Expediting Groundwater Remediation Through Enhanced Attenuation at the Mound, Ohio, Site

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Track 1.2: Groundwater Remediation and Compliance, Part 1
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Background - Mound Site

- Operated 1948-2003 as an integrated research, development, and production facility to support the nation’s energy and weapons programs
  - Stable isotope separation, fossil fuels research, tritium recovery, and development of radioisotope thermoelectric generators
- Named to National Priority List (1989) due to volatile organic compound (VOC) contamination in groundwater
  - Proximity to Buried Valley Aquifer
- Record of Decision signed in 1995: Collection, Treatment and Disposal of groundwater
  - Pump and treatment
Site Overview
Background - Operable Unit 1

65 year OU-1 history relevant to groundwater

  - Disposal of trash, debris and liquid waste

- 1970
  - Bulk waste relocation & encapsulation

- 1980
  - Groundwater pump & treat
  - Soil vapor extraction
  - Mound production wells “abandoned”
  - Waste & soil removal

- Present

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Remedy Progress

- P&T removed 26 lbs of cVOCs from 1997-2014
  - Expected to achieve cleanup standards for VOCs in groundwater by 2040
- Soil vapor extraction removed approximately 4100 lbs of VOCs (1997-2003)
- Rebound tests (2003 and 2011)
  - 2003 rebound test conducted prior to OU-1 landfill excavation
  - 2011 rebound test conducted after OU-1 landfill excavation
- Comprehensive evaluation of VOCs (2012 – 2013)
  - No primary sources of VOCs remaining
  - Former landfill would be continued long-term source
  - Generally low levels of cVOCs remained (<50 μg/L)
- Any way to expedite remediation?
Geochemical Conditions in OU-1 (2014)

- Aquifer is generally aerobic
- Groundwater in contaminated areas is generally anaerobic
- Reductive dechlorination of perchloroethene (PCE) to trichloroethene (TCE)
- Subsequent reductive dechlorination of TCE to cis-1,2-dichloroethene (DCE) is limited
- Cometabolic aerobic oxidation of TCE and cis-1,2-DCE is feasible
- Site is a suitable candidate for Enhanced Attenuation
Enhanced Attenuation Field Demonstration

- Initiated three-year field demonstration
  - P&T system turned off
- Estimated maximum contaminant levels (MCLs) could be attained by 2027
- Selected EA using edible oils to create “structured geochemical zones” and support passive natural attenuation process for VOCs in soil and groundwater
- Demonstration goals include:
  - Minimize/suppress rebounding groundwater concentrations
  - Avoid plume expansion while P&T system is turned off
  - Meet remediation goals faster and reduce costs

(After Hazen 2010)
Design Approach

- Develop structured geochemical zones and decrease chlorinated VOC concentrations

  - Relies on groundwater flow through succession of anaerobic and aerobic zones
  - Anaerobic zones stimulate rapid degradation of parent compounds
  - Aerobic areas encourage rapid degradation of daughter products
Field Deployment

- **Groundwater (E-series)**
  - Flow paths originating from beneath former landfill
  - Groundwater impact area downgradient of former landfill

- **Soil (N-series)**
  - Areas with elevated PCE and TCE soil concentrations

- **P&T system shut down**
  - Auxiliary treatment system plan
Field Deployment

Neat Oil Totes

Emulsified Oil Totes

Dosing Systems
Data Analysis

- Utilize multiple lines of evidence to interpret data
  - Concentrations and mass of cVOCs
    - Monitoring and Remediation Optimization System (MAROS)
  - Aquifer geochemistry and other physical parameters
    - Oxidation-reduction potential, dissolved oxygen, other indicators
    - Groundwater flow, water levels, temperature
  - Microbial community and active enzymes
    - Generation of daughter products and structured geochemical zones
    - Quantitative Polymerase Chain Reaction (qPCR) of microorganisms
    - Identification of functional genes

- Compare data to USEPA Monitored Natural Attenuation Guidance
First Line of Evidence - VOC Concentrations

August 2014 Baseline - TCE

August 2017 Year Three - TCE
Second Line of Evidence - Geochemical

August 2014 Baseline - ORP

July 2017 Year Three - ORP
Third Line of Evidence - Microbial

Key
- monitoring well (sampled for QuantArray)
- emulsion injection location
- neat oil injection location

Flow

Predeployment Plume Footprint

Cells/mL (1 to 1,000,000)

Favorable

Unfavorable

100 ft

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Summary of Results (2014-2017)

- Dissolved PCE and TCE plumes continue to decrease in size and mass
- Statistical tests indicate the concentrations of the parent constituents continue to decrease in majority of wells
- Biochemistry and microbial community within structured geochemical zones appear to be stable
- Drought and local dewatering project caused disruption in year 2 data
  - Extend study one year to collect additional data

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<th>Cleanup Time Frames</th>
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<td>P&amp;T System</td>
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<td>EA Field Demonstration</td>
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<td>End of Year 2 (2016)</td>
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<td>End of Year 3 (2017)</td>
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Enhanced Attenuation - The Path Forward

- Are contaminants likely to be addressed by natural attenuation processes?
- Will the plume remain stable and hydraulically contained?
- Any potential for unacceptable risk from the contamination?
- Analyze year four data
- Compare to EPA MNA Guidance
- Issue final summary report
- Engage EPA and Ohio EPA in discussions on remedy change