AIR-BASED REMEDIATION TECHNOLOGY SELECTION LOGIC

Overview

- Identify important site/project parameters
- Present general decision logic to select potentially applicable air-based remediation technologies
- Apply to example sites

Important Site/Project Parameters

- Media to be remediated (soil, groundwater, both soil and groundwater)
- Contaminant type
  - Low molecular-weight (MW) hydrocarbons
  - Medium/high-MW hydrocarbons
  - Chlorinated solvents
- Site hydrogeology
  - Homogeneous or heterogeneous subsurface materials
  - Sand/gravel or Silts/clays
- Time and funding available for project completion

General Approach

- Identify media to be treated
- Go to appropriate slide
  - Slide 5 for soil only
  - Slide 9 for groundwater only
  - Slide 15 for both soil and groundwater
- Follow logic shown on the slides to identify applicable air-based technologies
- Possible non-air-based technologies noted (in parentheses)

Treat Unsaturated Soil

- Low-MW Petroleum Hydrocarbons
  - If homogeneous sand/gravel:
    - SVE (if rapid restoration is required), possibly transitioning to BV;
    - BV if more time available and immiscible fuel not present in large quantities
  - If heterogeneous mix of sand/silt/clay:
    - SVE, with potential enhancements such as soil fracturing, long restoration times possible;
    - BV, long restoration times likely
    - ISTR, if shorter restoration times desired, higher costs

Treat Unsaturated Soil, Continued

- Low-MW Hydrocarbons, Continued
  - If predominantly silt/clay:
    - SVE, low flow rates with enhancements such as hot dry air injection and/or fracturing
    - ISTR (ERH, TCH, steam)
    - (Natural attenuation)

Treat Unsaturated Soil, Continued

- High-MW Petroleum Hydrocarbons
  - If homogeneous sand/gravel:
    - BV, possibly with early SVE phase, long restoration times possible
    - ISTR (ERH, steam, TCH) if quick restoration necessary
  - If mixture of sand/silt/clay:
    - BV (or SVE followed by BV), long restoration times likely, some residual low-solubility/mobility/toxicity hydrocarbons will remain
    - ISTR (steam, TCH, ERH) if quick restoration necessary
  - If predominantly silt/clay:
    - ISTR (ERH, TCH)
    - (Natural attenuation)

Treat Unsaturated Soil, Continued

- Chlorinated Solvents
  - If homogeneous sand/gravel:
    - SVE
    - Cometabolic BV, if little immiscible solvent present
    - Ozone oxidation possible alternative
  - If heterogeneous mix of sand/silt/clay:
    - SVE, longer restoration times possible, enhancements such as soil fracturing may be needed
    - Cometabolic BV, if little immiscible solvent present, long restoration times likely
  - If predominantly silt/clay:
    - ISTR (ERH, TCH)

Treat Groundwater

- Low-MW Hydrocarbons
  - If homogeneous sand/gravel
    - Air sparging, if little or no floating fuel, rapid restoration desirable, SVE may be necessary to capture vapors
    - Biosparging, if no floating fuel, short restoration time not needed
    - Product skimming, dual extraction, if floating fuels present
  - If heterogeneous mix of sand/silt/clay
    - Biosparging, if no floating fuel, long restoration times likely
    - Product skimming if goal is only to remove mobile product
    - TPE (particularly if floating fuel present) or DPE
    - Ground water circulation wells, if dissolved contaminant
    - ISTR (ERH, steam, TCH) if rapid restoration and/or very low concentrations desired
    - (In-situ chemical oxidation, bioremediation)

Treat Groundwater, Continued

- Low-MW Petroleum Hydrocarbons, Continued
  - If predominantly silt/clay:
    - High-vacuum two-phase extraction (if mostly silt)
    - ISTR (ERH, TCH)
    - (Natural attenuation)

Treat Groundwater, Continued

- High-MW Petroleum Hydrocarbons
  - If homogeneous sand/gravel:
    - Air sparging transitioning to biosparging if little floating fuel
    - Biosparging, if no floating fuel, short restoration time not needed
    - Product skimming, dual extraction, if floating fuels present
  - If heterogeneous mix of sand/silt/clay:
    - Biosparging, if no floating fuel, long restoration times likely
    - Product skimming if goal is only to remove mobile product
    - TPE (particularly if floating fuel present) or DPE, residual hydrocarbons likely following treatment
    - ISTR (ERH, steam, TCH) if rapid restoration and/or low concentrations desired
    - (In-situ chemical oxidation, bioremediation)

Treat Groundwater, Continued

- High-MW Petroleum Hydrocarbons, Continued
  - If predominantly silt/clay:
    - High-vacuum TPE (if mostly silt), significant residual low solubility/mobility/toxicity hydrocarbon will remain
    - ISTR (ERH, TCH)
    - (Natural attenuation?)

Treat Groundwater, Continued

- Chlorinated Solvents
  - If homogeneous sand/gravel:
    - Air sparging, if contaminant is primarily concentrated near water table; SVE may be necessary for vapors
    - Cometabolic air sparging (for chlorinated ethenes)
    - Product removal, if immiscible product (DNAPL) present, incomplete removal is highly likely
    - DPE if no immiscible product
    - ISTR if immiscible product (DNAPL) present and low residual concentrations required
  - If heterogeneous mix of sand/silt/clay:
    - DPE, TPE
    - Groundwater Circulation Wells, no immiscible product
    - ISTR (ERH, steam, TCH) if rapid restoration and/or low concentrations desired
    - (In-situ chemical oxidation, enhanced bioremediation)

Treat Groundwater, Continued

- Chlorinated Solvents, Continued
  - If predominantly silt/clay:
    - High-vacuum TPE (if mostly silt)
    - ISTR (ERH, TCH)

Treat Soil and Groundwater

- Low-MW Hydrocarbons
  - If homogeneous sand/gravel:
    - SVE and Air sparging, if little or no floating fuel, rapid restoration desirable, possibly transitioning to bioventing/biosparging
    - Bioventing and biosparging, if no floating fuel, short restoration time not needed
    - SVE and product skimming or dual extraction, if floating fuels present

Treat Soil and Groundwater, Continued

- Low-MW Petroleum Hydrocarbons, Continued
  - If heterogeneous mix of sand/silt/clay:
    - SVE (and/or bioventing) with biosparging, if no floating fuel, long restoration times likely, enhancements such as soil fracturing may be necessary above water table
    - SVE (and/or bioventing) and product skimming if goal for water is only to remove mobile product
    - TPE (particularly if floating fuel present) or DPE
    - Ground water circulation wells, if dissolved contaminant
    - ISTR (ERH, steam, TCH) if rapid restoration and/or very low concentrations desired
  - If predominantly silt/clay:
    - High-vacuum TPE (if mostly silt)
    - ISTR (ERH, TCH)
    - (Natural attenuation)

Treat Soil and Groundwater, Continued

- High-MW Petroleum Hydrocarbons
  - If homogeneous sand/gravel:
    - SVE and air sparging transitioning to bioventing and biosparging if little floating fuel
    - Bioventing and biosparging, if no floating fuel, short restoration time not needed, residual contaminants likely
    - SVE and product skimming or dual extraction, if floating fuels present, residual contaminants likely

Treat Soil and Groundwater, Continued

- High-MW Petroleum Hydrocarbons, Continued
  - If heterogeneous mix of sand/silt/clay:
    - Bioventing and biosparging, if no floating fuel, long restoration times likely
    - Bioventing and product skimming if goal for water is only to remove mobile product, residual hydrocarbons likely
    - TPE (particularly if floating fuel present) or DPE, residual hydrocarbons likely
    - ISTR (ERH, steam, TCH) if rapid restoration desired
    - (In-situ chemical oxidation, bioremediation)
  - If predominantly silt/clay:
    - High-vacuum TPE (if mostly silt)
    - ISTR (ERH, TCH)
    - (Natural attenuation)

Treat Soil and Groundwater, Continued

- Chlorinated Solvents
  - If homogeneous sand/gravel:
    - SVE and air sparging, if contaminant is primarily concentrated near water table
    - Cometabolic bioventing and air sparging (for dissolved chlorinated ethenes)
    - SVE and product removal, if immiscible product (DNAPL) present, incomplete removal is likely
    - DPE if no immiscible product
    - ISTR if immiscible product (DNAPL) present and low residual concentrations required

Treat Soil and Groundwater, Continued

- Chlorinated Solvents, Continued
  - If heterogeneous mix of sand/silt/clay:
    - DPE, TPE
    - Groundwater Circulation Wells, no immiscible product
    - ISTR (ERH, steam, TCH) if rapid restoration and/or low concentrations desired
    - SVE or cometabolic bioventing, possibly with enhancements (e.g., soil fracturing), with cometabolic biosparging, risk of incomplete treatment
    - (In-situ chemical oxidation, enhanced bioremediation)
  - If predominantly silt/clay:
    - High-vacuum TPE (if mostly silt)
    - ISTR (ERH, TCH)

Example Application 1

- Hypothetical Site
  - Underground storage tank that leaked diesel fuel over past 20 years
  - Geology: interbedded fine sands and silts
  - Groundwater is deep (~30 m), contamination extends only to ~20 m
  - Site is soon to be developed for residential use

Example Application 1, Continued

- Decision logic
  - Soil only
  - High-MW Petroleum Hydrocarbons
  - Mixture of sands/silts
  - Options:
    - SVE followed by BV (or BV) – slow but low cost
    - ISTR, if want to attain low concentrations – fast, but more costly
    - Too deep for practical excavation

Example Application 2

- Hypothetical Site
  - Trichloroethene-contaminated sump water discharged to on-site ditch
  - Geology: thin (1-2 m) silt-rich layer over fine to medium grained sands, impermeable bedrock at 25 m
  - Groundwater is shallow (7 m), contamination (up to 700 ug/L) extends only to ~15 m, no immiscible product suspected
  - Site is and will be used for industrial purposes

Example Application 2, Continued

- Decision logic
  - Soil and groundwater to be treated
  - Chlorinated solvents
  - Homogeneous sands
  - Options:
    - SVE and air sparging
    - Cometabolic bioventing and air sparging
    - DPE
    - SVE and simple ground water pumping another option, if containment of plume required
    - (In-situ chemical oxidation)

Example Applications

- Students' Projects
  - Media to be treated
  - Contaminant(s)
  - Geology
  - Constraints on goals, schedules, funding