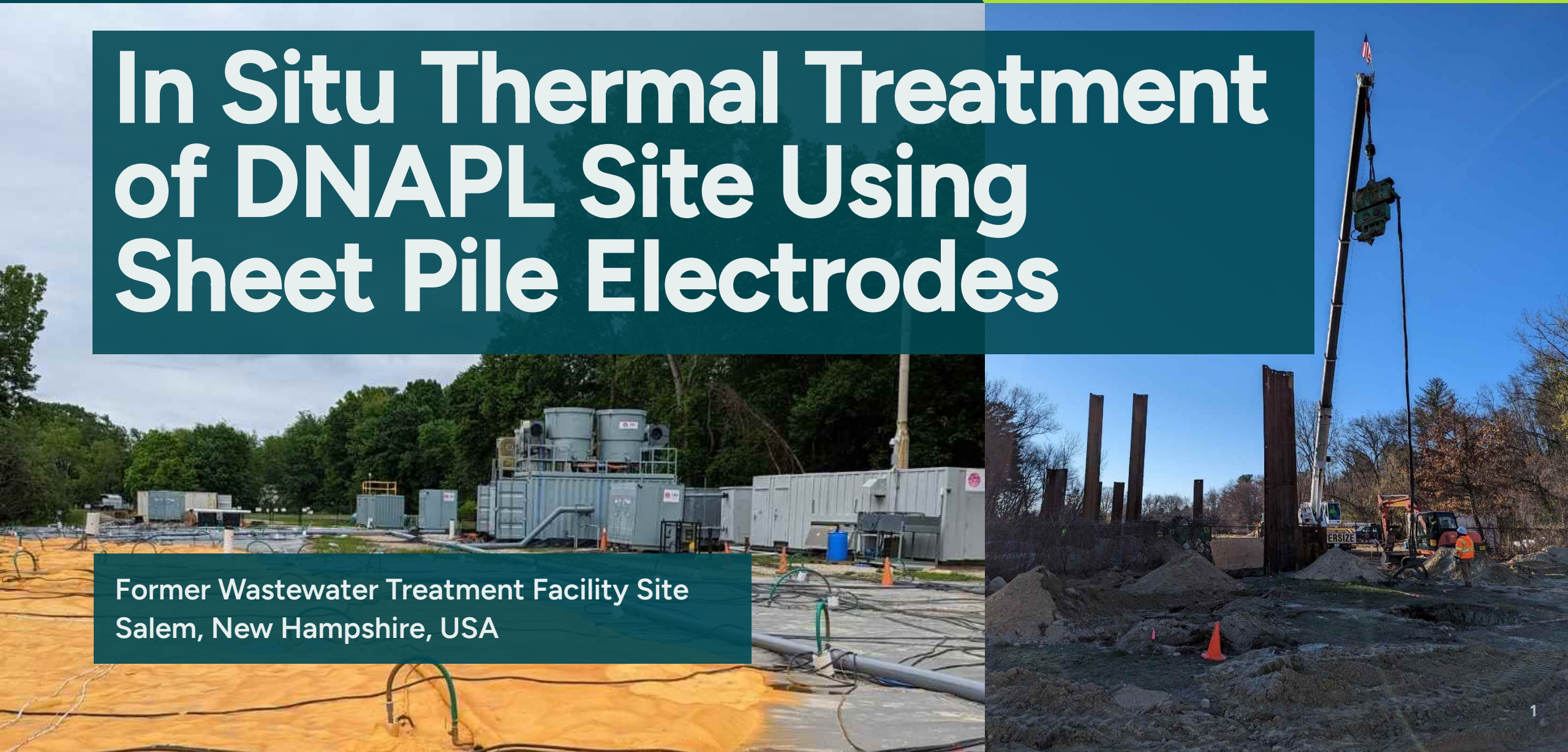
verdantas TRS Group

Wednesday, June 5, 2024

# In Situ Thermal Treatment of DNAPL Site Using Sheet Pile Electrodes



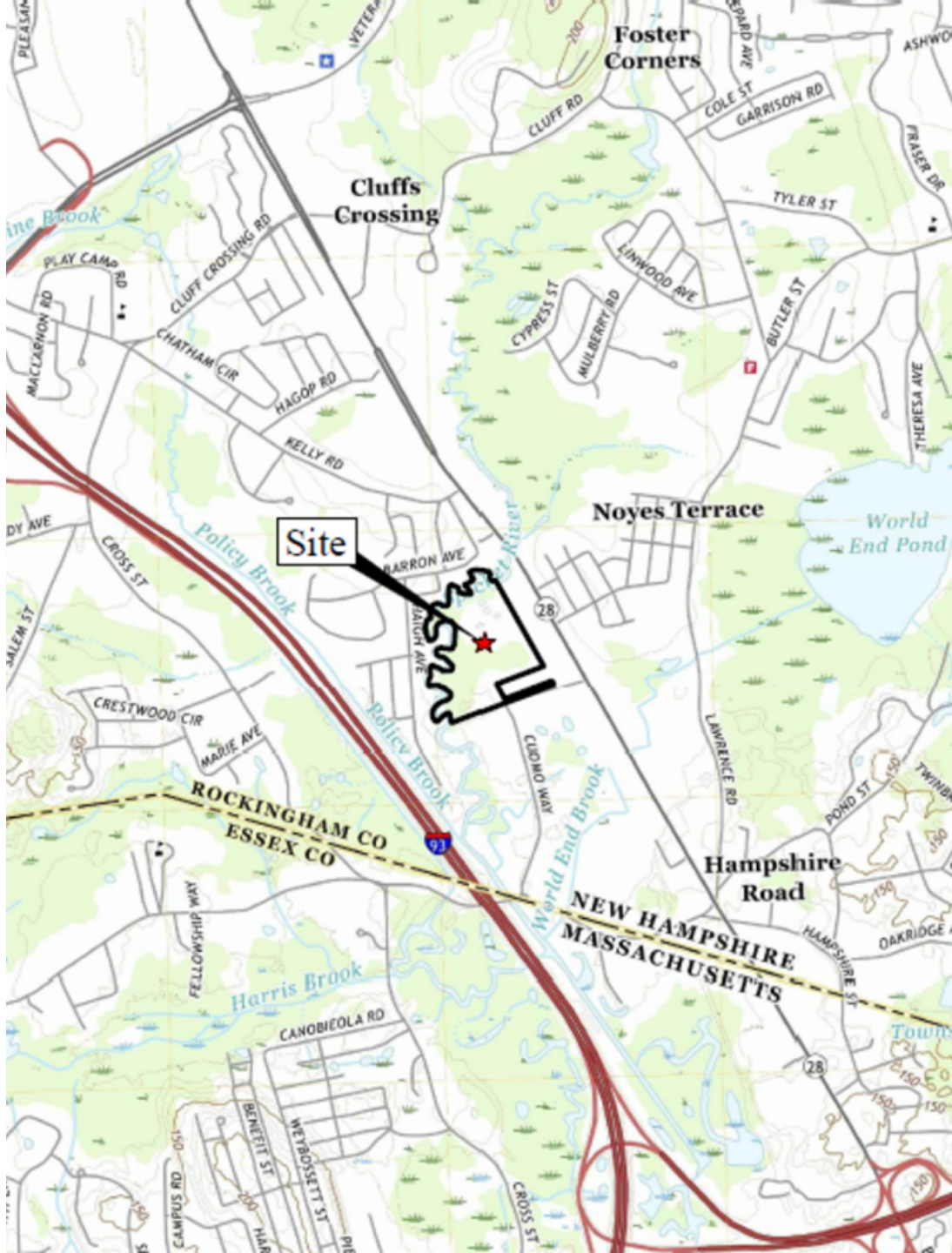
Former Wastewater Treatment Facility Site
Salem, New Hampshire, USA

# Organizational Chart – Project Team

346 SOUTH BROADWAY (AKA SARL DRIVE), SALEM, NH

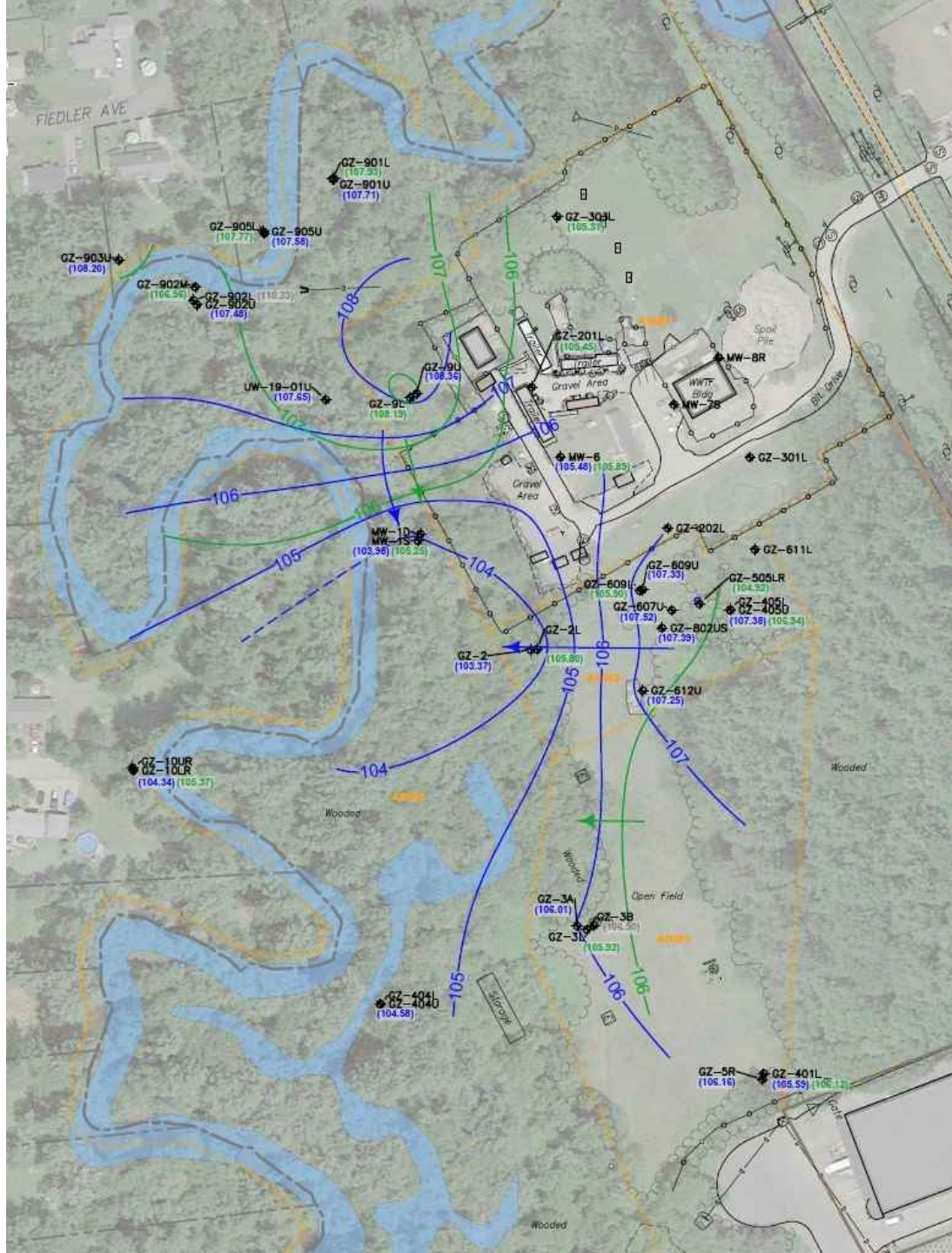
# Former Wastewater Treatment Facility

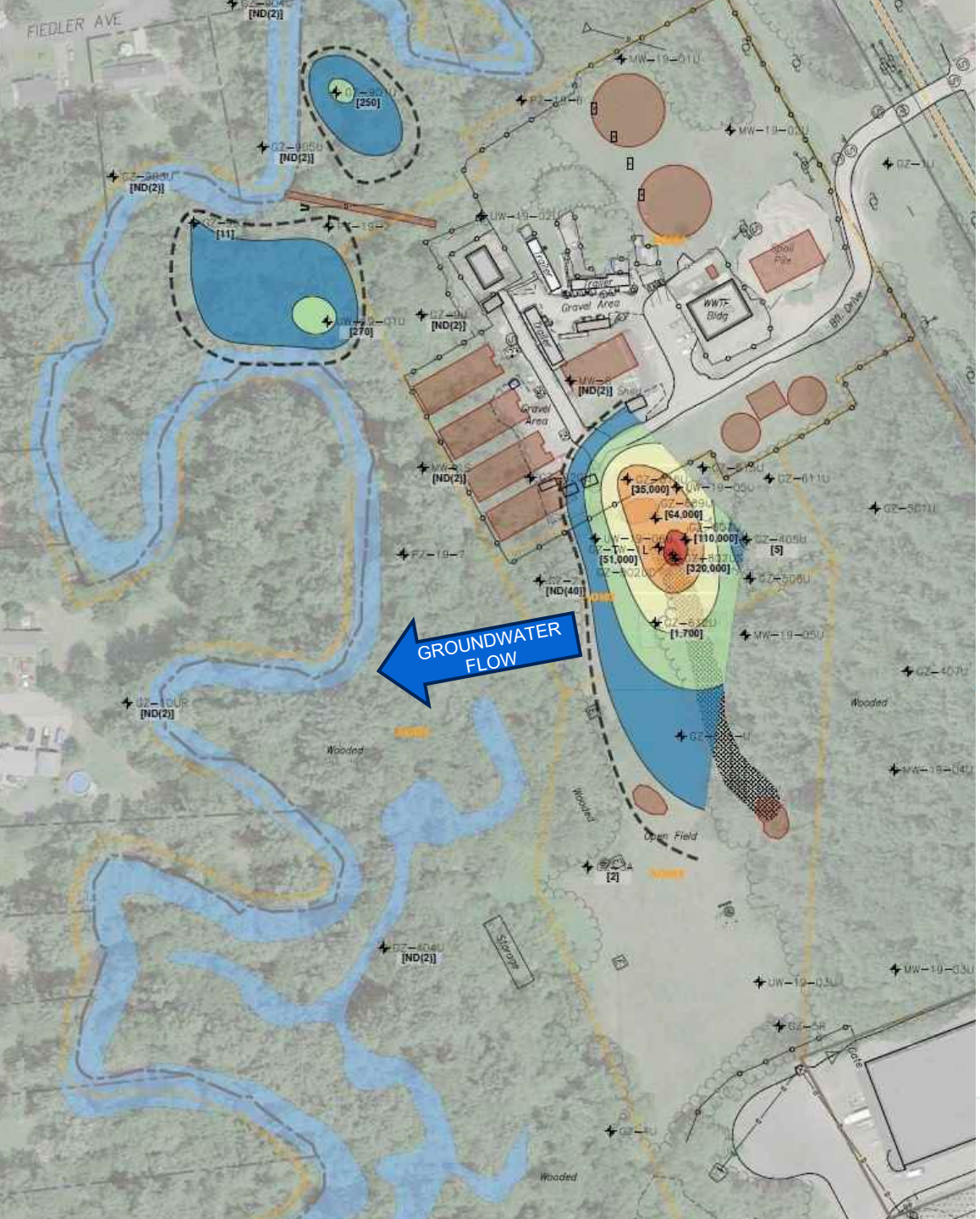
- 32-acre property in busy commercial area
- Active WWTF 1964-1986
- CVOC/DNAPL; PFAS in groundwater and soil
- History of assessment and remediation
- Last WWTF structure removed in 2021
- Remediation for future redevelopment



# Geologic and Hydrogeologic Setting

- Multiple overburden geologic units
  - Upper Sand Unit (USU)
  - Silty Clay Unit (SCU)
  - Lower Sand Unit (LSU)
  - Dense glacial till
- Two primary overburden aquifers: USU & LSU
- Groundwater depth from 3 to 9 feet bgs
- Flat topography with shallow flow gradient
- Overall westerly groundwater flow



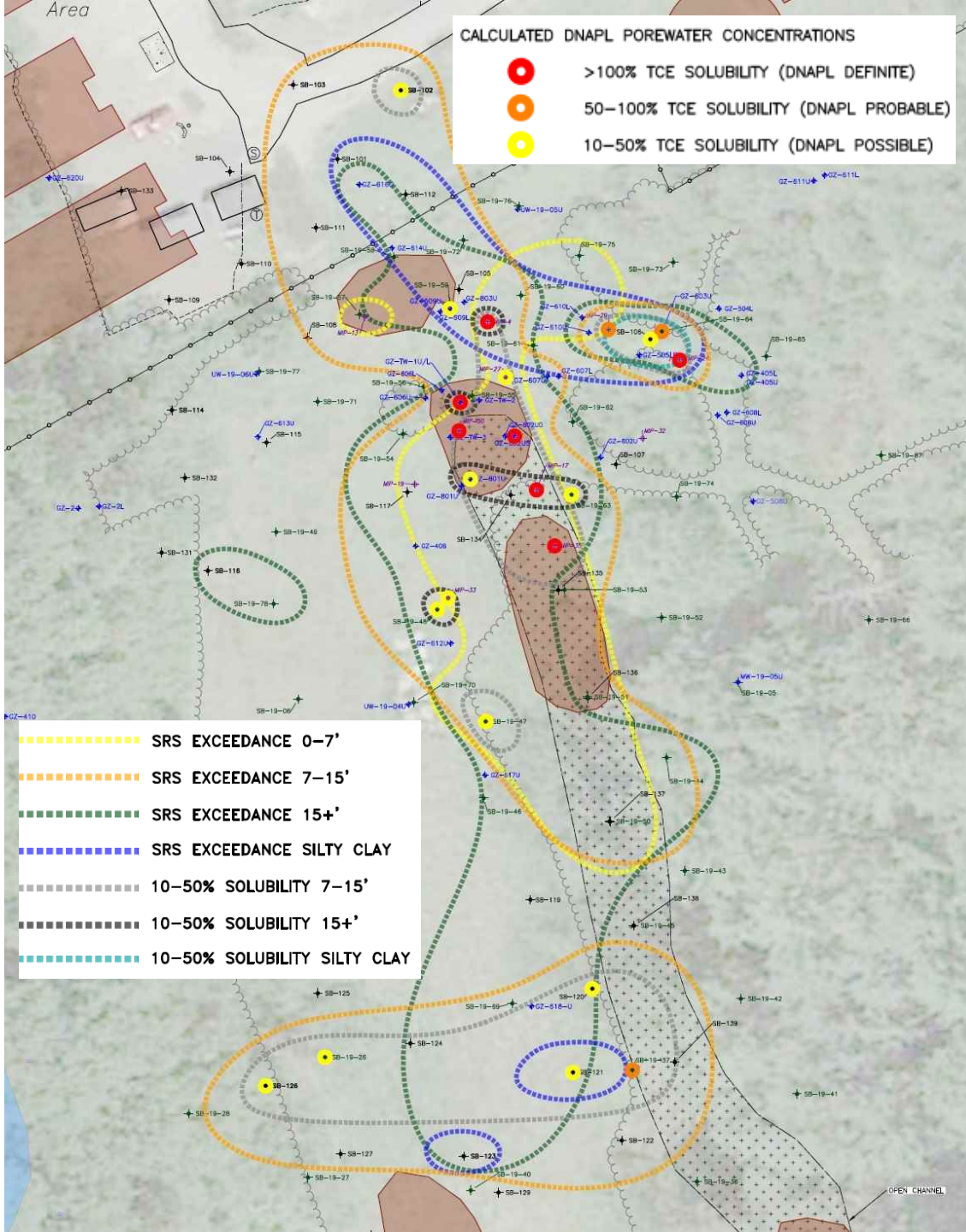



# CVOCs in Groundwater

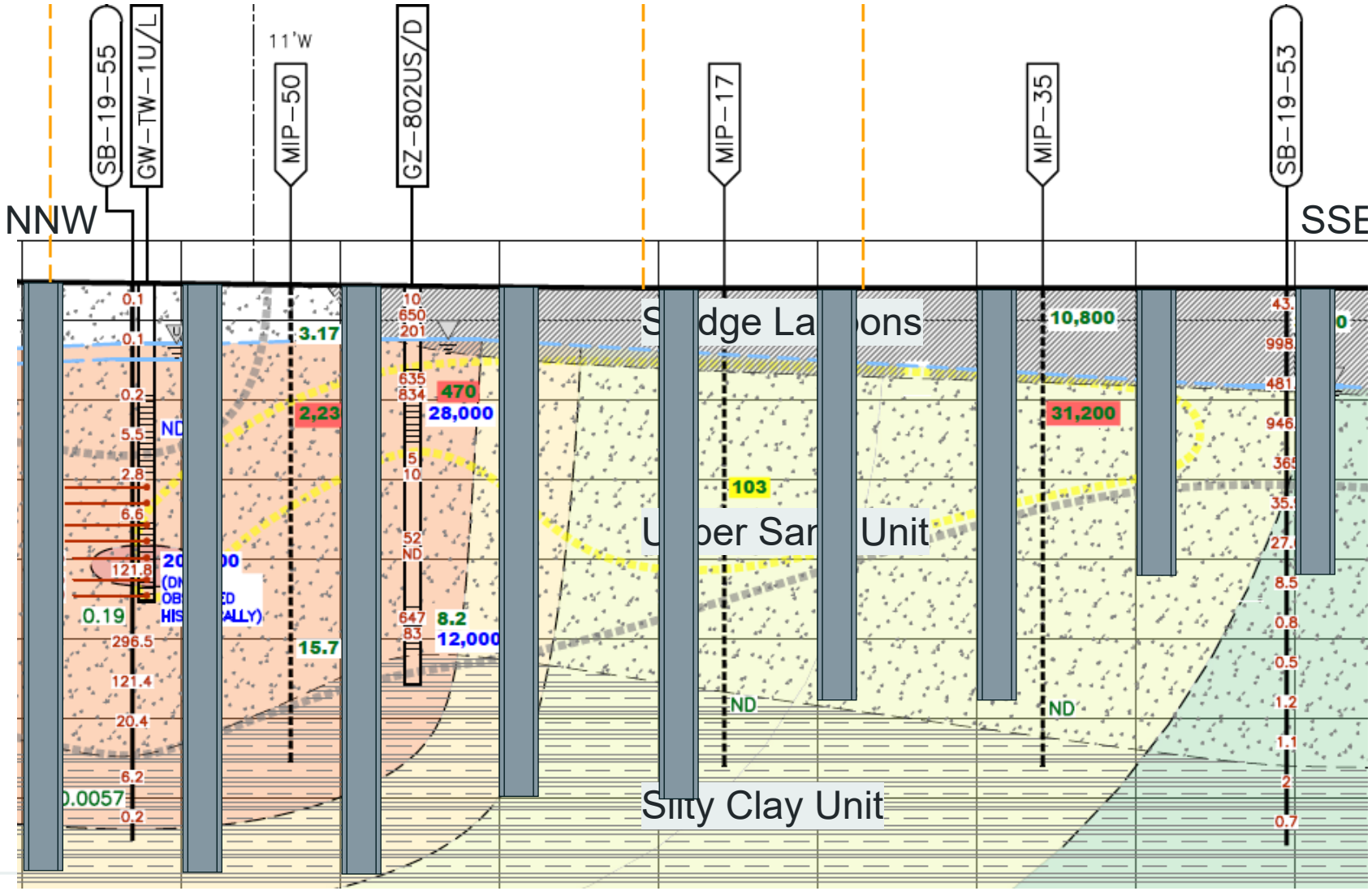
- Primary constituents of concern
  - TCE, PCE, c-DCE, VC, TCA
- DNAPL in site monitoring wells
- Maximum TCE in soil 32,100 mg/kg
- Maximum TCE in groundwater >500,000 µg/L
- DNAPL vertical migration limited by confining layer

# Pre-Remedial Investigation

- Inferred CVOC source associated with historical sludge lagoons
- Historical and recent investigation data
- Data gap investigation 2022
- Delineation of CVOCs > NH Soil Remediation Standards (SRS)
- DNAPL distribution modeled on TCE porewater concentrations



# Geologic X-Section: Investigation Data




CALCULATED DNAPL POREWATER CONCENTRATIONS

- >100% TCE SOLUBILITY (DNAPL DEFINITE)
- 50–100% TCE SOLUBILITY (DNAPL PROBABLE)
- 10–50% TCE SOLUBILITY (DNAPL POSSIBLE)

- APPROXIMATE EXTENT OF SRS EXCEEDENCE FOR TCE
- APPROXIMATE EXTENT OF POREWATER TCE CONCENTRATION GREATER THAN 10% TCE SOLUBILITY LIMIT

TCE (ug/L)

- 100,000
- 10,000
- 1,000
- 100
- 10

# Selection of Remedial Alternative

Site Objectives

- Complete active remediation < 5 yr
- Minimal restrictions for reuse
- Reduced post-remediation monitoring

Technology Screening

- Excavation and treatment/disposal
- In situ chemical oxidation (ISCO)
- In situ thermal remediation (ISTR)

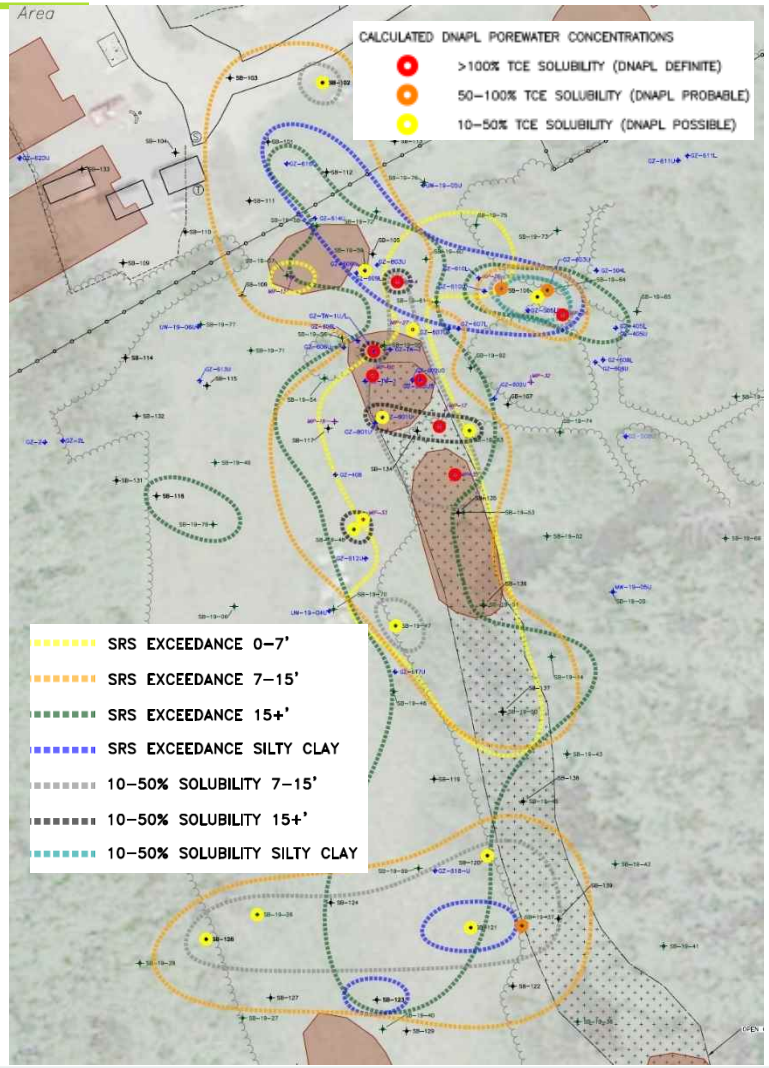
ISTR selected based upon

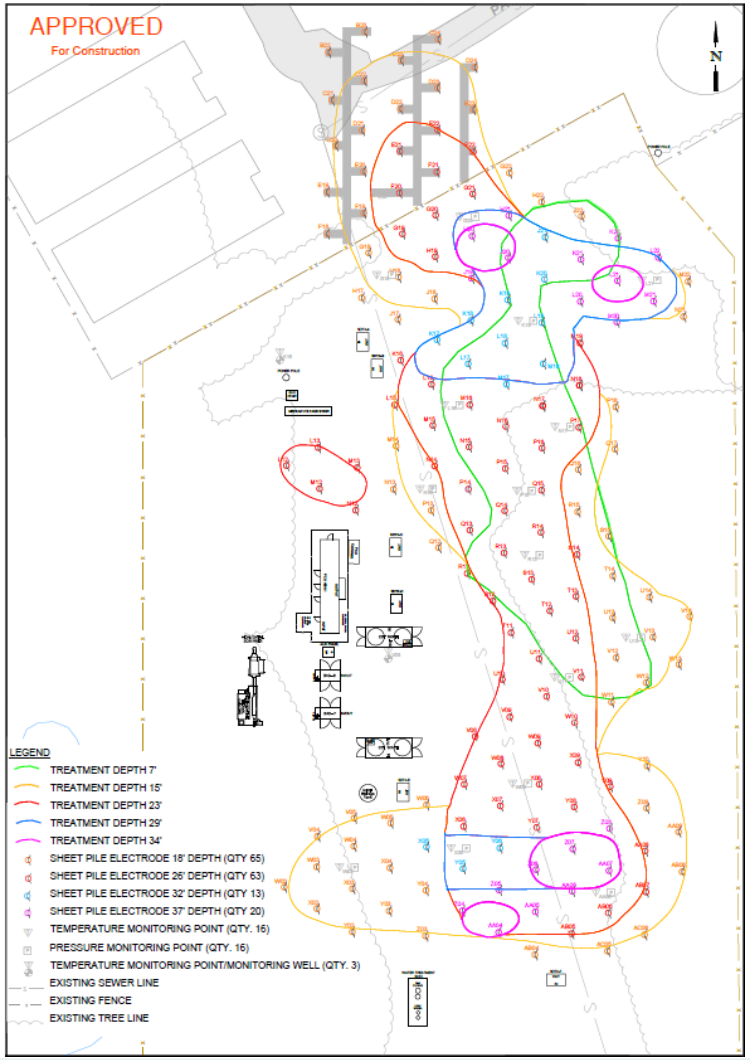
- Shortest implementation schedule
- High degree of certainty
- Treat above/below the water table
- Limited subsurface disturbance
- Reduced generation of waste soils

ISTR technologies considered

- Thermal conductive heating (TCH)
- Electrical resistance heating (ERH)
- Steam-enhanced extraction (SEE)

# Thermal Remediation System Extent



# Sheet Pile Electrodes

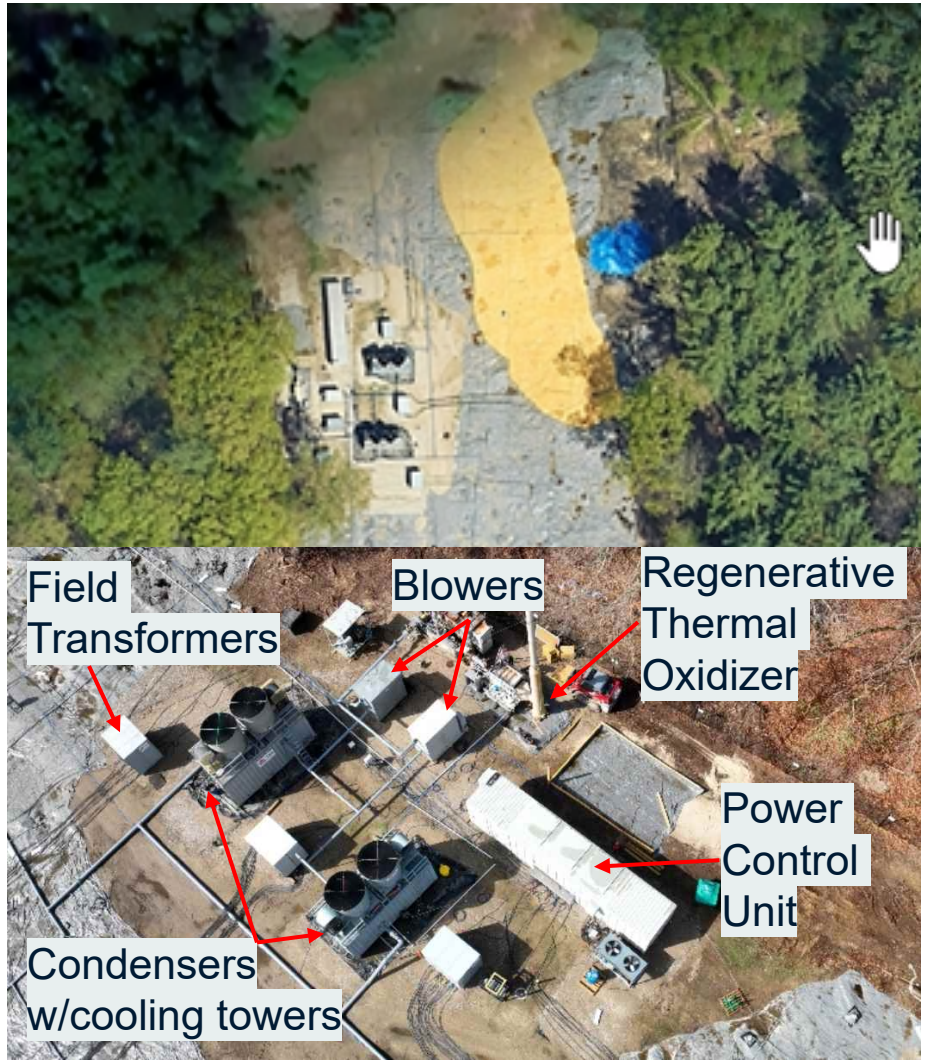
- Site suitability evaluation required
- Reduced installation time
- Recyclable materials
- Minimized contaminated soil cuttings
- Reduced management, transport, secondary liability

# Sheet Pile vs Bored Electrodes

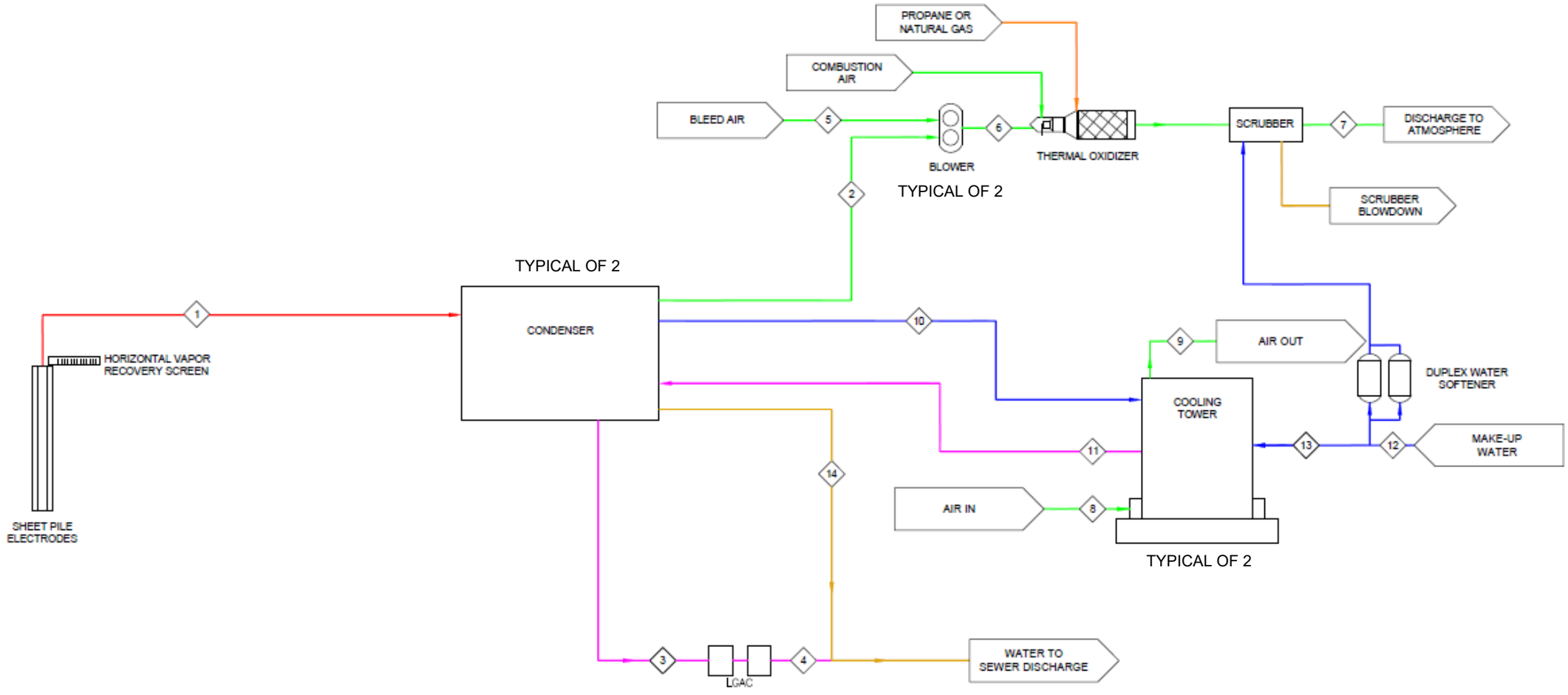
- 161 sheet pile electrodes
  - ~30 minutes per electrode
  - 81 hours sheet pile driving
- 185 bored electrodes equivalent power
  - 384 hours drilling estimated
- 166 tons soil cuttings eliminated

# Electrical Resistance Heating Design

- 34,735 $ft^2$ treatment area
- 161 sheet pile electrodes
- 18 to 37 ft bgs
- Surface liner and insulation
- 16 pressure monitoring points
- 16 temperature monitoring points
- Vapor treatment: regenerative thermal oxidizer

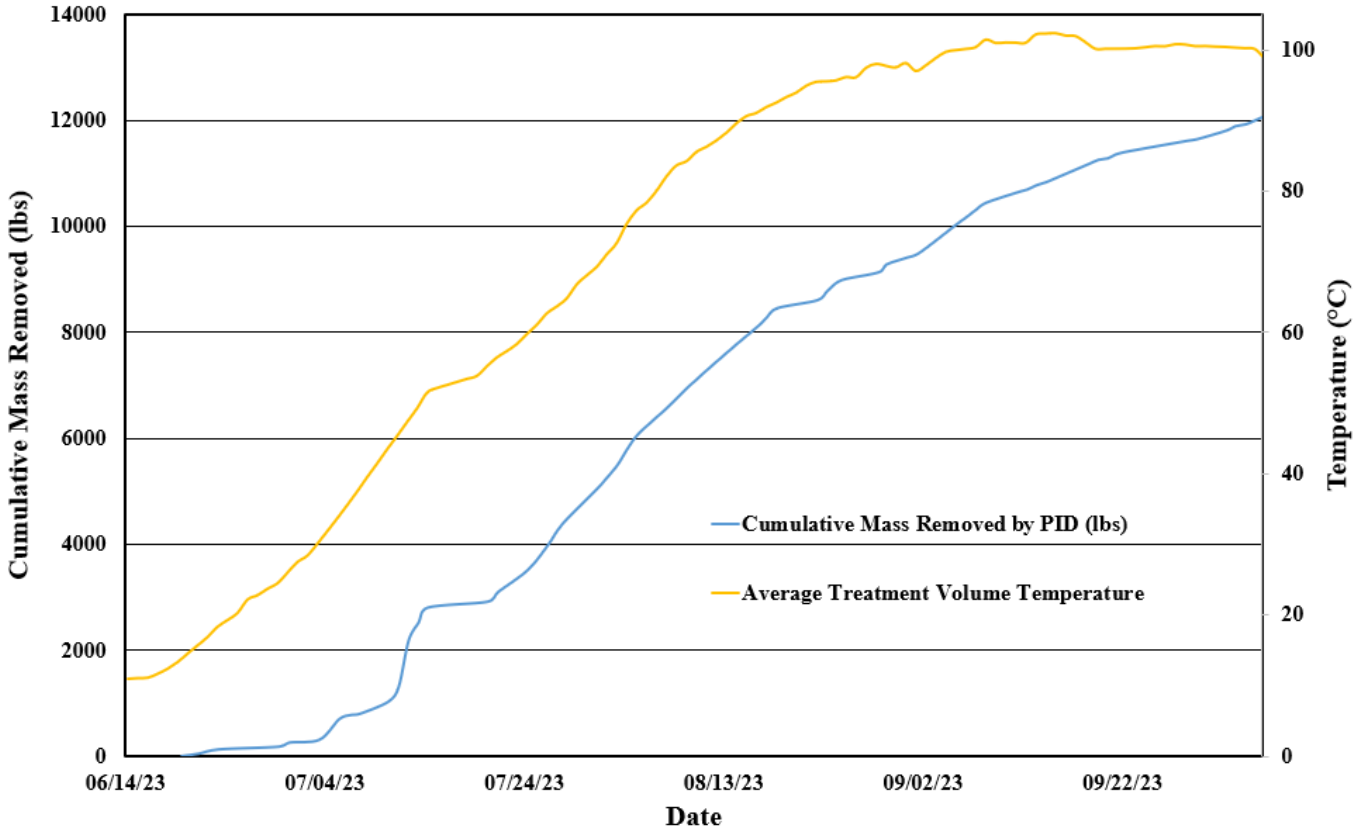


# Process Flow Diagram

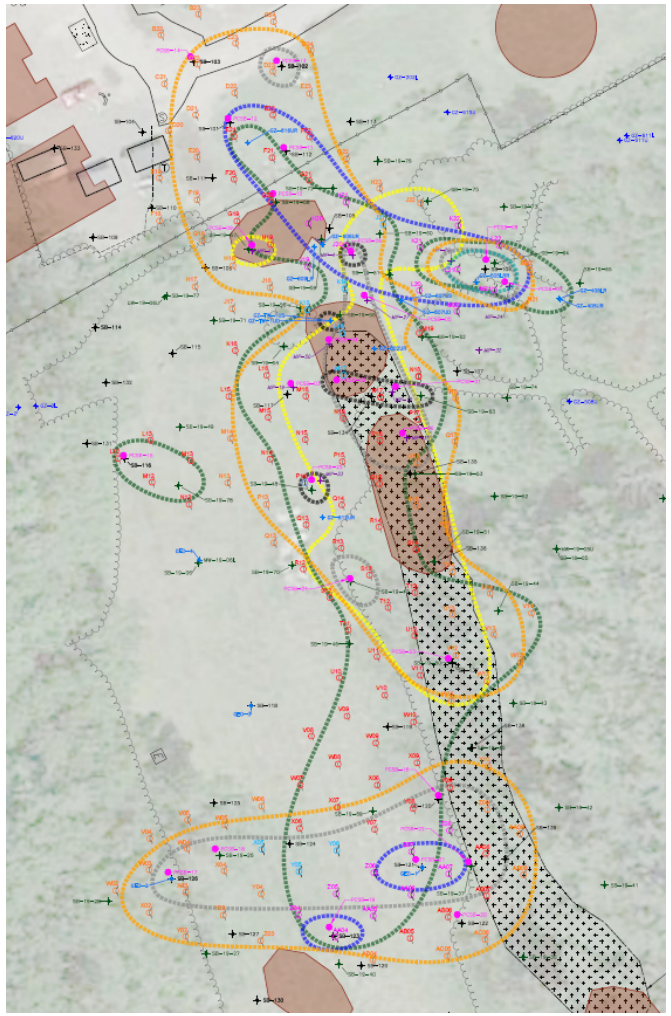


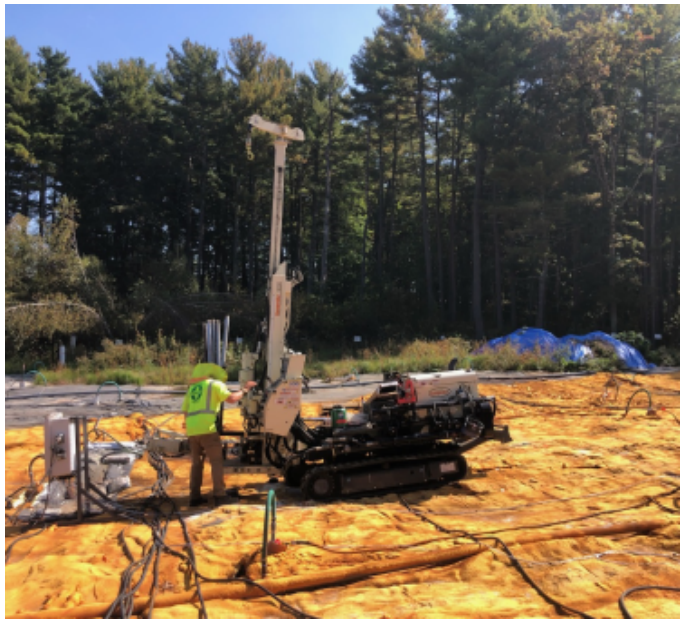
# Site Operations Summary

- 113 days operations
- 6,150,839 kWh applied
- 104.8°C max average site temperature
- 12,280 lbs cumulative mass removal



# Soil ERH Performance Assessment

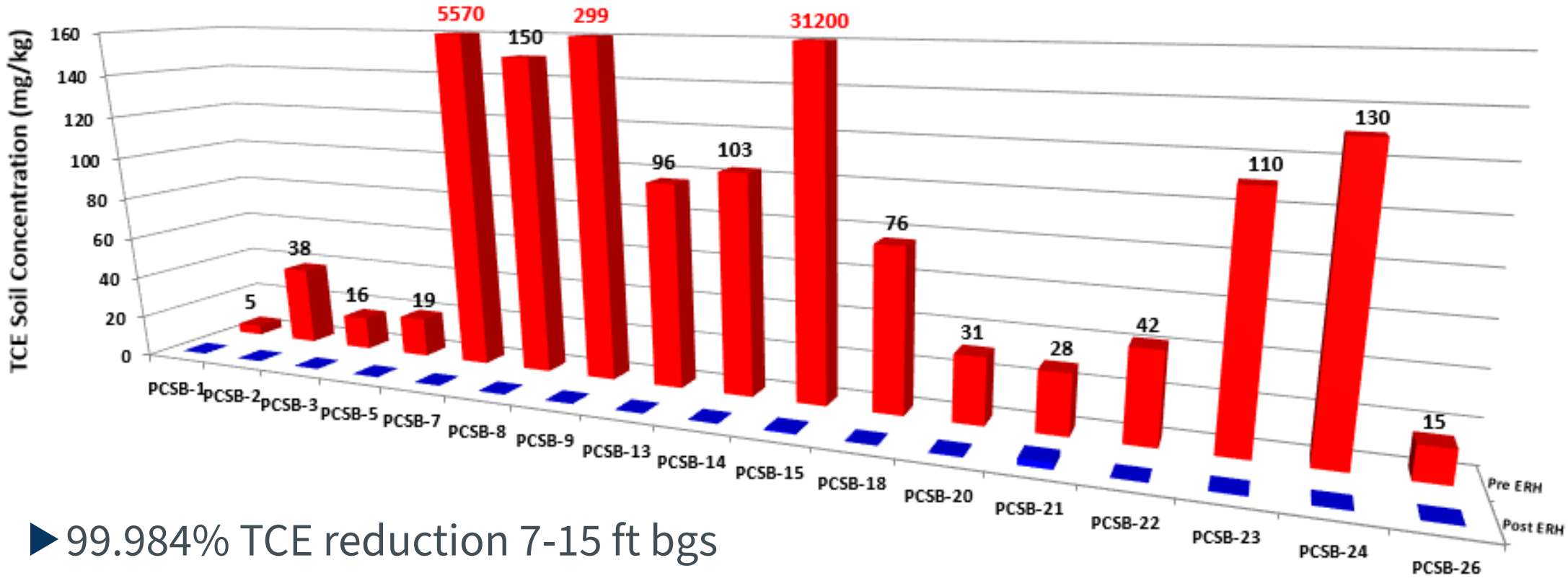




## Performance Confirmation Soil Sampling

- 40 samples from 26 boring locations
  - DNAPL and NH SRS areas
  - Co-located with previous data
- August 30 - DNAPL milestone
  - 3 samples: TCE > 10% sol. (DNAPL)
  - 11 samples: TCE and/or c-DCE > SRS
- October 5 - NH SRS milestone
  - DNAPL not present
  - 3 samples: TCE and/or c-DCE > SRS
  - Remediation goal achieved based upon 95% UCLs below NH SRSs

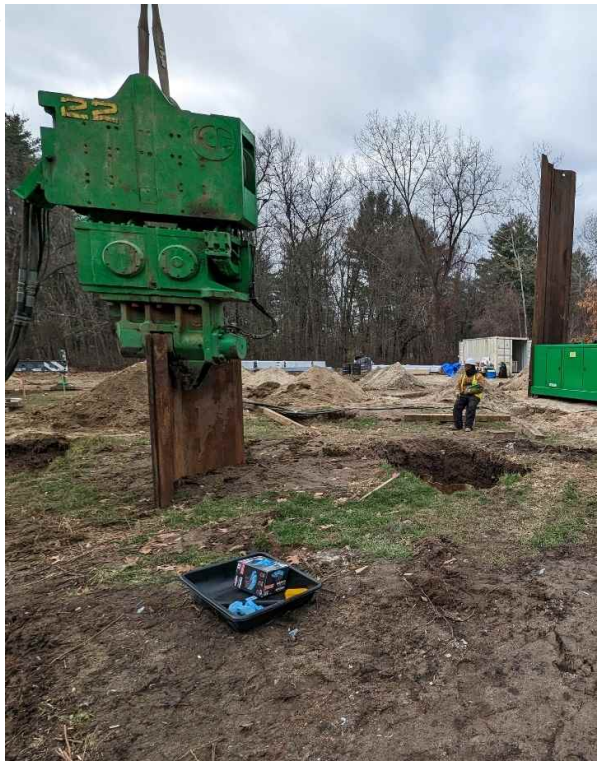
# Soil ERH Performance Assessment




- 99.984% TCE reduction 7-15 ft bgs
- 95% UCL achieved for PCE, TCE, cis-1,2-DCE, VC, 1,1,1-TCA

# Key Points

- Efficient installation
- Remedial performance objectives met in 3.7 months
- 99.984% reduction TCE in soil
- Pneumatic and hydraulic control maintained
- RTO vapor treatment emissions in compliance
- Sheet pile power output exceeded expectations



# Questions?

## In Situ Thermal Treatment of DNAPL Site Using Sheet Pile Electrodes

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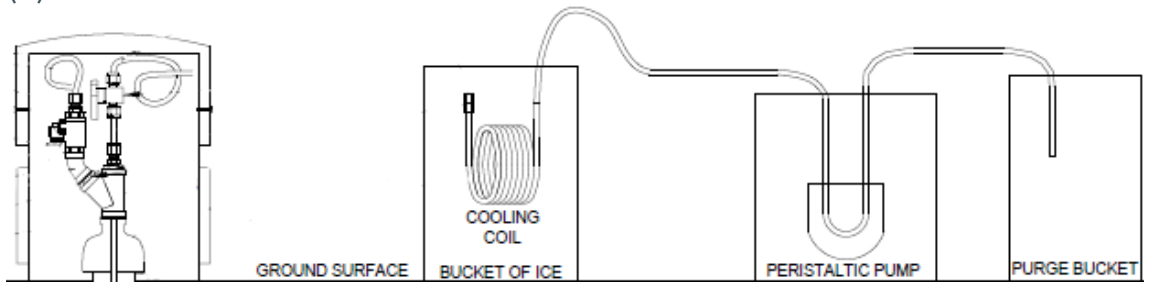
TRS Group

SPARE SLIDE

# Environmental Monitoring - SPARE SLIDE

## Groundwater Sampling

- Monitoring network of 15 monitoring wells and 5 shallow piezometers
  - Uncontrolled contaminant migration
  - Temperature migration
  - Remedial performance*
- Semi-monthly sampling during ISTR, alternated between comprehensive and perimeter/downgradient only
- Sampling conducted using low-flow methods modified for hot sampling
  - Condenser heads fitted with Teflon or stainless-steel dedicated tubing
  - Sampling through dedicated stainless steel cooling coils submerged in ice baths
- Sample analyses included (20) VOCs, (8) arsenic, (5) PFAS, and (3) PCBs
- Monthly sampling 4 months after completion of ISTR
- Quarterly monitoring for 2 years (1st - March 2024)




THE SITE THAT HAS IT ALL!

# Former Wastewater Treatment Facility

- CVOC/DNAPL; PFAS in groundwater and soil
- Two aquifer system and confining layer
- History of assessment and remediation
- PCB & asbestos abatement and demolition
- PCB TSCA investigation/remediation
- NH Brownfields Program