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2024 Battelle Chlorinated Conference

Innovative Solutions for Implementing Thermal Treatment of a Deep TCE Source Beneath an Active Facility

Presented by:
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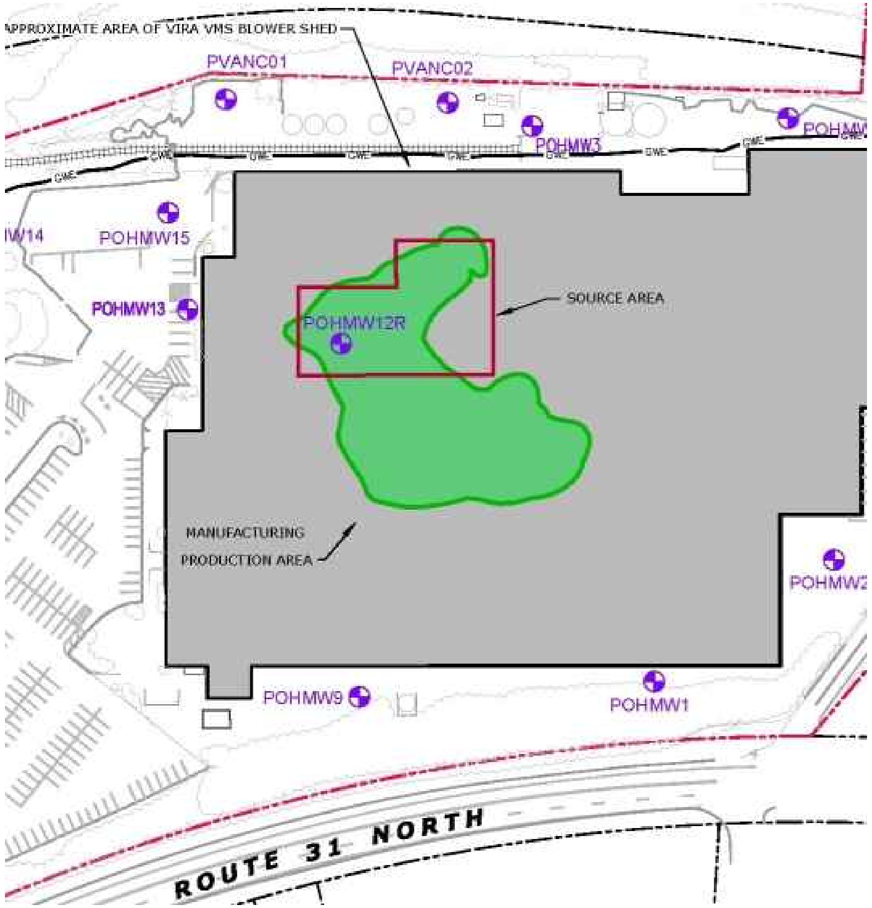
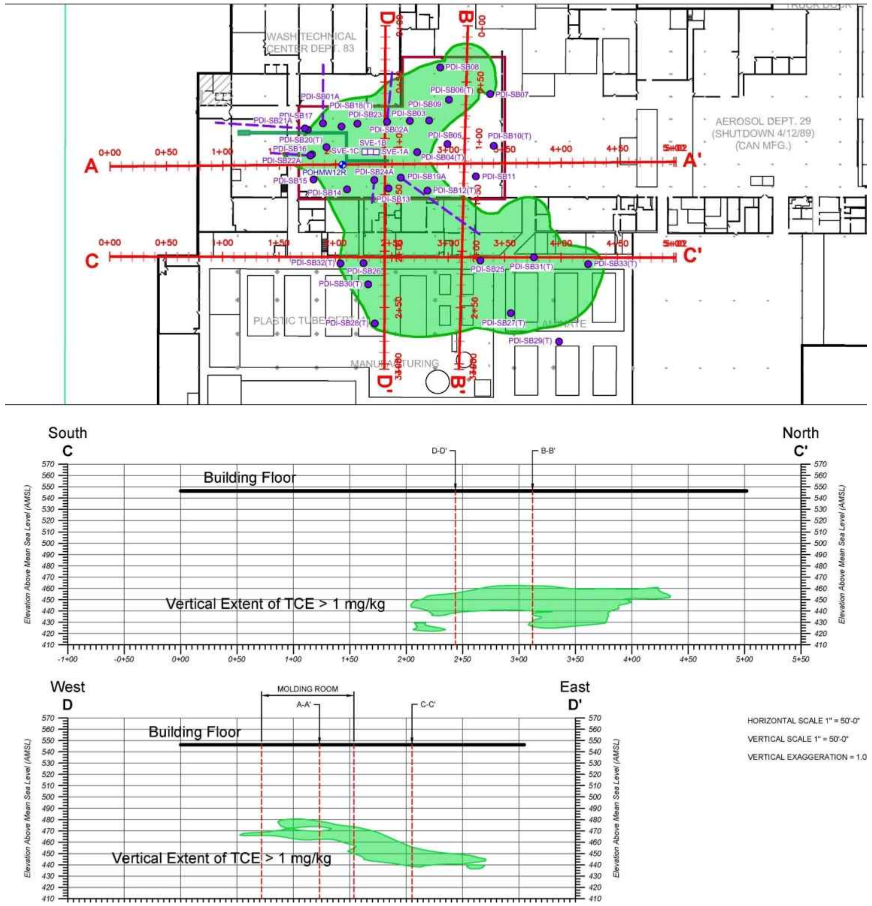
Site Setting



- Superfund site with source soil impacts from legacy manufacturing operations involving the use of trichloroethene (TCE)
- TCE concentrations up to 10 mg/kg were centrally located beneath a 294,000 sq. ft. active facility

Site Setting

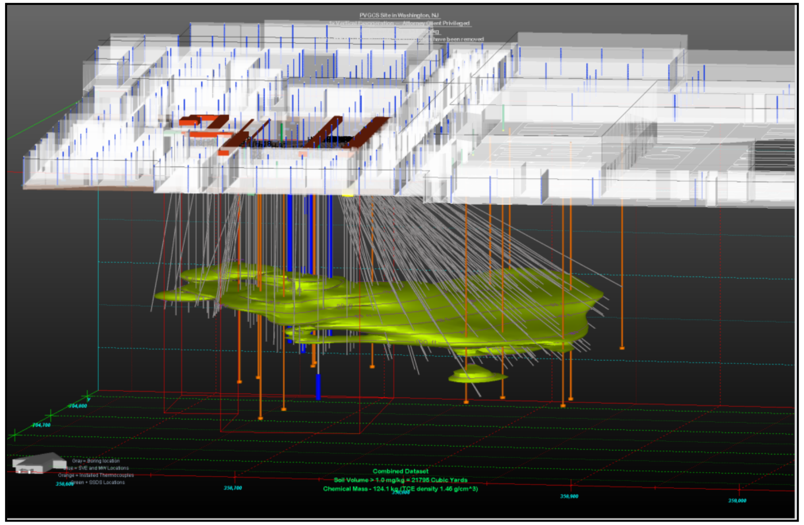


- 23,000 Cu.Yd. target treatment zone (TTZ) located 60 to 120 feet beneath the building floor
- 120-foot-thick vadose zone consisting of glacial till with cobbles to the surface of bedrock with groundwater residing at a depth of 130 feet within bedrock
- In-Situ Thermal Remediation by means of thermal conduction heating (TCH) technology was EPA’s selected remedy to address the source TCE contamination

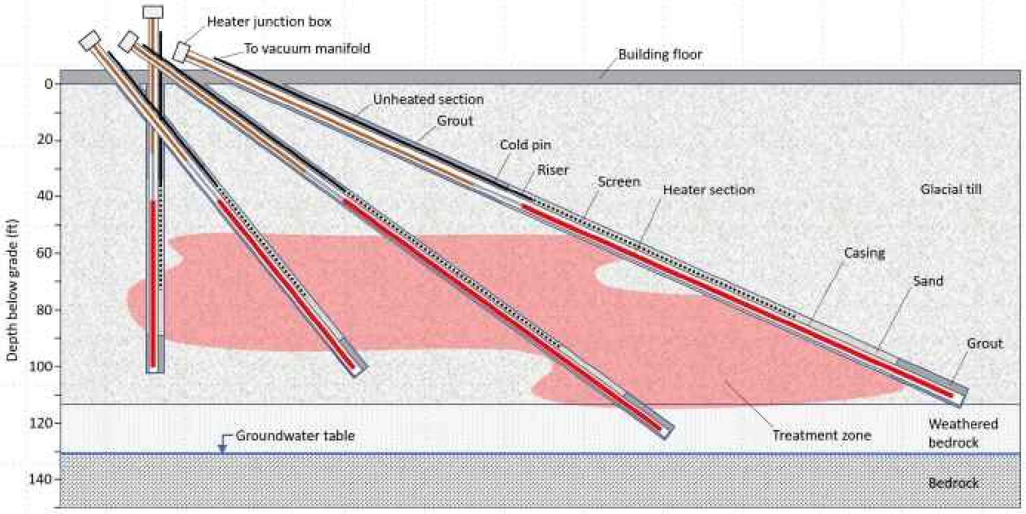
TCH Remedy Implementation Difficulties

- Location, depth, and geometry of subsurface impacts forced the need to perform installation of heaters within building
- Facility operations required construction to be undertaken within a 10,000 ft^2 interior room
- Conventional vertical drilling techniques could not be used to install TCH heater casings
- Low overhead clearance with many obstructions within interior room
- Verifying the placement of as-built angled heaters
- High potential to disrupt facility operations

Heater Arrangement and Design



EVS illustration of TCE impacts and designed TCH heater layout



Conceptual layout of vertical and angled heaters

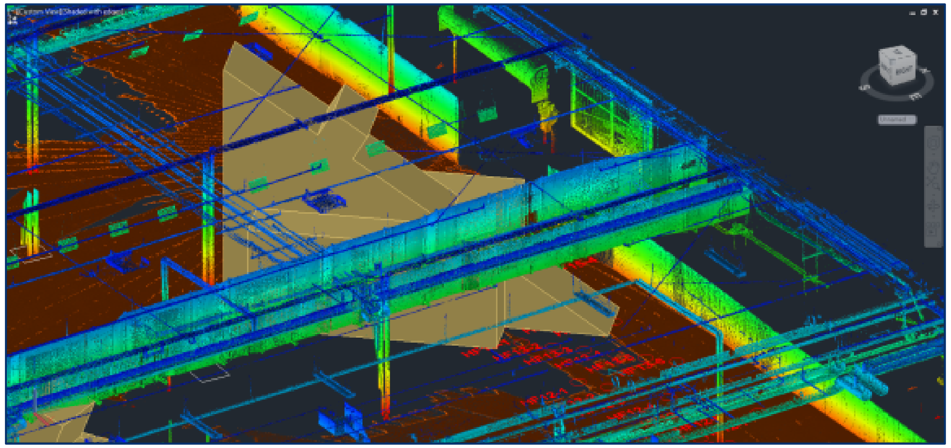
Key Advantages:

- EVS model provided visual confirmation of heater placement throughout TTZ
- Custom heater design resulted in:
  - ✓Smaller heater casing size which minimized material quantities and drill cutting waste
  - ✓Reduced energy use by up to 80% resulting in a significant project cost savings
  - ✓Smaller temperature rise in shallow soils that reduced indoor air heating and VI risk

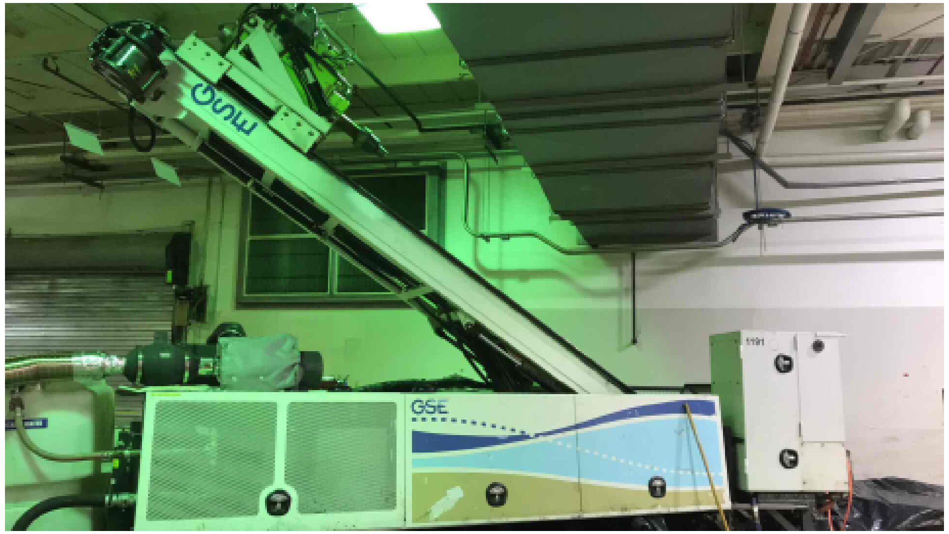
- High resolution site characterization data used to generate a 3D visualization of the TCE impacted soils (EVS model)
- EVS and thermal models used to establish the boundaries of the TTZ and optimize a complex arrangement of 123 angled and 57 vertical heaters
- Customized heater design to minimize heat output above TTZ

Drill Rig Clearance Evaluation

- Low overhead clearance and building structural impediments called-for a design evaluation to identify interferences prior to drilling
- 3D LiDAR point cloud survey of entire interior storage room with AutoCAD desktop analysis
- Allowed for pre-construction adjustment to the location of drilling start points and inclination angles and/or minor modifications to overhead ductwork



3D Point Cloud Survey
and Drill Rig Clearance Evaluation

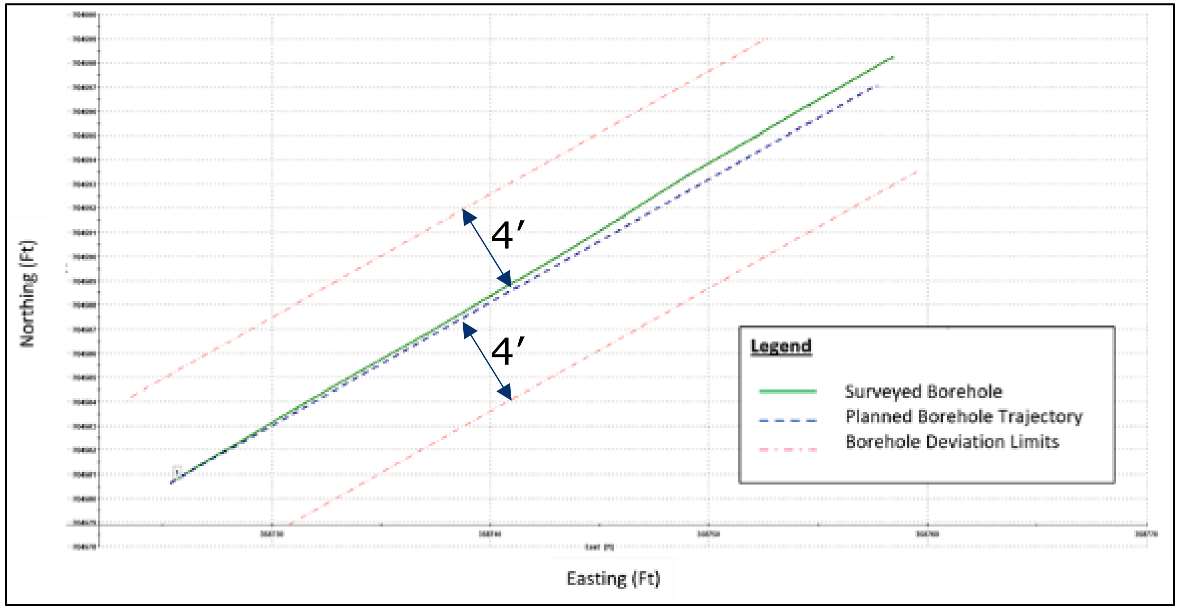


<u>Key Advantages:</u>

- Led to increased confidence that heaters could be installed at designed locations
- Avoided potential schedule delays for in-field heater adjustment and design modifications
- Allowed for simultaneous operation of up to four drilling rigs within the interior room

Angled Borehole Alignment Verification

- Drill rig setup and alignment conducted using DeviAligner™ portable surface alignment tool
- Verification of constructed angled heaters conducted using DeviFlex™ survey tool



DeviFlex™ borehole trajectory survey in X-Y plane

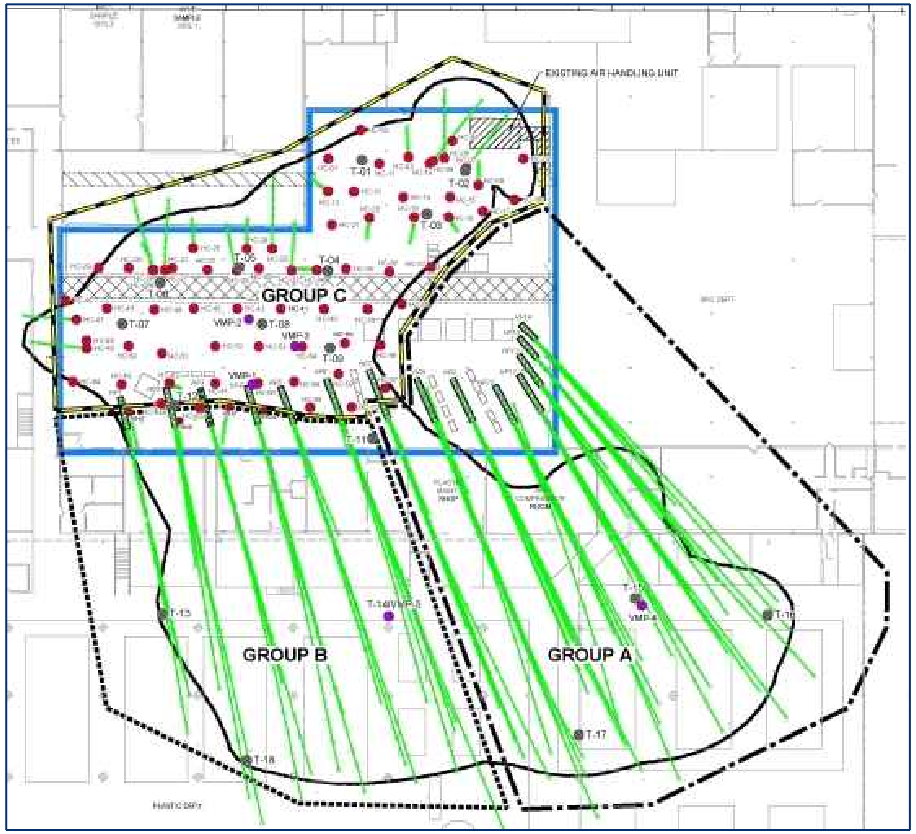
Initial drill casing set-up using DeviAligner™ tool

Surveying of completed heater casing using DeviFlex™ tool

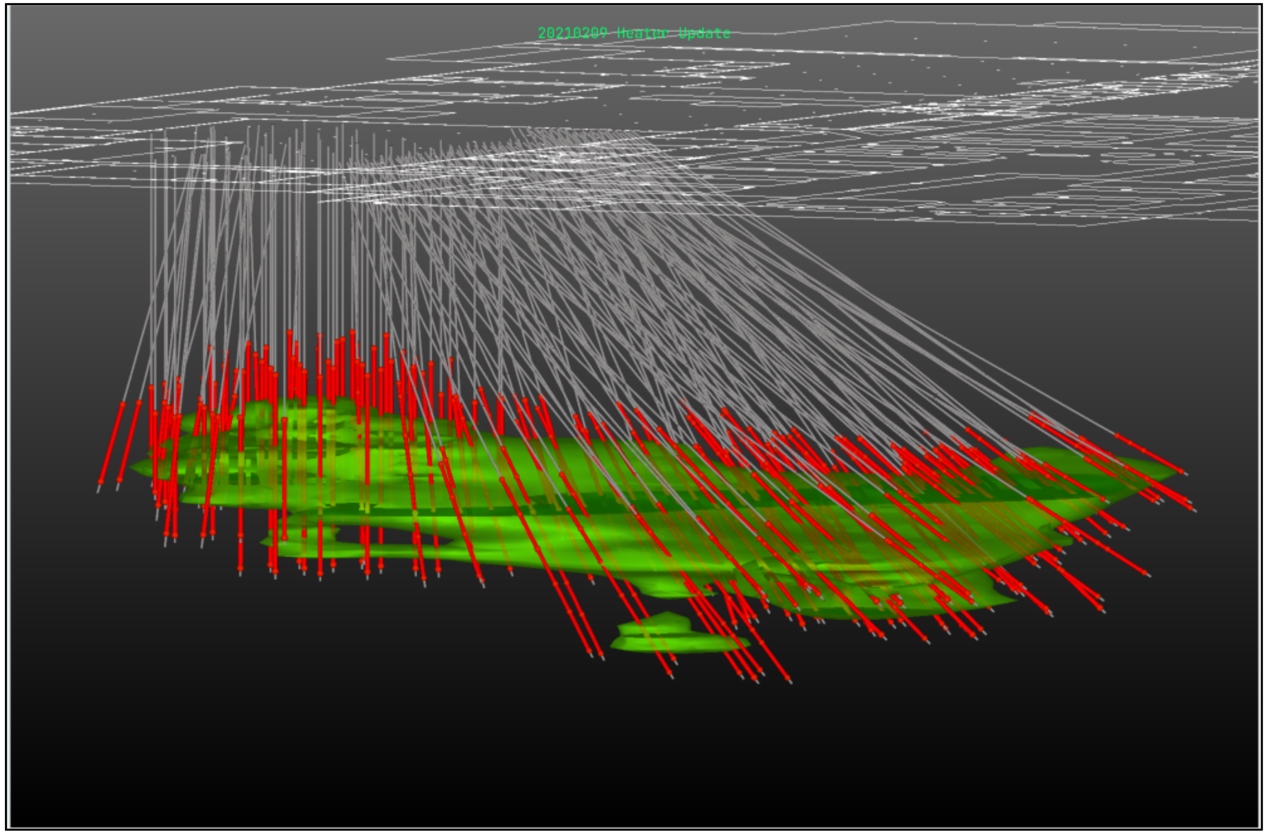
Key Advantages:

- DeviFlex™ survey verified that the heater casings were within the maximum heater spacing tolerance limit of 22 ft
- Allowed for real time adjustments to succeeding adjacent heater borings to compensate or the addition of heaters to ensure effective heating throughout the TTZ

As-Built Heater Layout using DeviFlex™ Survey Data



Plan view of as-built heater casings within TTZ



3D EVS illustration of final TCH layout with heated section locations

Process Treatment System Installation

- Additional difficulties constructing/ installing above-ground treatment system equipment
  - Indoor and outdoor space limitations
  - Forklift pathway across interior room needed by facility
- Solutions to minimize disruption to facility operations
  - Linear alignment of exterior treatment equipment along building
  - Coordinated equipment layout design with the facility’s manufacturing operations
  - Piping and cables routed to outside on roof to free up space inside room

Interior TCH System Process Equipment

Forklift Pathway

Exterior ISTR Treatment System Equipment

Rooftop Cable Trays and Piping Runs

Understanding the operations of the facility and incorporating their requirements into the TCH system design and layout minimized the potential for significant business interruption

Successful partnership and collaboration with the technical contractor and thermal experts resulted in meeting the project delivery requirements and effective remediation of the deep TCE impacts

Results/Lessons Learned

Careful pre-planning and engineering design at the initial stage of the project

- Essential for overcoming the numerous implementation issues associated with the project
- EVS modeling as a design tool under complex plume geometry settings
- Custom heater design resulted in project cost and operational efficiencies
- Identifying potential indoor constructability issues prior to mobilization

Verifying as-built heater placement at prescribed design locations within the TTZ ensured effective heating throughout the TTZ

Acknowledgements

Co-Authors

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