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High-Resolution Site Characterization of Contaminants in Soil and Sequence Stratigraphy for Effective Remedial Design

Performed by CDM Smith under contract to the US Army Corps of Engineers

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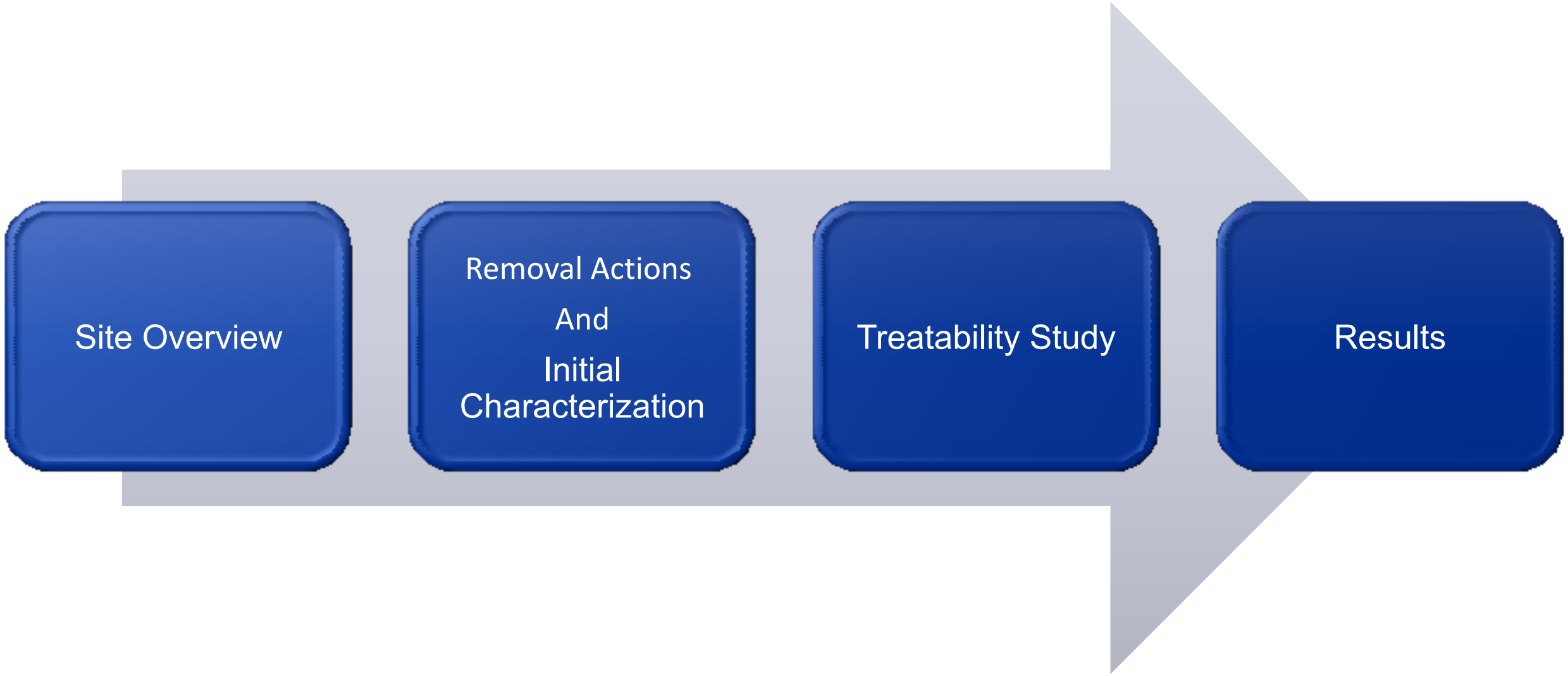
Outline of Presentation



Site Description

Source

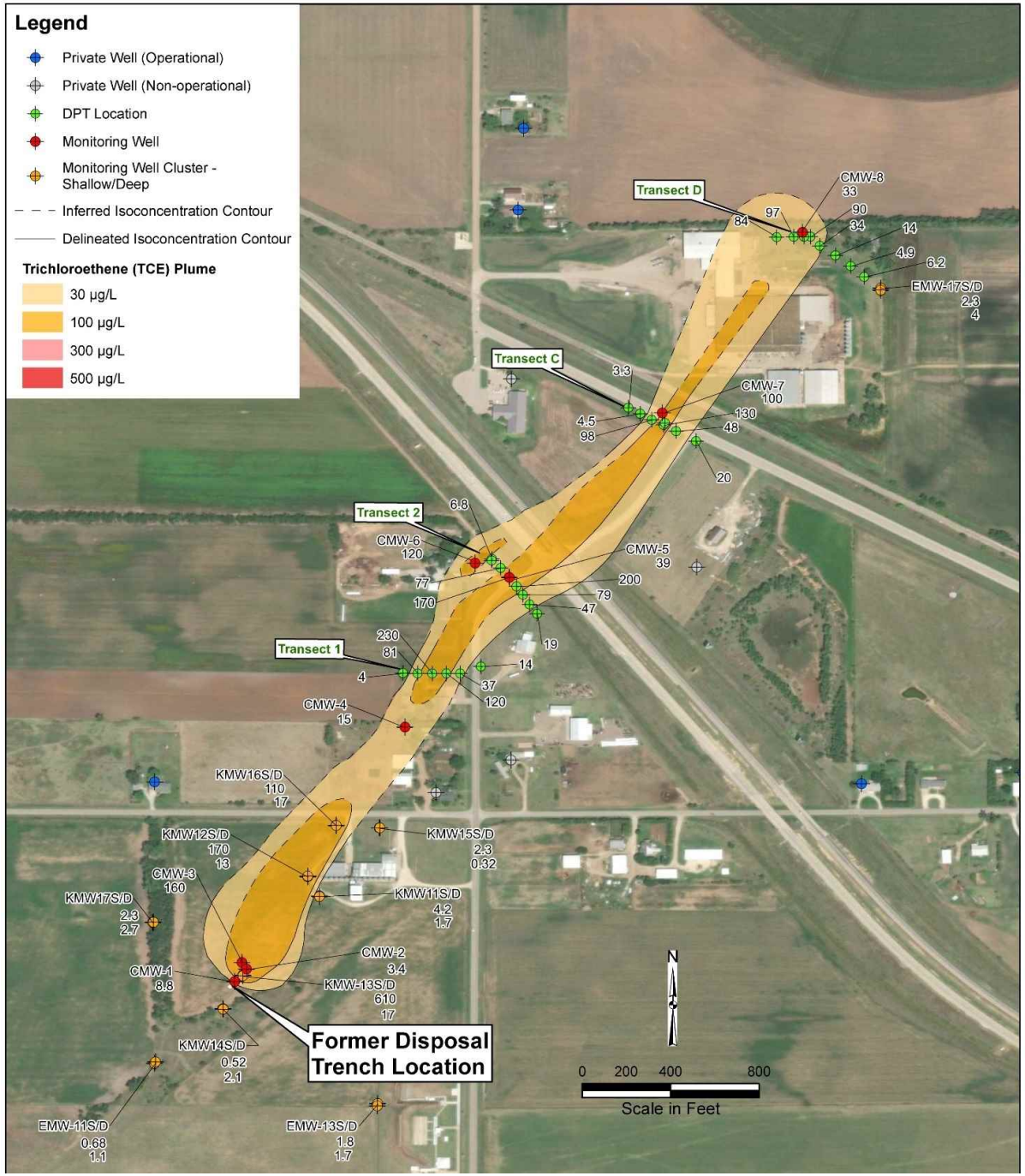
- Former disposal trench in Kansas with buried drums of TCE and CT

Contamination

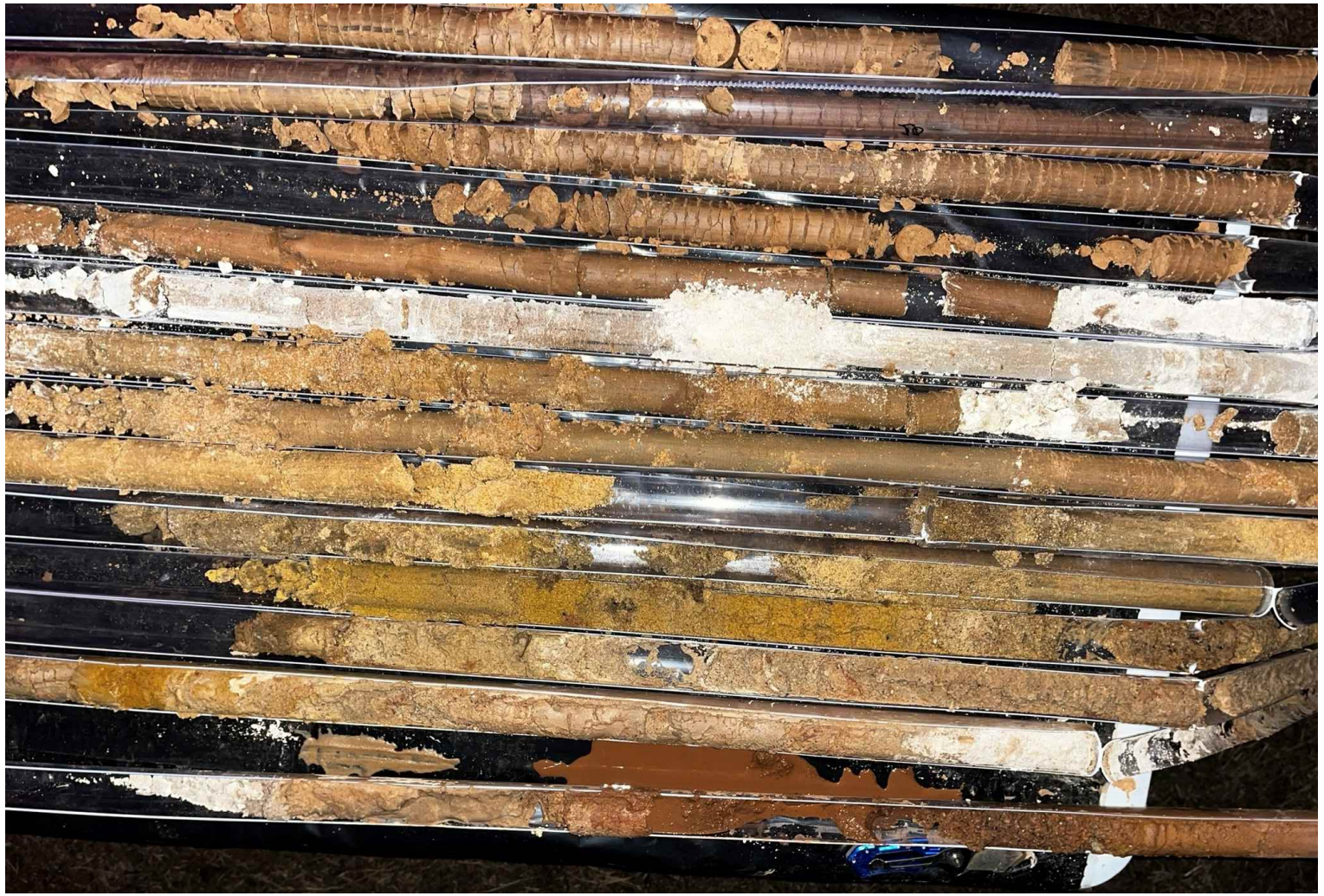
- TCE, CT, and CF exceedances in soil
  - EPA residential soil RSLs
  - KDHE Tier 2 residential screening levels for the soil to groundwater pathway
- TCE plume greater than 100 µg/L extends 3,700 feet to northeast toward domestic supply wells

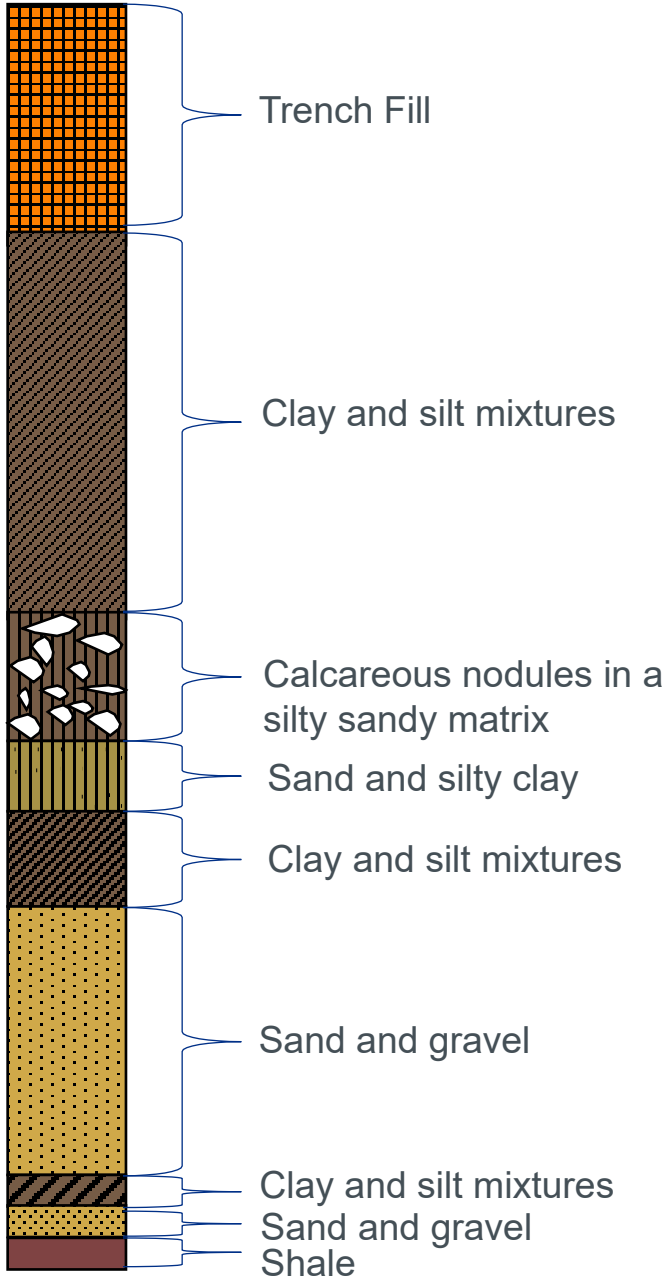
Problem

- Source removal (2013) and ISCO (2015) – exceedances remained

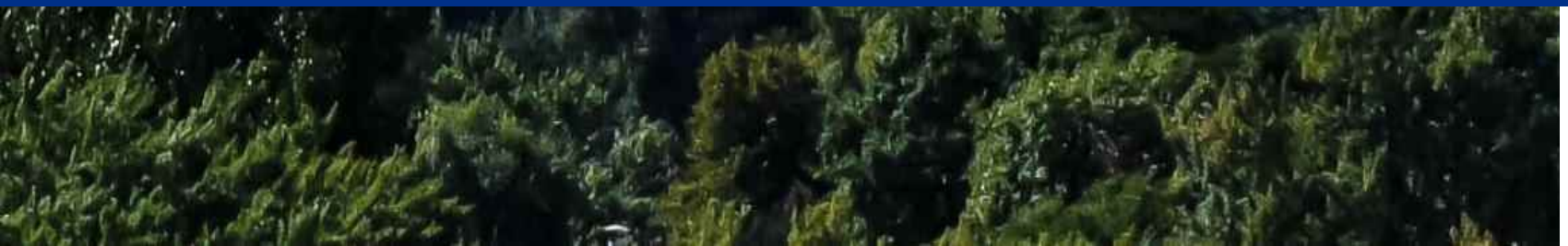


Lithology




Trench Fill
Clay and silt mixtures
Calcareous nodules in a silty sandy matrix
Sand and silty clay
Clay and silt mixtures
Sand and gravel
Clay and silt mixtures
Sand and gravel
Shale

Removal Actions and Initial Characterization

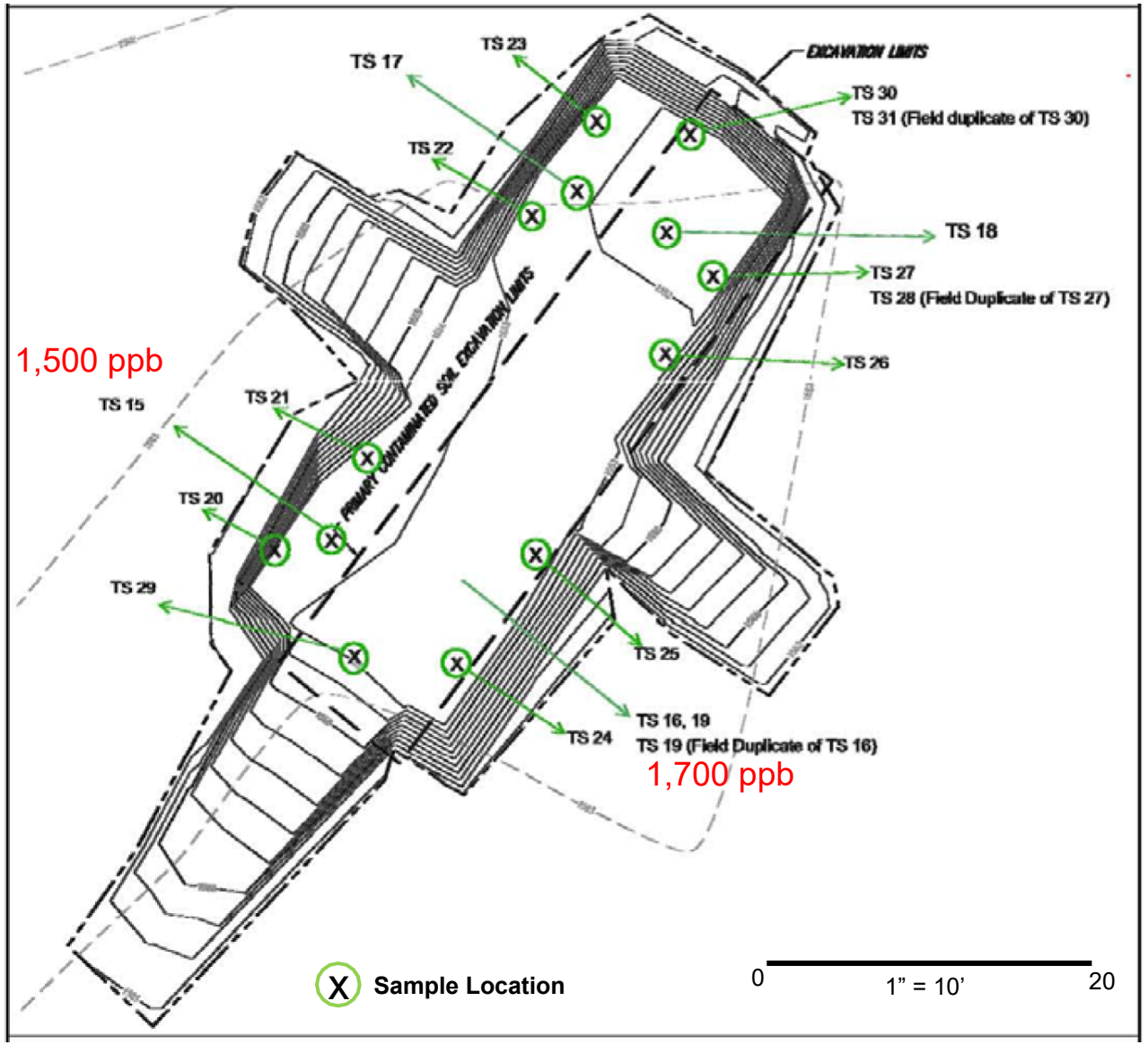


Time Critical Removal Actions: 2013 Excavation

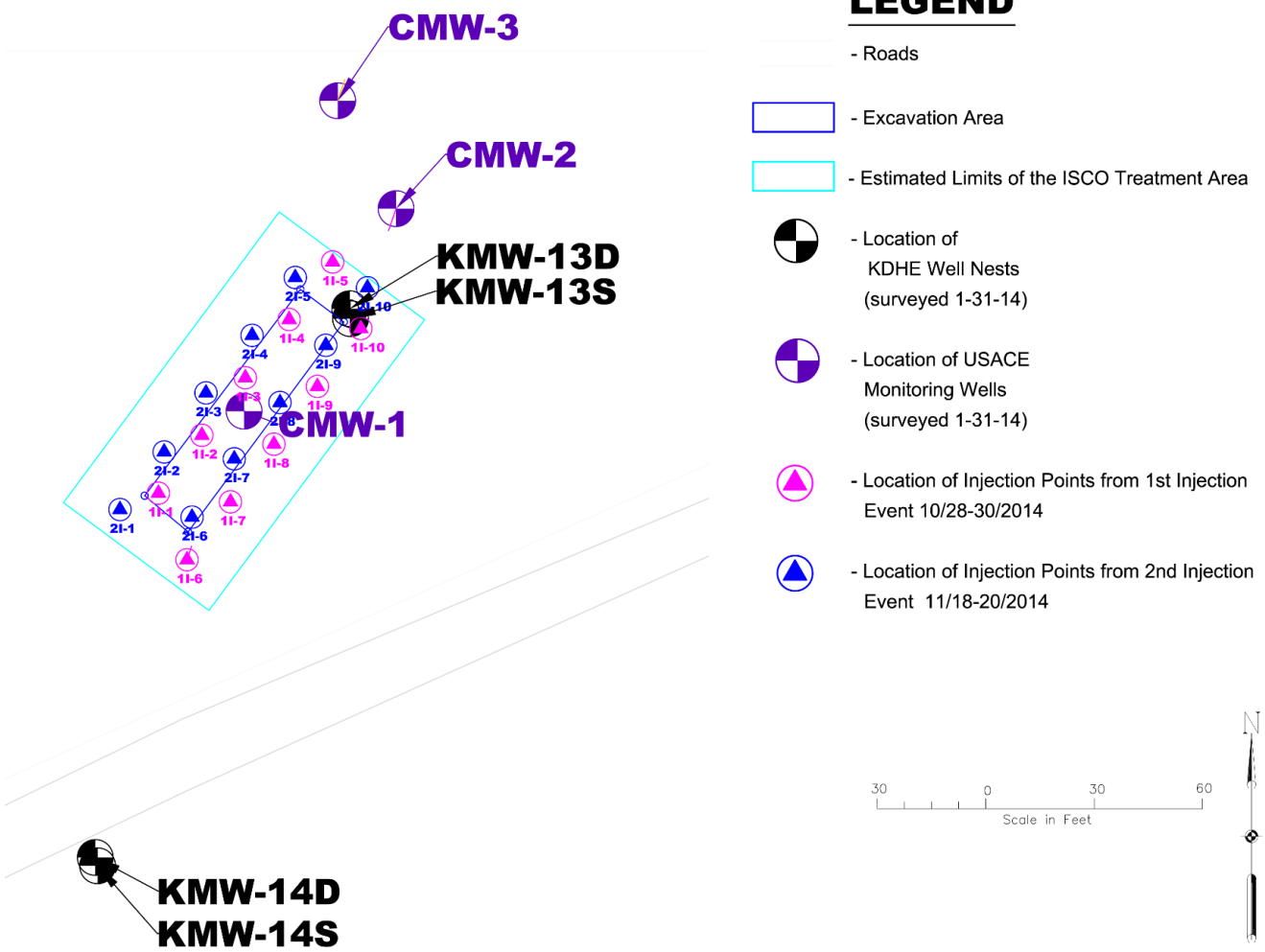
- Removed first 12 feet of soil (943 tons) from the former trench area
- Residual TCE contamination in base of southwest and southeast corners of trench (1,500 µg/kg – 1,700 µg/kg).

Problem

- No decrease in COC concentrations in groundwater
- Continual source of groundwater contamination remaining – approx. 35 feet of soil between base of excavation and water table



Time Critical Removal Actions: 2015 ISCO

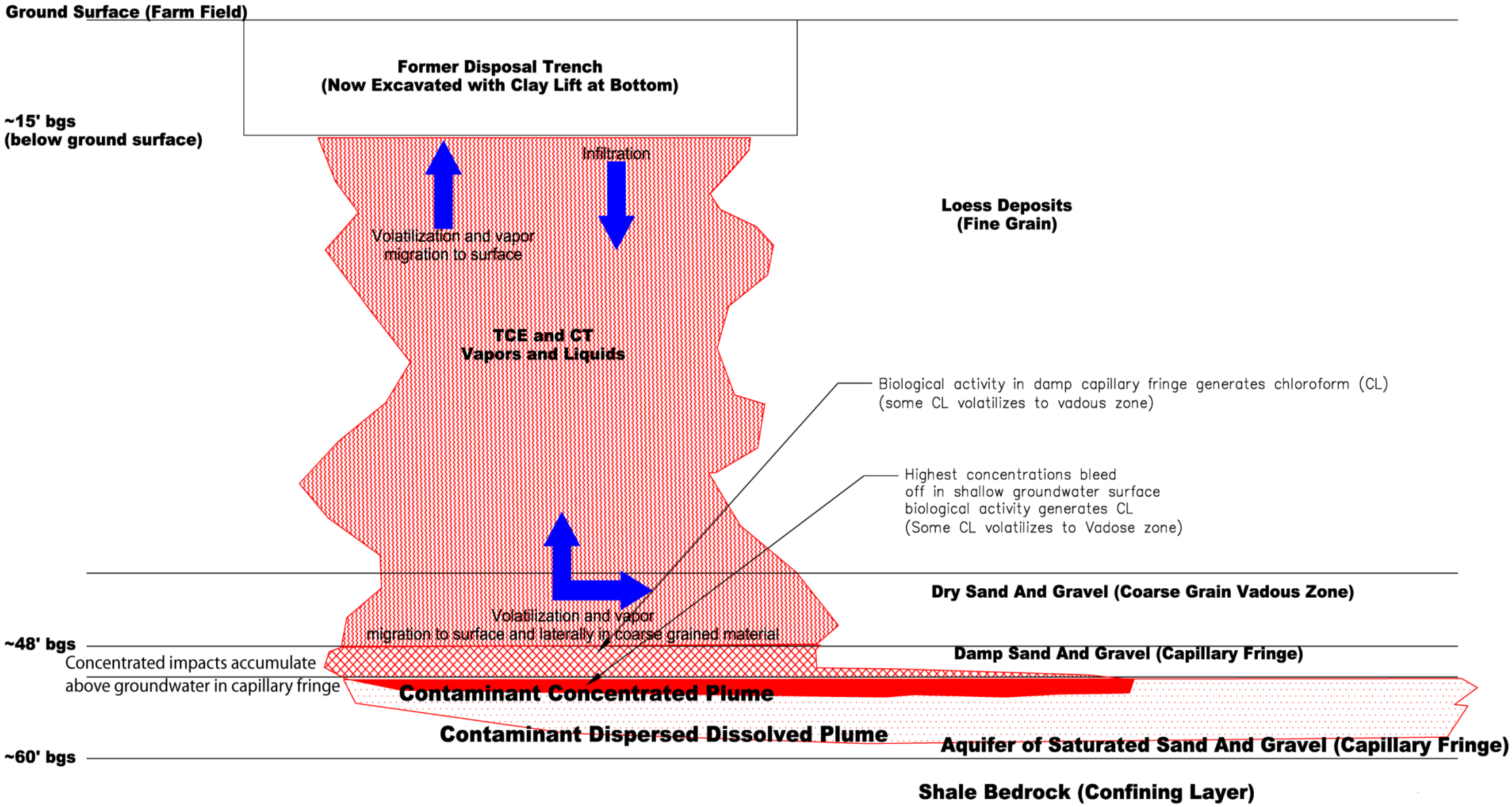


- Injections 59 and 62 feet bgs with an 8-foot injection screen.
- Reagent - neutral pH chelated iron catalysts in water and hydrogen peroxide
- Initial decrease in VOC concentrations in all source area wells except CMW-2 (slight increase)
- Concentrations rebound slightly

Problem

- VOC concentrations remain above MCLs and are not decreasing

Removal Action CSM (2015)



Remedial Investigation

2016 – 2020
RI Activities in Source Area

Conventional Investigation

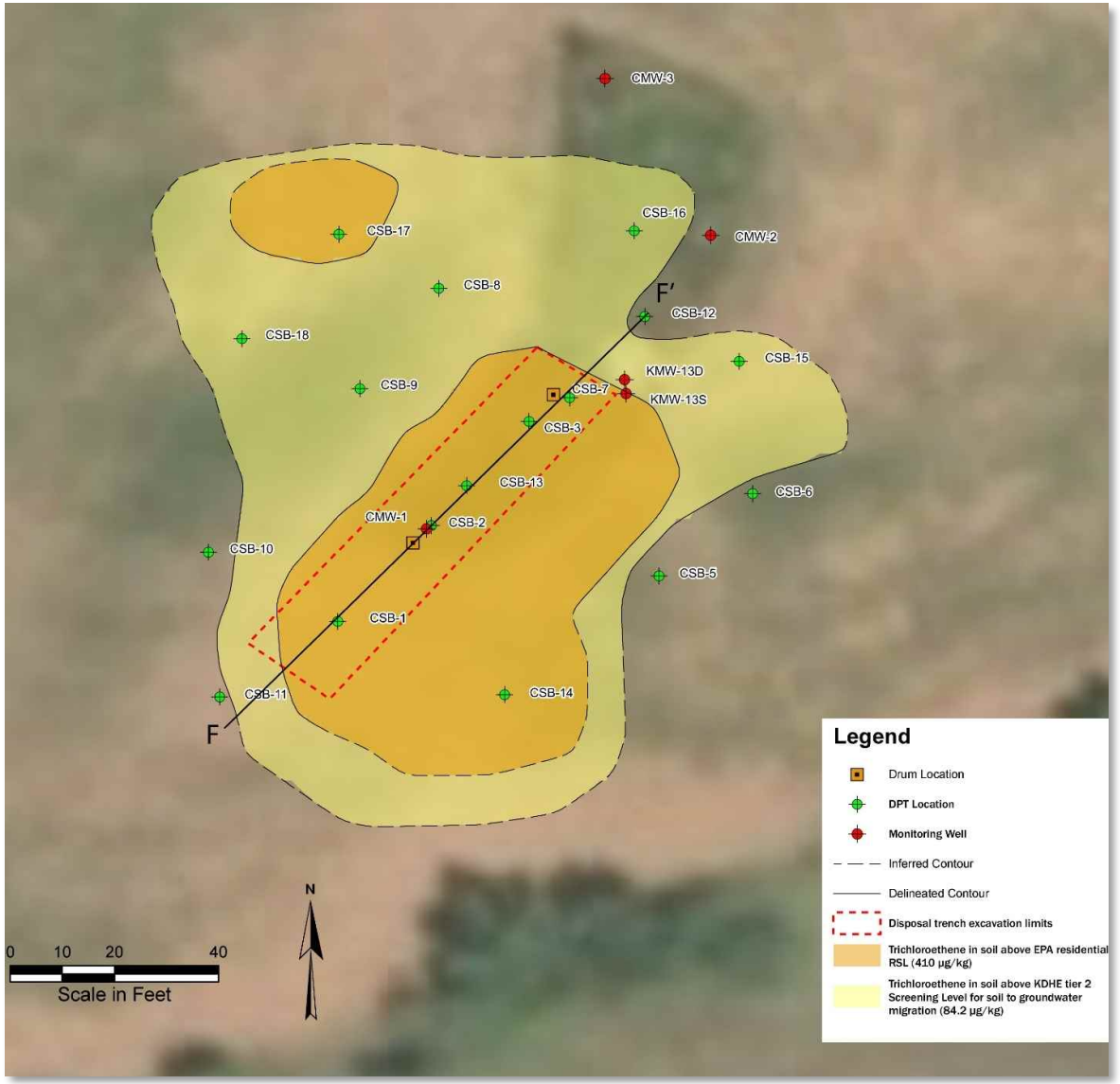
- 6 pre-planned DPT borings to the water table for lithology and VOC soil sampling. Standard turnaround time.

Resulting Data Gaps

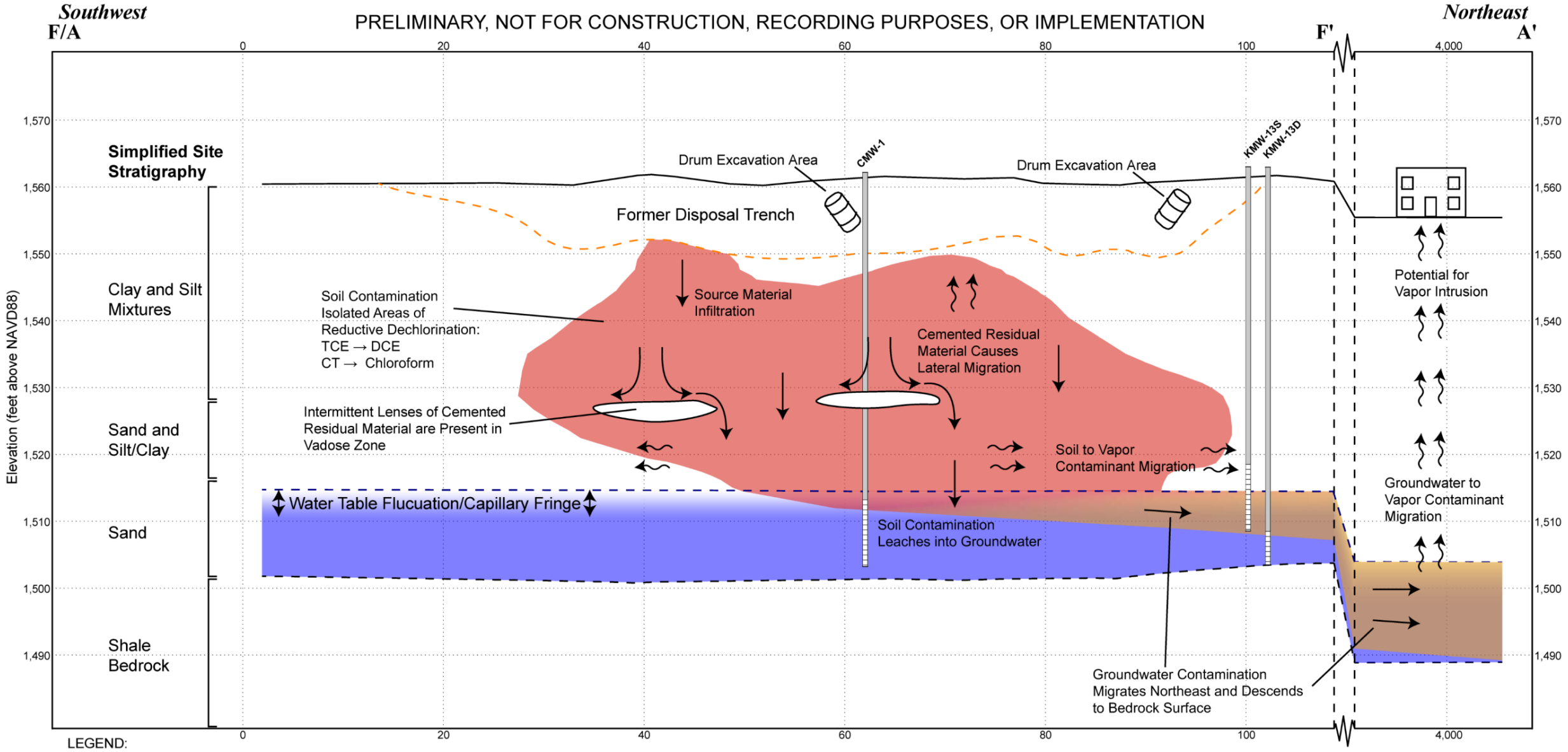
- Source material above KDHE Tier 2 residential soil to groundwater levels not delineated to the north and south of the former trench

Action Needed

- Residual contaminants in source area exceed screening levels
- Continual source to groundwater contamination; remedial action necessary
- Further source characterization required



RI CSM


Southwest
F/A
PRELIMINARY, NOT FOR CONSTRUCTION, RECORDING PURPOSES, OR IMPLEMENTATION
Northeast
F'
A'
0
20
40
60
80
100
4,000
Simplified Site Stratigraphy
Clay and Silt Mixtures
Sand and Silt/Clay
Sand
Shale Bedrock
Elevation (feet above NAVD88)
1,570
1,560
1,550
1,540
1,530
1,520
1,510
1,500
1,490
Drum Excavation Area
CMW-1
Drum Excavation Area
KMW-13S
KMW-13D
Former Disposal Trench
Source Material Infiltration
Soil Contamination Isolated Areas of Reductive Dechlorination: TCE → DCE CT → Chloroform
Cemented Residual Material Causes Lateral Migration
Intermittent Lenses of Cemented Residual Material are Present in Vadose Zone
Soil to Vapor Contaminant Migration
Potential for Vapor Intrusion
Groundwater to Vapor Contaminant Migration
Water Table Flucuation/Capillary Fringe
Soil Contamination Leaches into Groundwater
Groundwater Contamination Migrates Northeast and Descends to Bedrock Surface
LEGEND:

Treatability Study

Treatability Study – Filling the Data Gaps

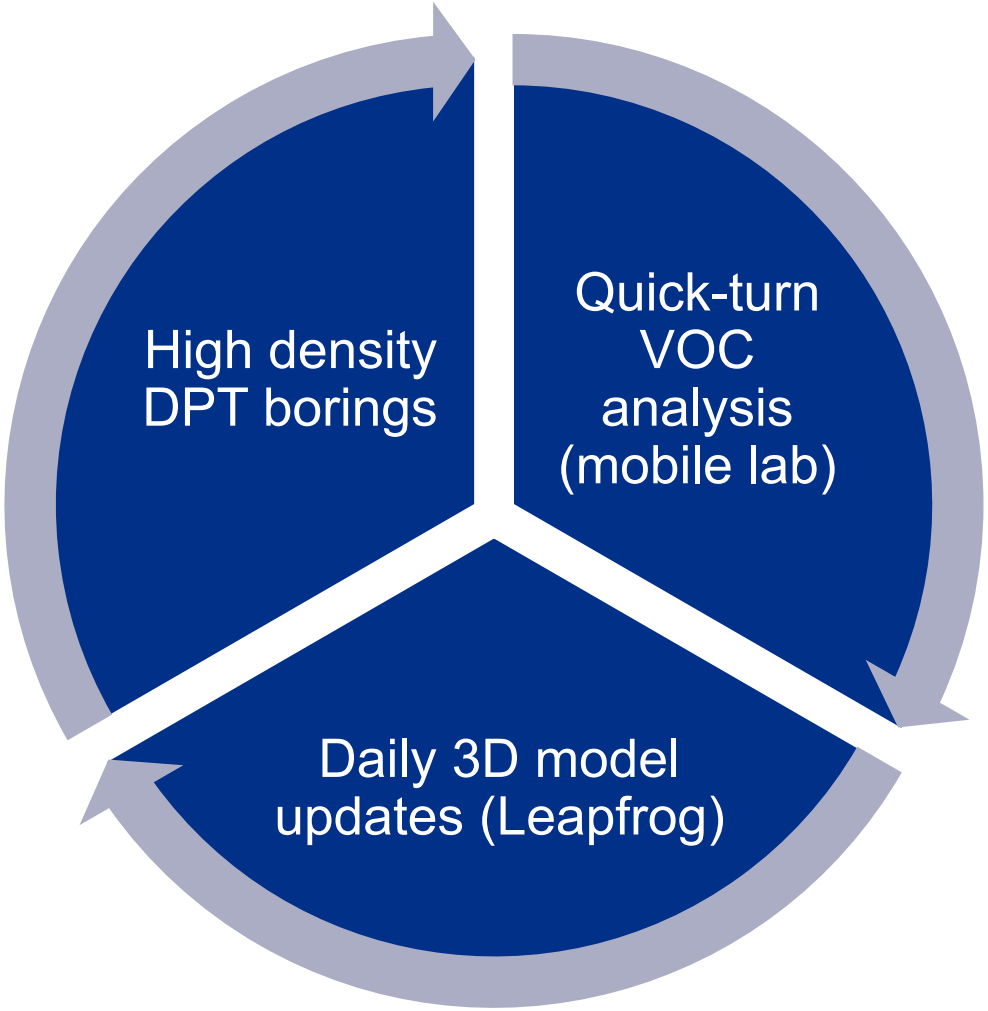
The current extent of TCE and CT concentrations in soil greater than KDHE's Tier 2 residential standards for soil to groundwater are uncertain.

The current extent of VOCs in the known source area saturated zone is uncertain.

Determine the lateral and vertical extent of VOCs in source area soil

Delineate VOCs in groundwater and soil between water table and bedrock surface

Dynamic Work Strategy
and
Real-Time Measurements



Delineation Borings

Initial expanded delineation of source area soil

- 17 planned primary borings with vadose zone samples

Review rapid results and 3D model to fully delineate nature and extent of soil

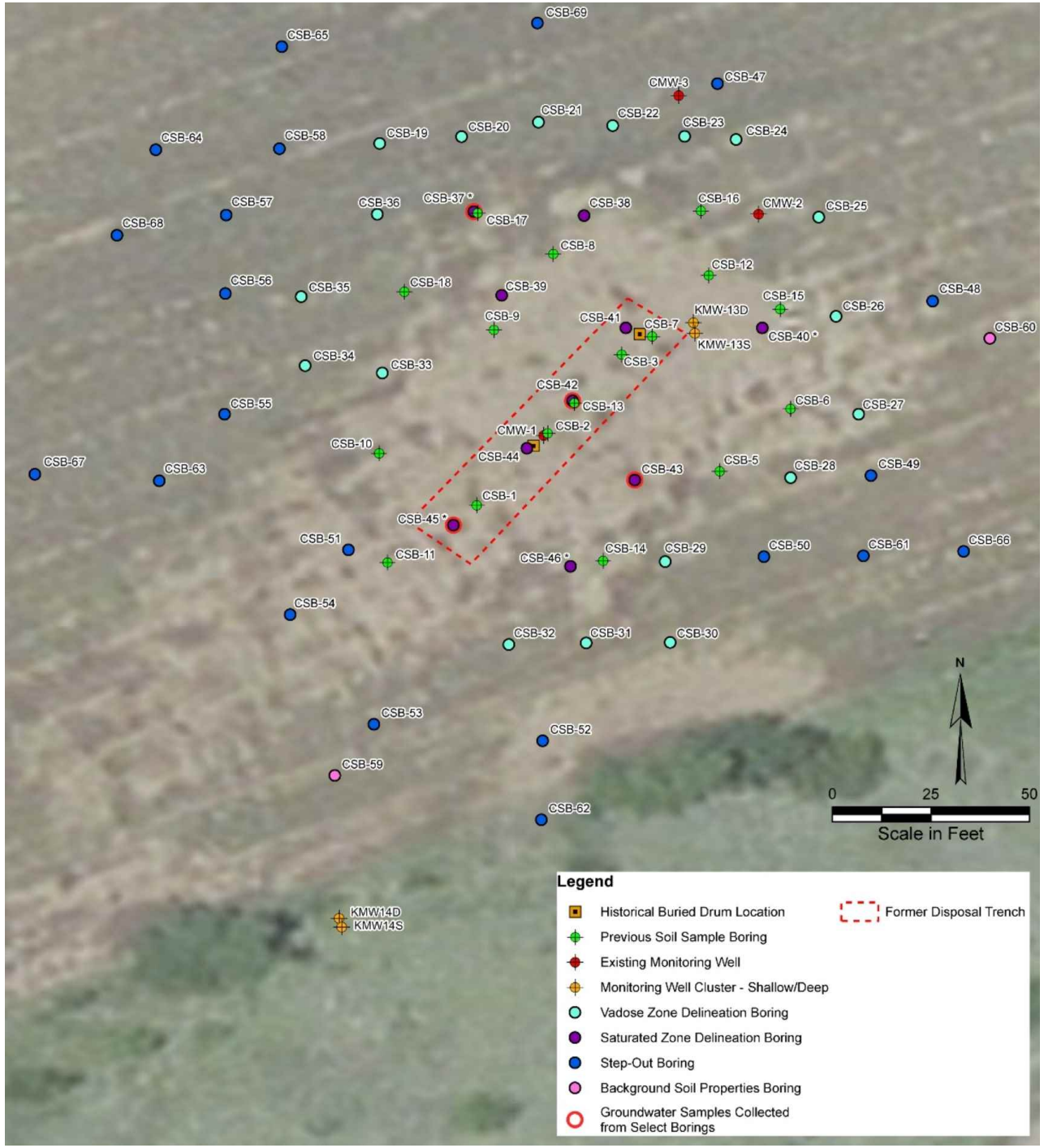
- 21 additional step-out borings with vadose zone samples

Expand CSM to include data for saturated soil in the source zone

- 10 source area borings with saturated zone samples

Expand CSM to include groundwater data to bedrock in the source zone

- 2 discrete interval GW samples at 4 locations: near water table and at bedrock



Leapfrog Works 3D Visualization

Carbonate Nodules

Carbonate Nodules

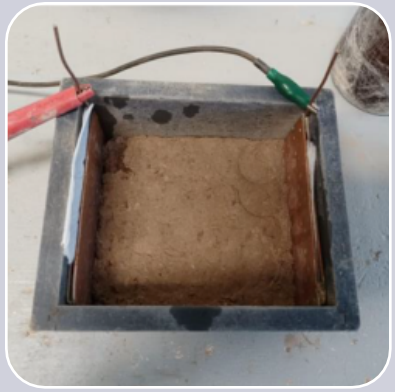
Carbonate Nodules

Carbonate Nodules

Data for Design – In-Situ Thermal Remediation

Aquifer Performance Testing

Soil Testing for Physical Properties



Definitive data for understanding heat loss from the Target Treatment Zone (TTZ) and planning GW extraction.

Hydrogeologic Properties

- Hydraulic Conductivity
- Groundwater Velocity

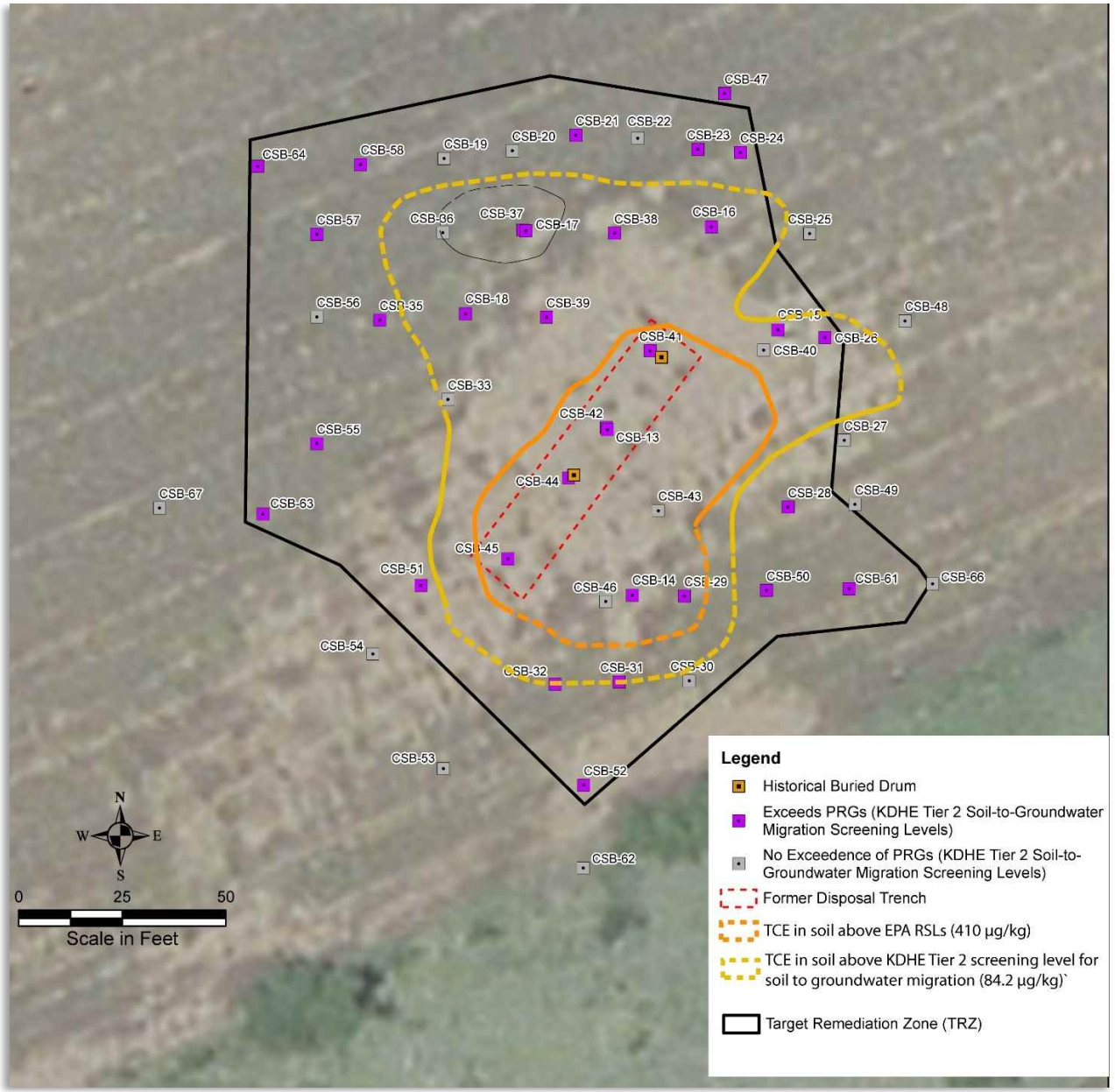
Physical Properties of Soil

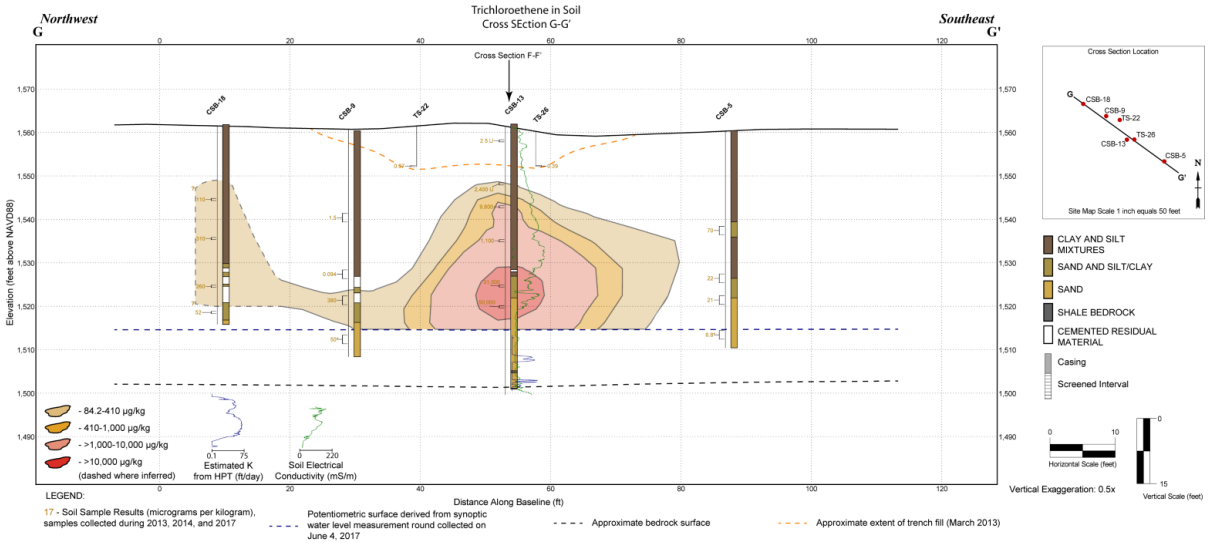
- Bulk Density
- Porosity
- TOC
- Moisture Content
- Static and Dynamic Resistivity

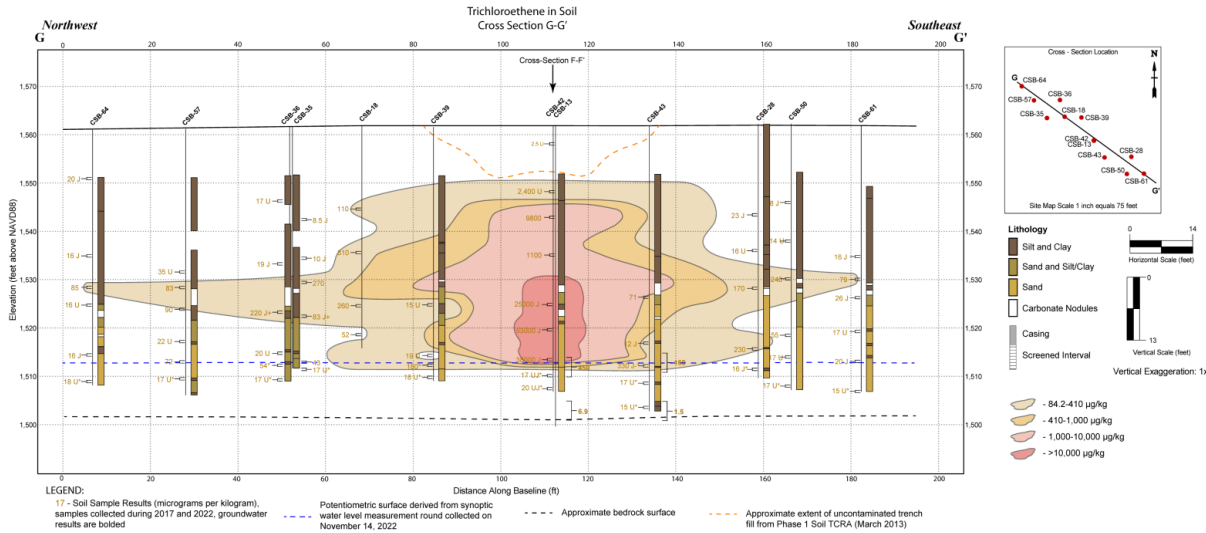
Definitive data for appropriate thermal treatment design and cost optimization.

Results

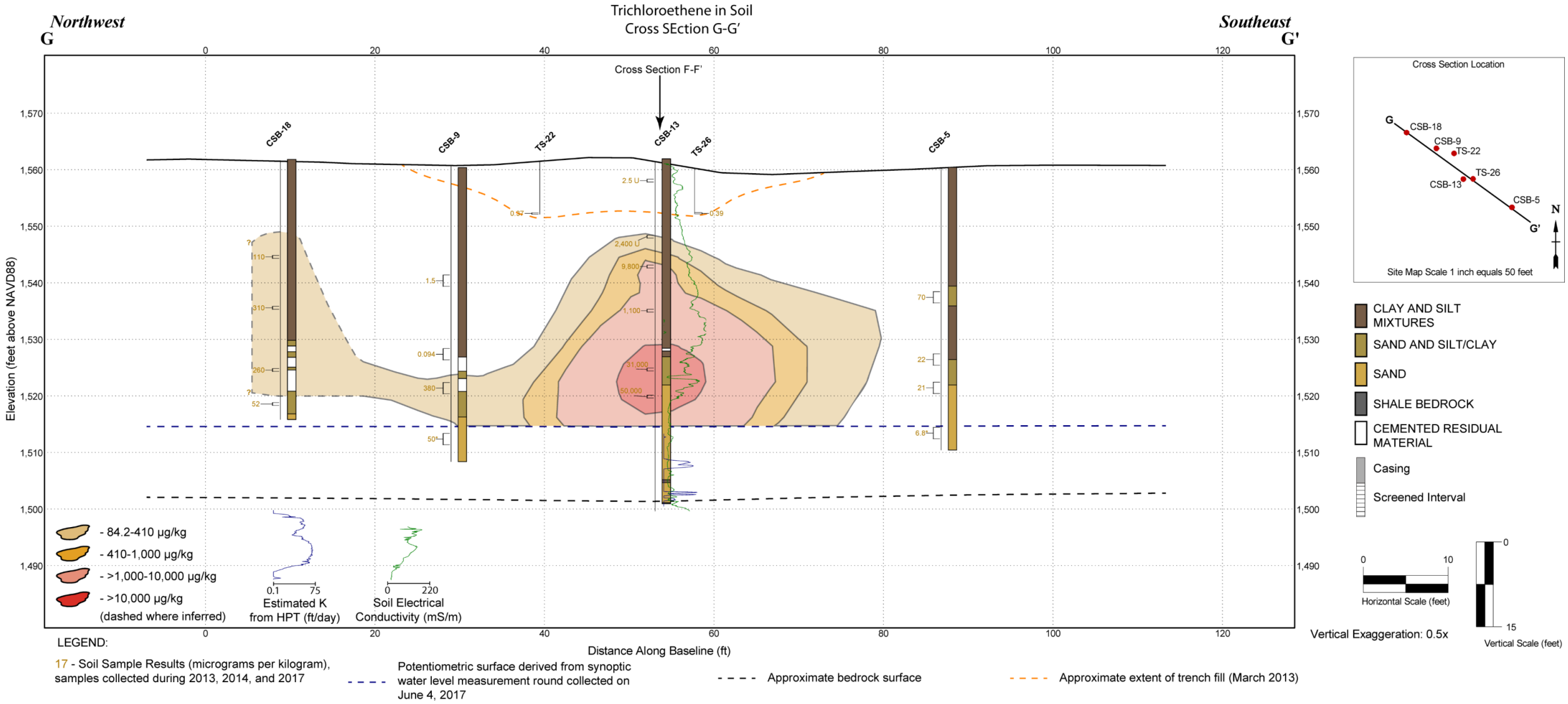
Target Treatment Zone Expansion



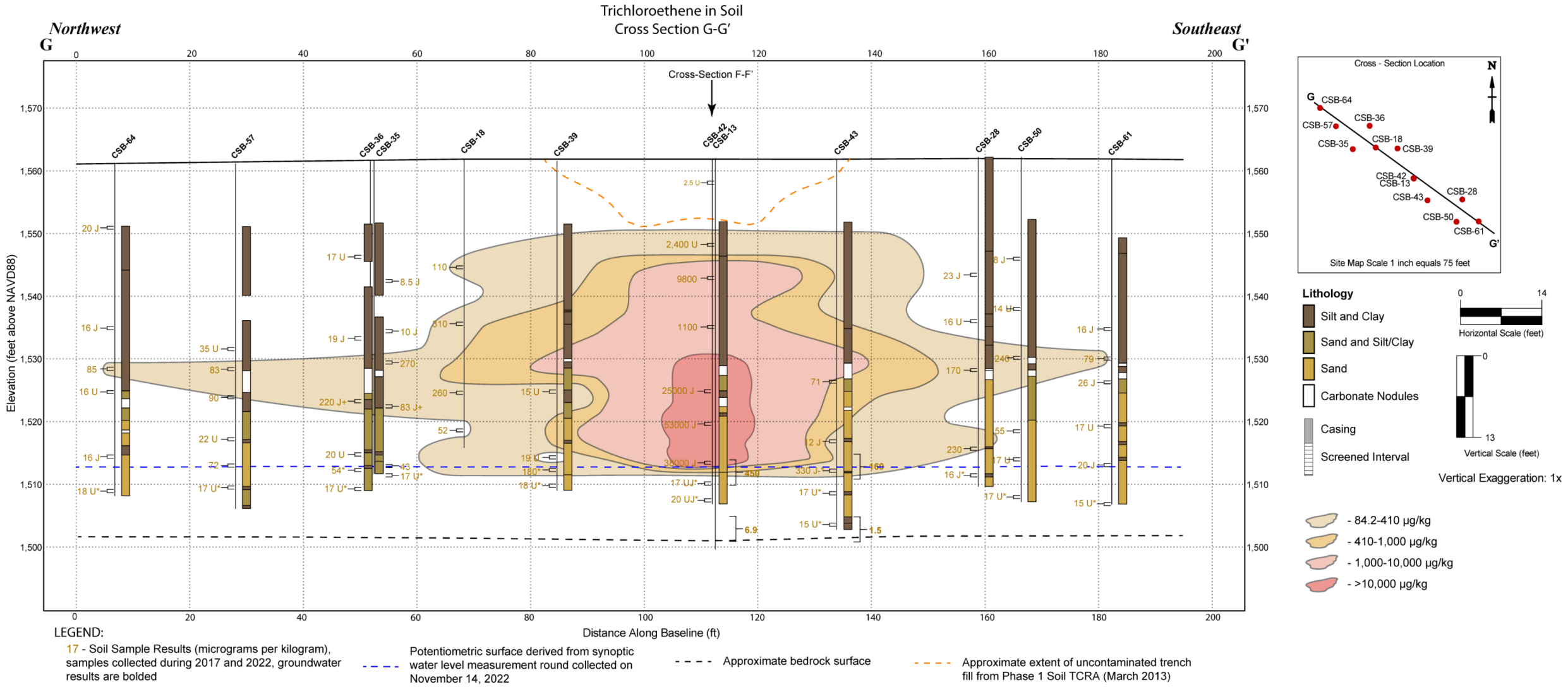




Cross Section: Southeast to Northwest



Cross Section: Southeast to Northwest



Target Treatment Zone Expansion

	Pre-TS	Post-TS
Mass of COCs	• TCE: 4.24 kg • CT 0.66kg	• TCE: 19.72 kg • CT 2.76 kg
Hydrology	• K = 17 ft/day • V = 0.23 ft/day	• K = 184 ft/day • v = 2.5 ft/day
Soil Properties	• Resistivity, TOC, porosity, and moisture content unknown	• Resistivity, TOC, porosity, and moisture content determined
Hydrogeologic Model	• Unidentified transport mechanisms in carbonate nodule layer	• Relatively higher permeability carbonate nodule layer acting as preferential pathway for VOCs
TTZ Geometry	• Uncertain lateral and vertical extents for soil impacts • Uncertain concentrations in groundwater near water table and at bedrock interface • Few groundwater observations in source area	• Well-defined TTZ geometry • Increased lateral and vertical resolution for groundwater concentrations in source zone

Results

- **Substantial lateral migration of COCs above screening levels identified in the calcareous nodule zone**
  - Allows for targeted treatment design; less materials and energy expended; avoids redesign to treat unidentified source areas
- **Increased mass estimates for TCE and CT remaining in soil**
  - Allows for more effective treatment; no need for further characterization
- **COCs in groundwater predominantly observed at the top of water table**
  - More effective remedy design that accounts for water near excavation or heating elements; avoid redesign costs
- **Estimates of hydraulic conductivity and average seepage velocity have been revised from 17 to 184 ft/day and 0.223 to 2.5 ft/day, respectively**
  - More effective remedy design that accounts for loss of heat; avoid redesign costs

Thank you!

To learn more, contact:

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