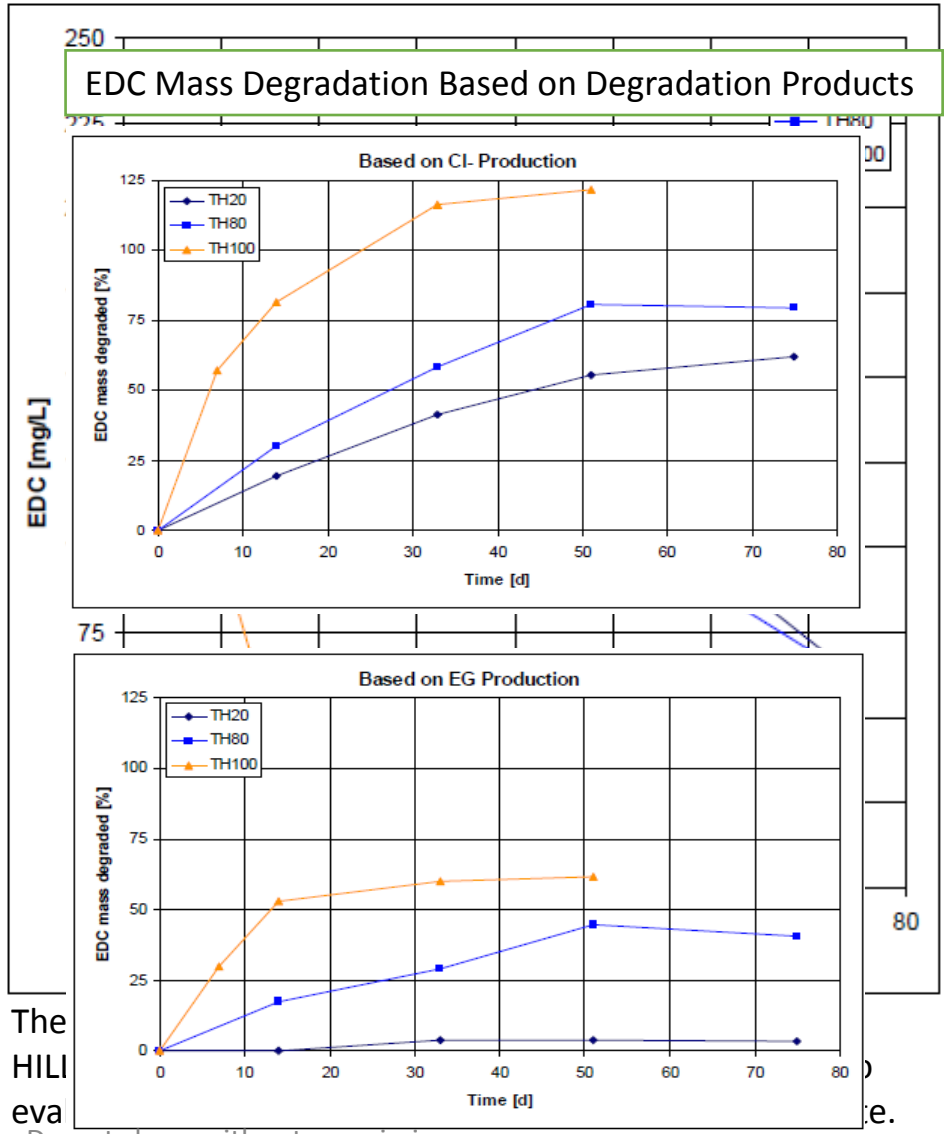
- Neutral Hydrolysis – reaction with water at neutral pH conditions
- EDC Hydrolysis
  - $C_2H_4Cl_2$ (EDC) + $2H_2O$ → $C_2H_6O_2$ (ethylene glycol) + $2H^+$ + $2Cl^-$
  - Abiotic production of ethylene glycol
  - Ethylene glycol is biodegradable
  - Temperature strongly accelerates hydrolysis rate



EDC **Ethylene Glycol**

Thermal Hydrolysis Lab Test

- 2008 Lab Study:
  - Site soil/groundwater
  - Closed batch reactors incubated at approx.:
    - 20°C
    - 80°C
    - 100°C
  - Monitored for EDC and abiotic degradation products (Cl^-, glycol)



Field Scale Pilot Test

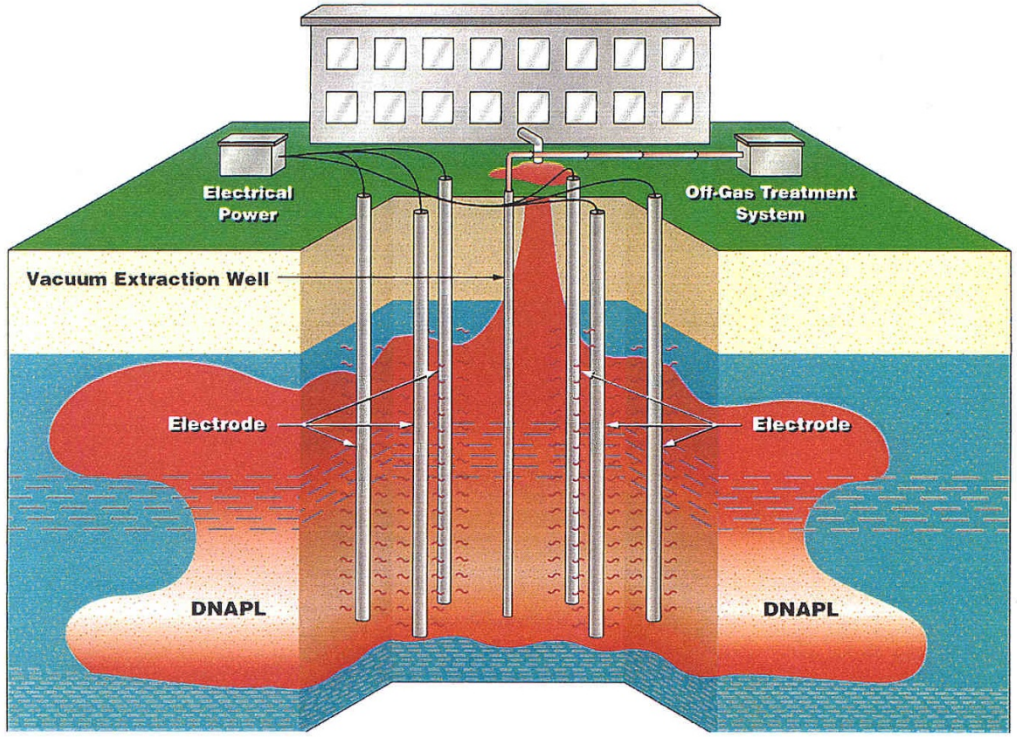
Field-scale Pilot Study

Pilot Objectives:

1. To reduce the concentration of EDC in soil at Block 270 Former Railcar Loading Area.
2. Develop a better understanding of the effectiveness and applicability of in situ thermal hydrolysis as a remedial technology for EDC
3. Provide operational data to help optimize the design and operation of future in situ thermal hydrolysis at other sites.
4. Target Concentrations: 500 mg/kg in soil

Electrical Resistance Heating

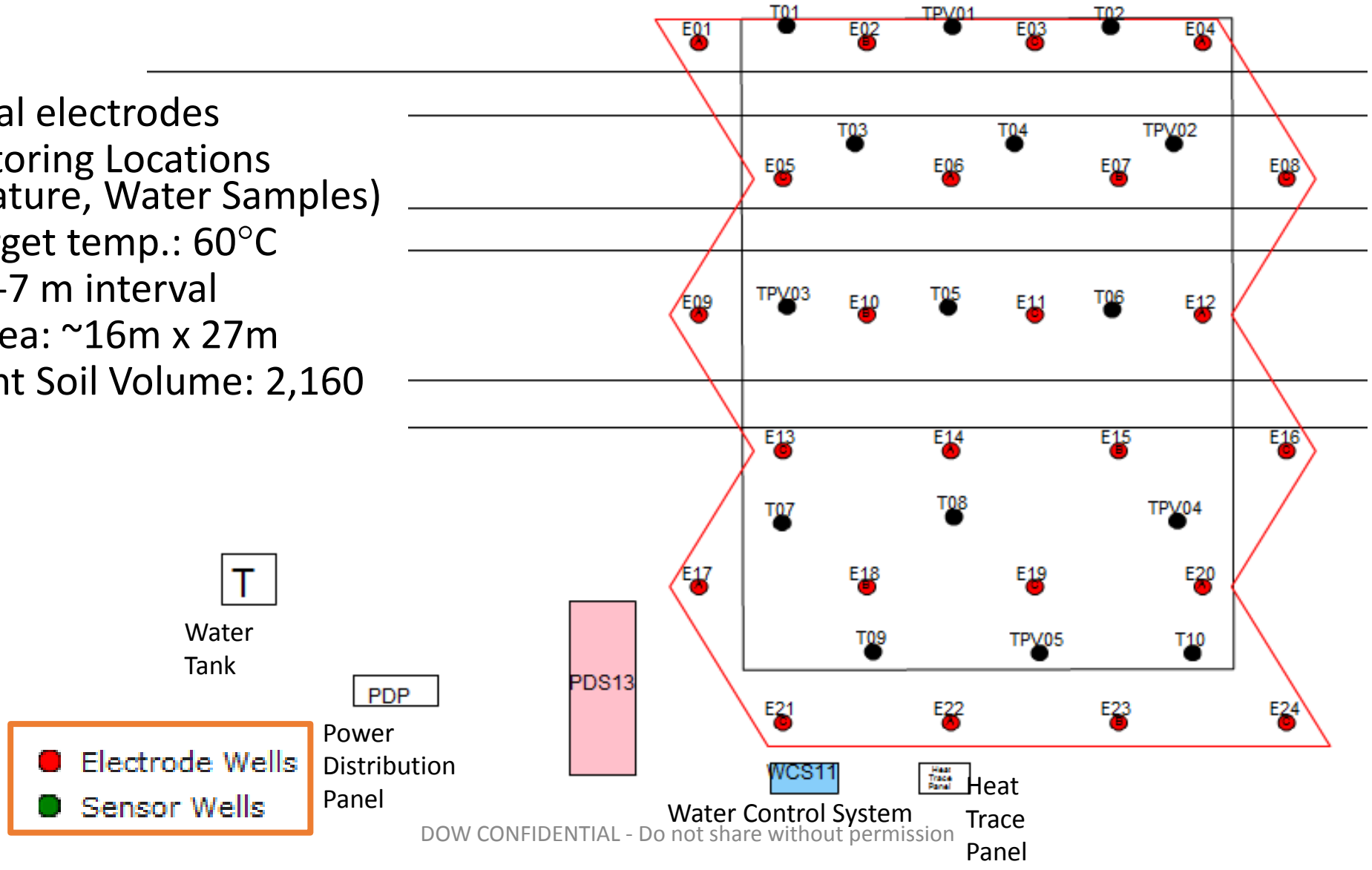
- Alternating current is applied to subsurface electrode arrays
- Electrical resistance of the soil generates heat
- ERH relies on water for electrical conductance
- SVE for contaminant recovery when needed
- Temperature limited to boiling point of water at local pressure



Typical energy applied – 200 to 300 kW-hrs/cy

Site Layout

- 24 vertical electrodes
- 15 Monitoring Locations (Temperature, Water Samples)
- Initial target temp.: 60°C
- Depth: 2-7 m interval
- Target area: ~16m x 27m
- Treatment Soil Volume: 2,160 m^3



Site Photos

Site Preparation

Electrode Connections

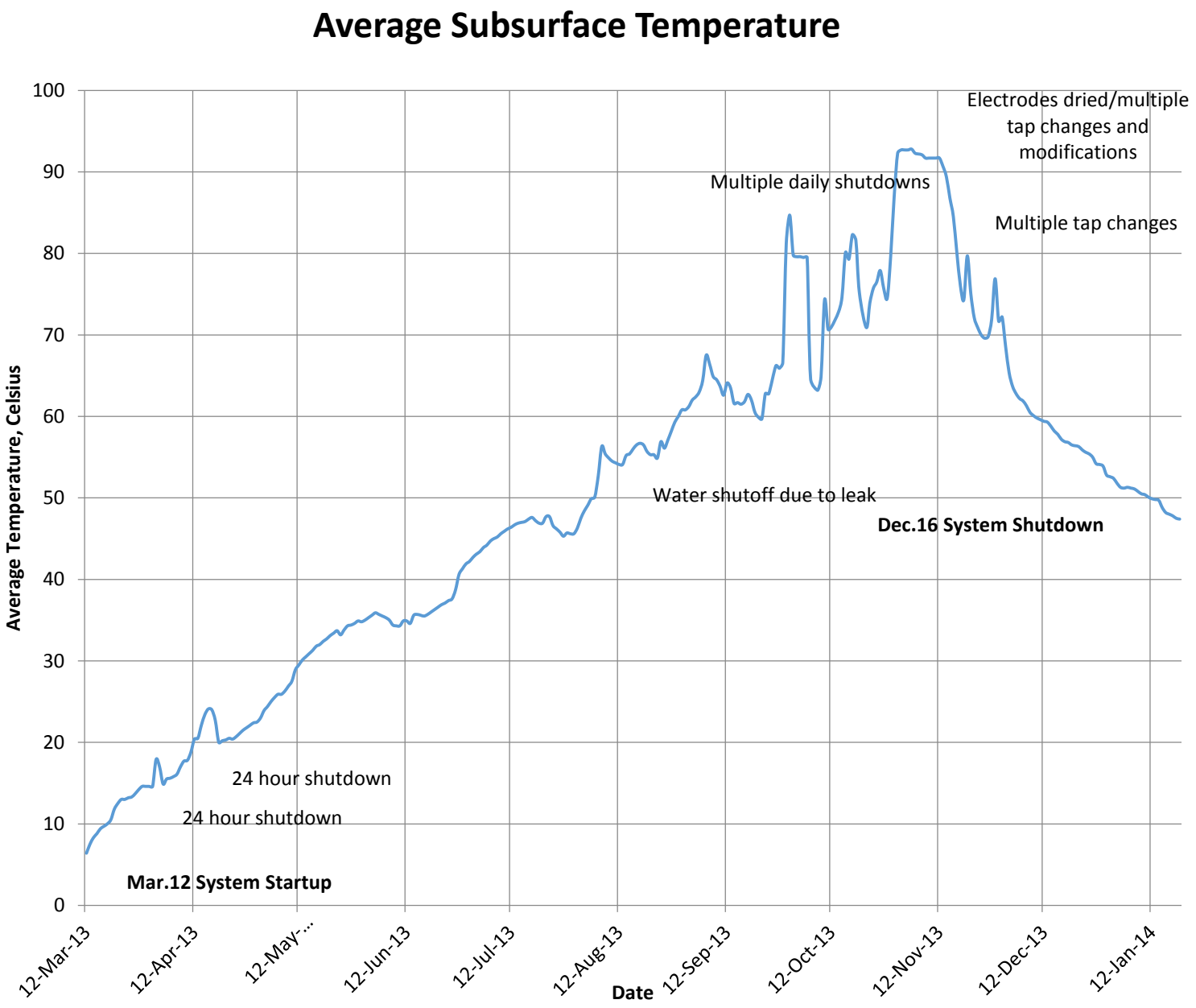
Monitoring Well

Site Looking Southwest

Heating History and Issues

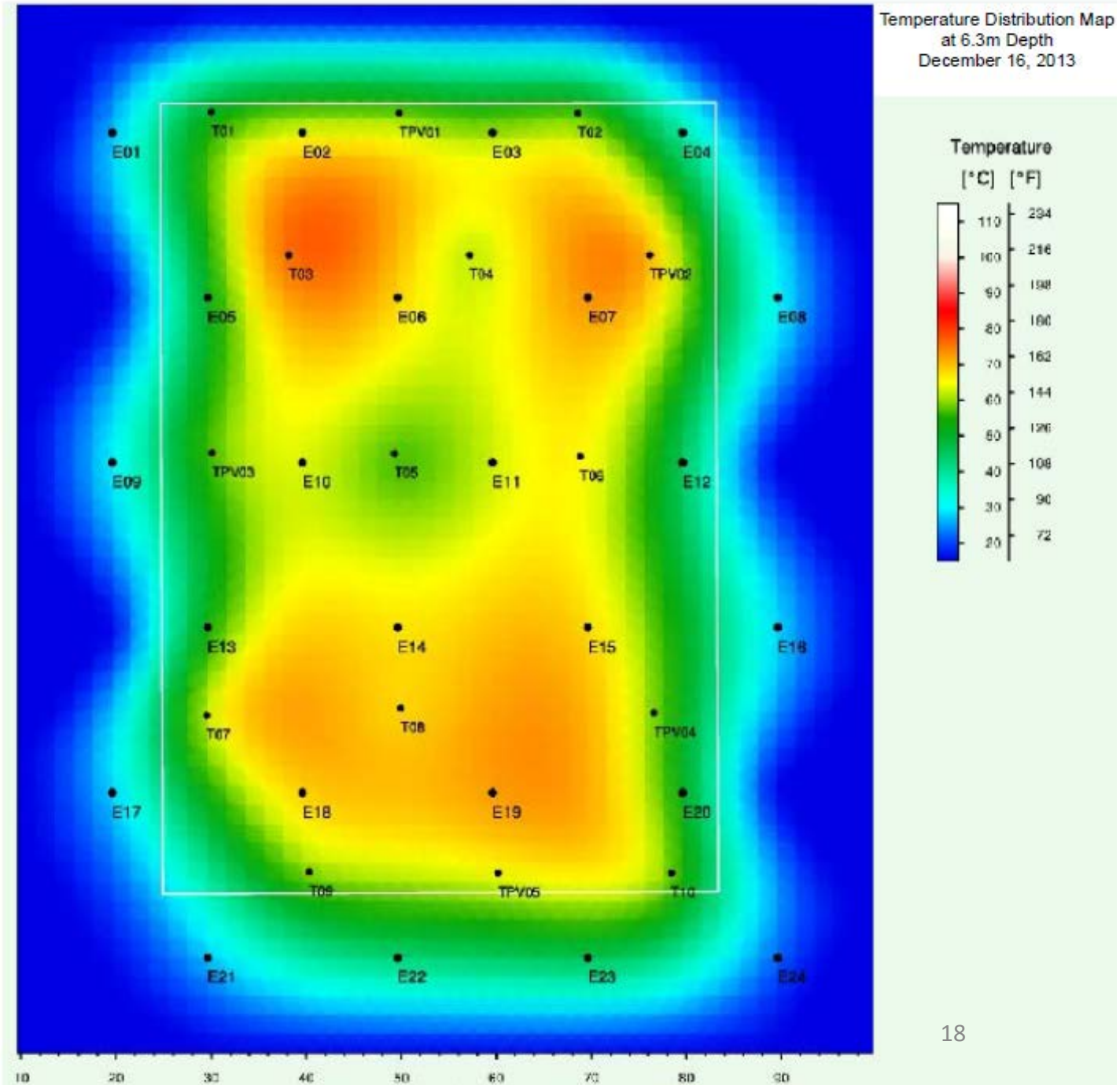
Unexpected Observations:

- Rapid response to system changes
- Area near center of site difficult to heat



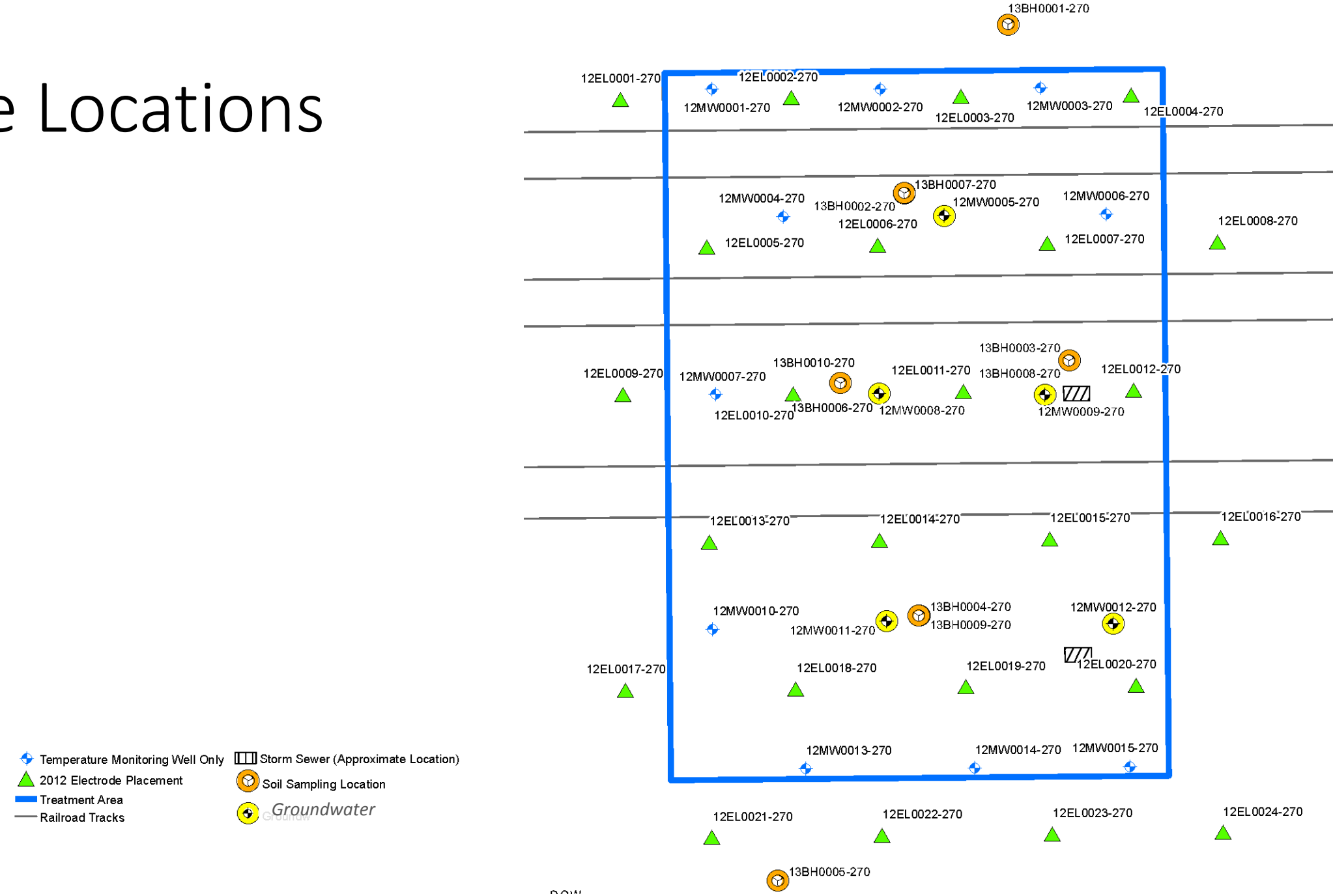
Soil Temperatures Varied in Pilot Test Area

- Differences in soil properties (EC)?
- Unknown source of water in area?



Sampling Results

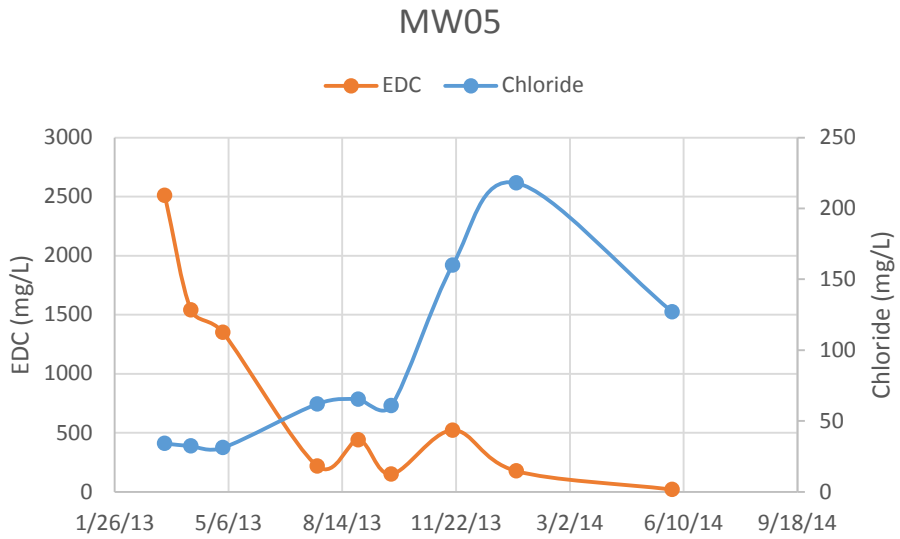
Sample Locations

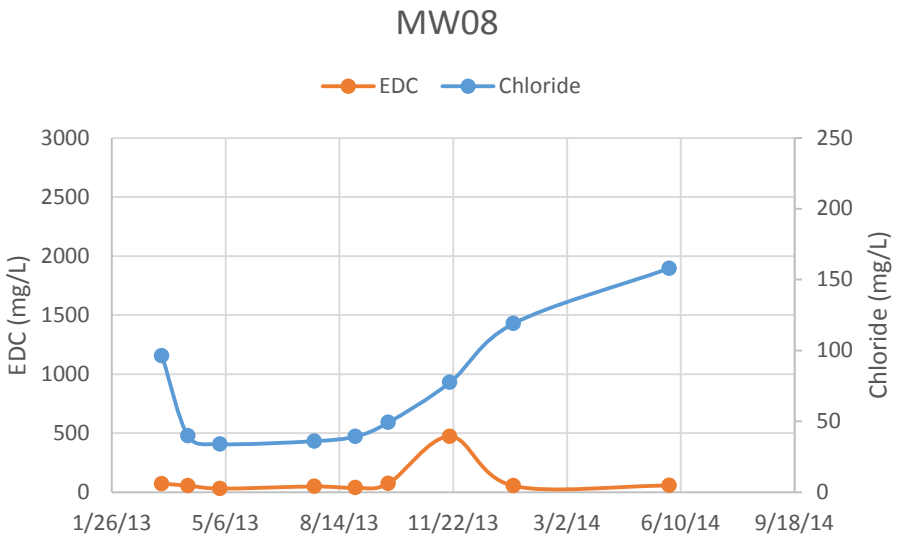


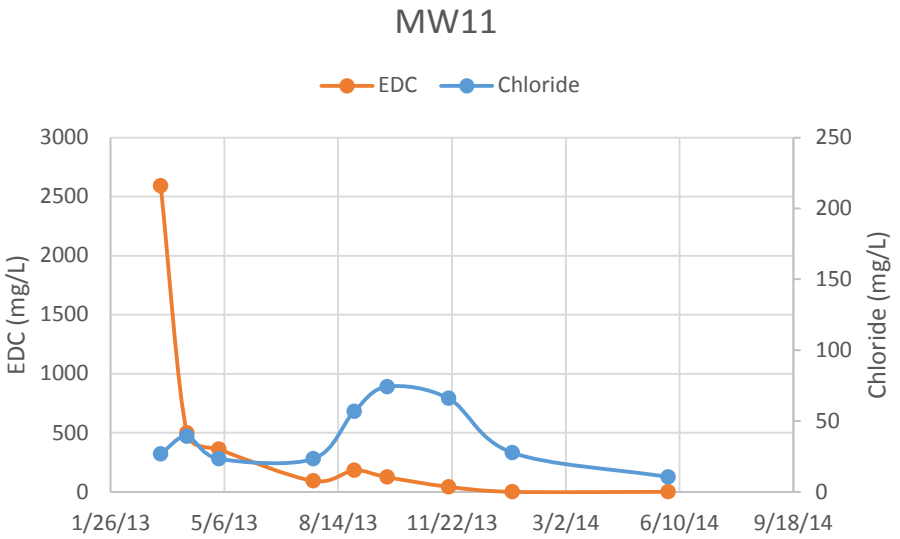
Groundwater Results - Summary

Location Name	Sample Date	EDC (mg/L)	Chloride (Cl) (mg/L)	% Reduction ([O-E]/E)
12MW0005-270	11-Mar-13	**2510**	**34.1**	
	31-May-14	**19.3**	**127**	-99%
12MW0008-270	11-Mar-13	**71.9**	**96.2**	
	31-May-14	**56.3**	**158**	-22%
12MW0009-270	28-Aug-13	**1540**	**298**	
	31-May-14	**10.5**	**62.5**	-99%
12MW0011-270	11-Mar-13	**2590**	**26.8**	
	31-May-14	**0.0958**	**10.5**	-100%
12MW0012-270	28-Aug-13	**153**	**108**	
	31-May-14	**23**	**192**	-85%

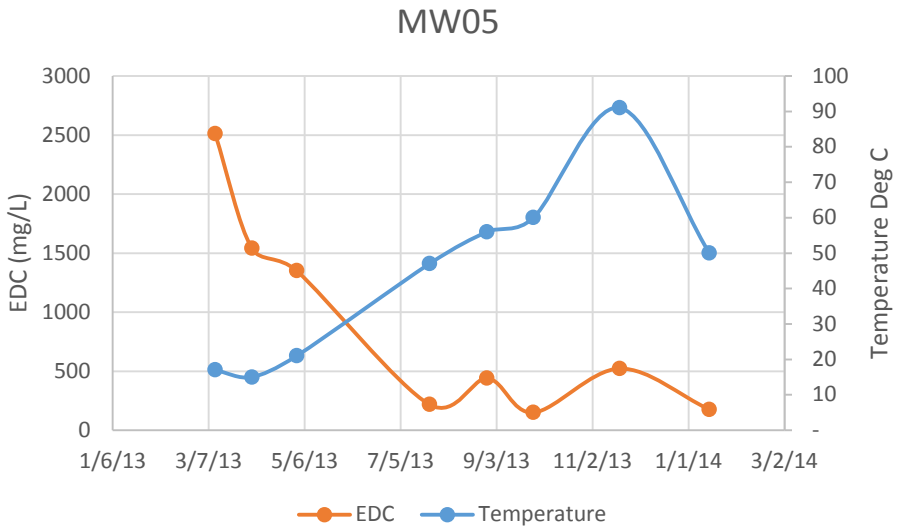
EDC vs. Chloride

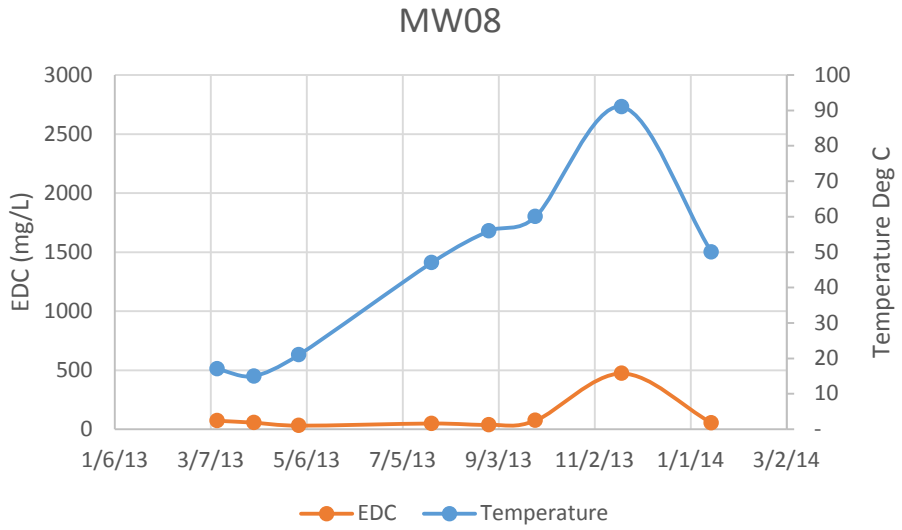


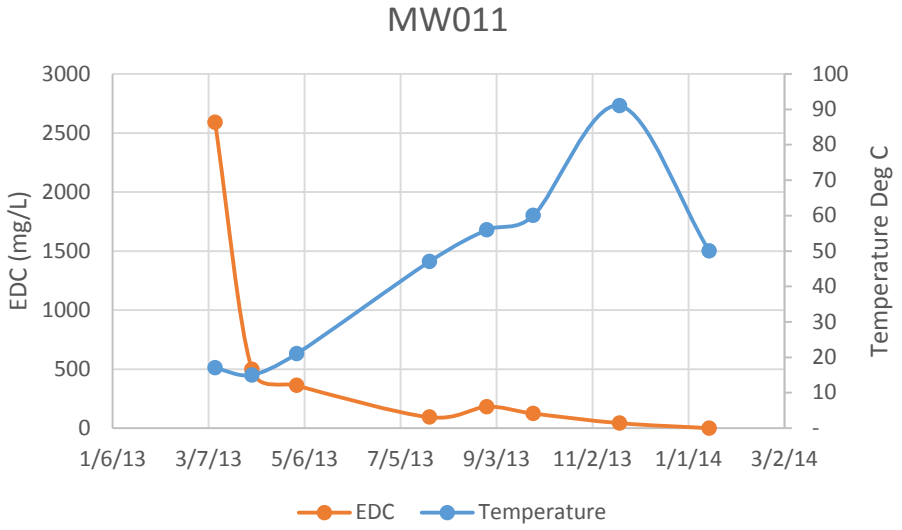




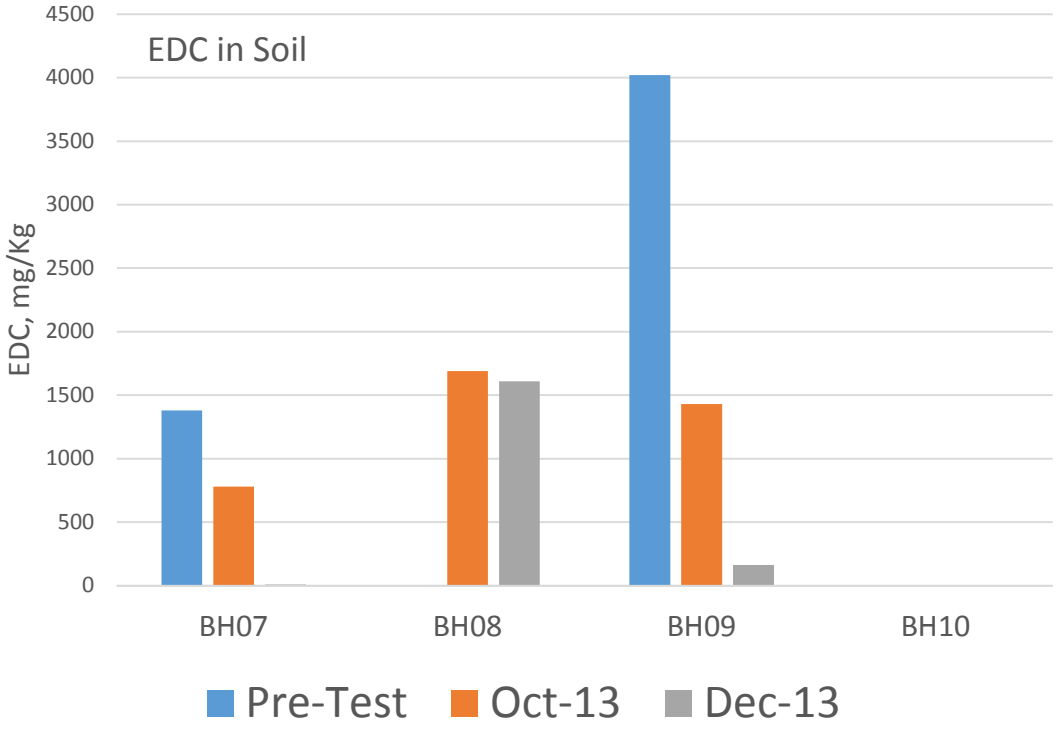
EDC Vs. Temperature

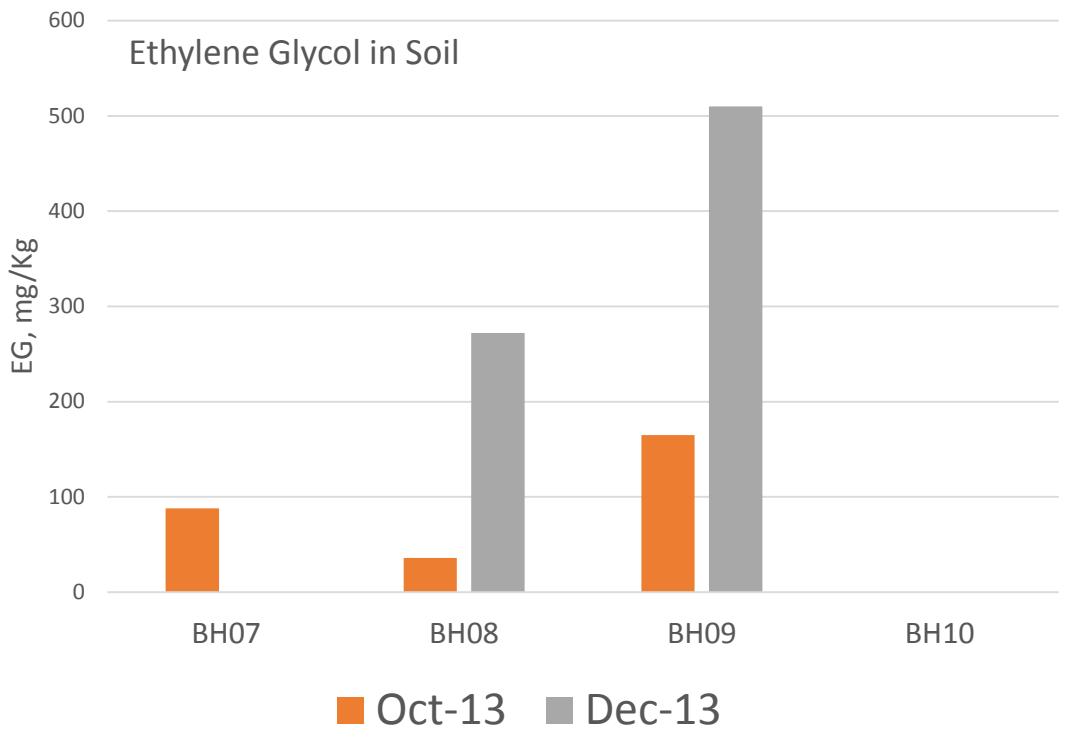






Soil Results





Summary and Conclusions

Summary and Conclusions

- EDC Reduced in soil and groundwater (pilot test objectives met)
- Indications that hydrolysis occurred
- Some reductions may be result of other factors (volatilization?)
- Uneven soil heating was a problem
- Final soil and groundwater sampling underway this week
- Wells are being slug tested to evaluated differences in hydraulic K across the site

Factors affecting choice of in situ hydrolysis

- Only appropriate for chemicals that hydrolyze at relatively low temperatures (for example, EDC, 1,1,1-TCA)
- Site hydrogeology (low groundwater flow velocities helpful in achieving target temperatures)
- Site factors, such as access restrictions or presence of structures, that might preclude other approaches, such as soil mixing
- Availability and cost of energy
- Local infrastructure, especially occupied buildings

EDC, Chloride, and Ethylene Glycol