Real-time Solutions to the Challenges Encountered during Thermal Remedy Implementation: Example of Adaptive Management

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Challenges To ISTR

1. When to use Thermal
2. Mass loading
3. Bioactivity and emulsions
4. Shallow water tables
5. Excessive cooling
6. Unexpected conditions
Challenge #1 - When to Use Thermal

• Source area removal
• Difficult geology and lithology
  Clay, Gravel, Bedrock
• Volatile and semi-volatile organics
  Solvents, Petroleum Products, MGP
• DNAPL and LNAPL
• Urgent remediation schedule (sales)
• Stringent clean up goals
  Soil and/or Groundwater
Thermal Treatment Technologies

DECADES OF EXPERIENCE

THERMAL CONDUCTION HEATING
In Situ | Ex Situ | Heated Box (HB)1100

STEAM ENHANCED EXTRACTION
Steam Flushing
Combined SEE and TCH/ERH

ELECTRICAL RESISTANCE HEATING
Three and Six-Phase Heating
Dynamic Systems – Why Adaption is Key

Vapor pressure change
Viscosity Change

Viscosity Change: Adaption is Key

1. Gasoline
2. Kerosene
3. No. 5 Fuel Oil
4. SAE 30 Oil
5. No. 6 Fuel Oil
6. Bunker C
Challenge #2 High Mass Loading

Treat in phases to even out mass loading
Overlap phases to manage heating time

Start Phase 1
End Phase 1
Start Phase 2

Phase 1
Phase 2

SRSNE Superfund site, Connecticut
Challenge #2 High Mass Loading

SRSNE Superfund site, Connecticut

500,000 lbs removed
Challenge #2 High Mass Loading

**Lessons learned: LEL ≠ LFL**

Problem: Thermal oxidizer damage

Issue: Temperature at oxidizer heat exchanger exceeded lower flammability limit (LFL), causing pre-combustion of vapors.

Root causes:
- NAPL carryover into air stripper from condensation step
- Dilution air sensor upstream of air stripper inlet to oxidizer
- Too high operating temperature in therm-ox heat exchanger

Solution:
- Shifted to vapor phase GAC for ~5 week period to repair/upgrade oxidizer
Challenge #3 Emulsions and Bioactivity

In weir tank  
In bucket  
In Jar  

JP-4 Jet fuel SEE site in Meza, Arizona
Challenge #3 Emulsions and Bioactivity

JP-4 Jet fuel SEE site in Meza, Arizona

Jet fuel

Cloudy matter: (dead bacteria & minerals?)

Water
Challenge #4 Shallow Water Table

If extraction screens are flooded - contaminants cannot be removed.

Teterboro, New Jersey
Challenge #4 Shallow Water Table

Thermal Can Bring Up The Water Table

TCH and ERH are net extractors of groundwater

- However -

• Vapor recovery vacuum will draw up water
• Steam production will displace water
• In-situ steaming may push up water

Video showing entrained/geysering water will be shown here
Challenge #5  Excessive Cooling - Deep

• Heat capacity of water is 4 times higher than soil
• Flowing water will cool treatment areas
• Energy usage will increase

Groundwater flow

1 gpm  5 gpm  10 gpm
Challenge #5 Excessive Cooling - Deep

Issue: Inability to heat bottom of the treatment zone

Solutions:
- Apply more energy
  - Add heaters or electrodes
- Install barrier walls to cut off water flow
- Pump upgradient for hydraulic control
- Inject steam
Challenge #5  Excessive Cooling - Shallow

- Surface water is also a problem
- Leaking cover will cool treatment zone

IPTD project

IPTD project, High temperature application

Average Pile Temperatures by Depth

Rain water infiltration

IPTD project, High temperature application

2019 Design and Construction Issues at Hazardous Waste Sites
Challenge #6 Unexpected Site Conditions

Freezing at SEE site, New Hampshire

Pipes Filling with Tar
MGP site, Illinois
Summary

- Thermal remedies are aggressive - operational issues must be addressed immediately
- Real-time data collection and evaluation is required
- On-the-fly decision needs to be made by the contractor, client and agencies
- Operational changes have to be implemented rapidly in the ever changing environment
Questions?

Large TCH Site

Small TCH Site

Bedrock Cores