

BASICS OF PETROLEUM REMEDICATION - 101

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October 2, 2009



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REMEDIATION PROCESS



- Assessment
- Design
- Installation
- Operation
- Monitoring
- Closure



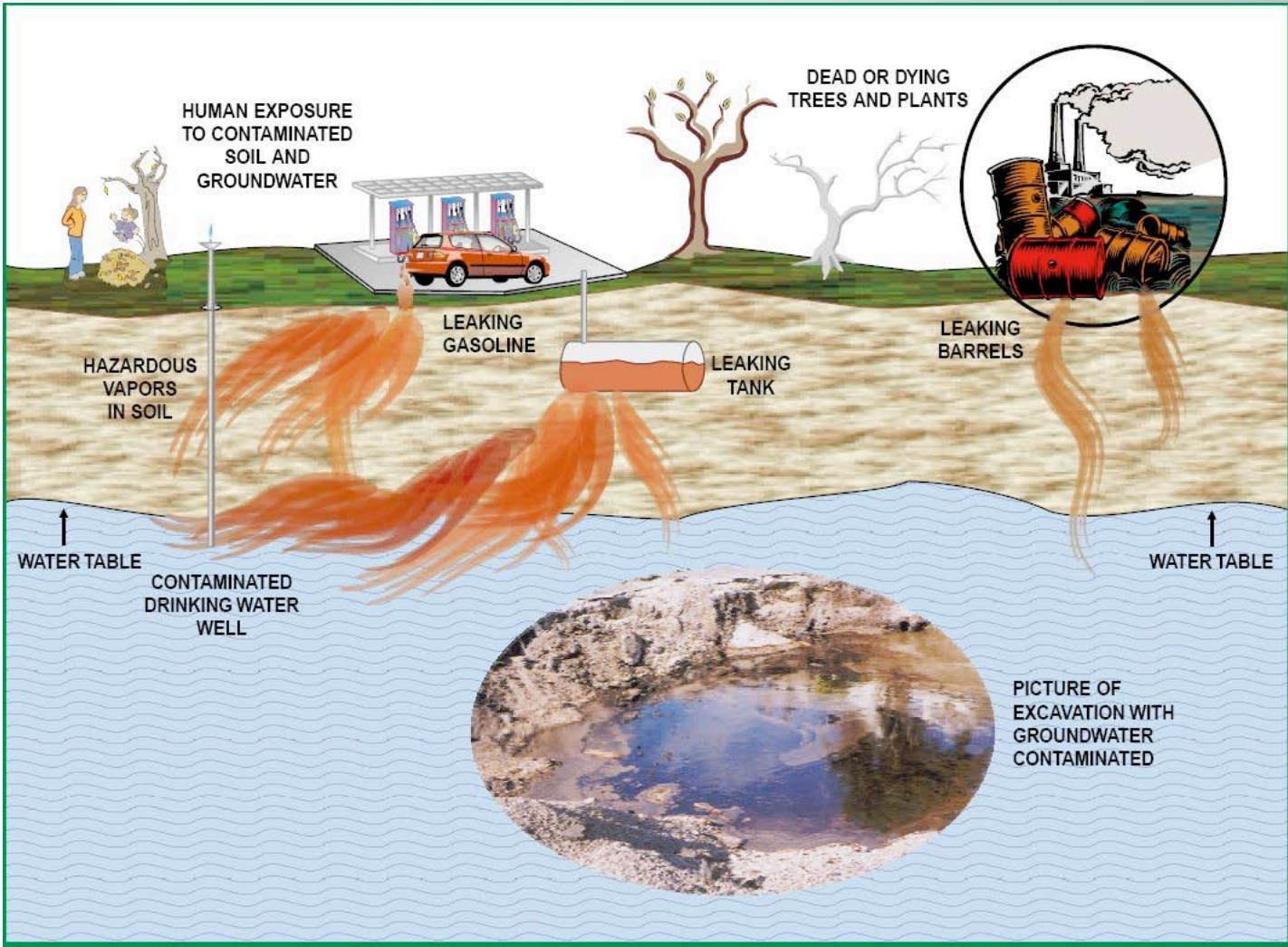
ASSESSMENT PROCESS



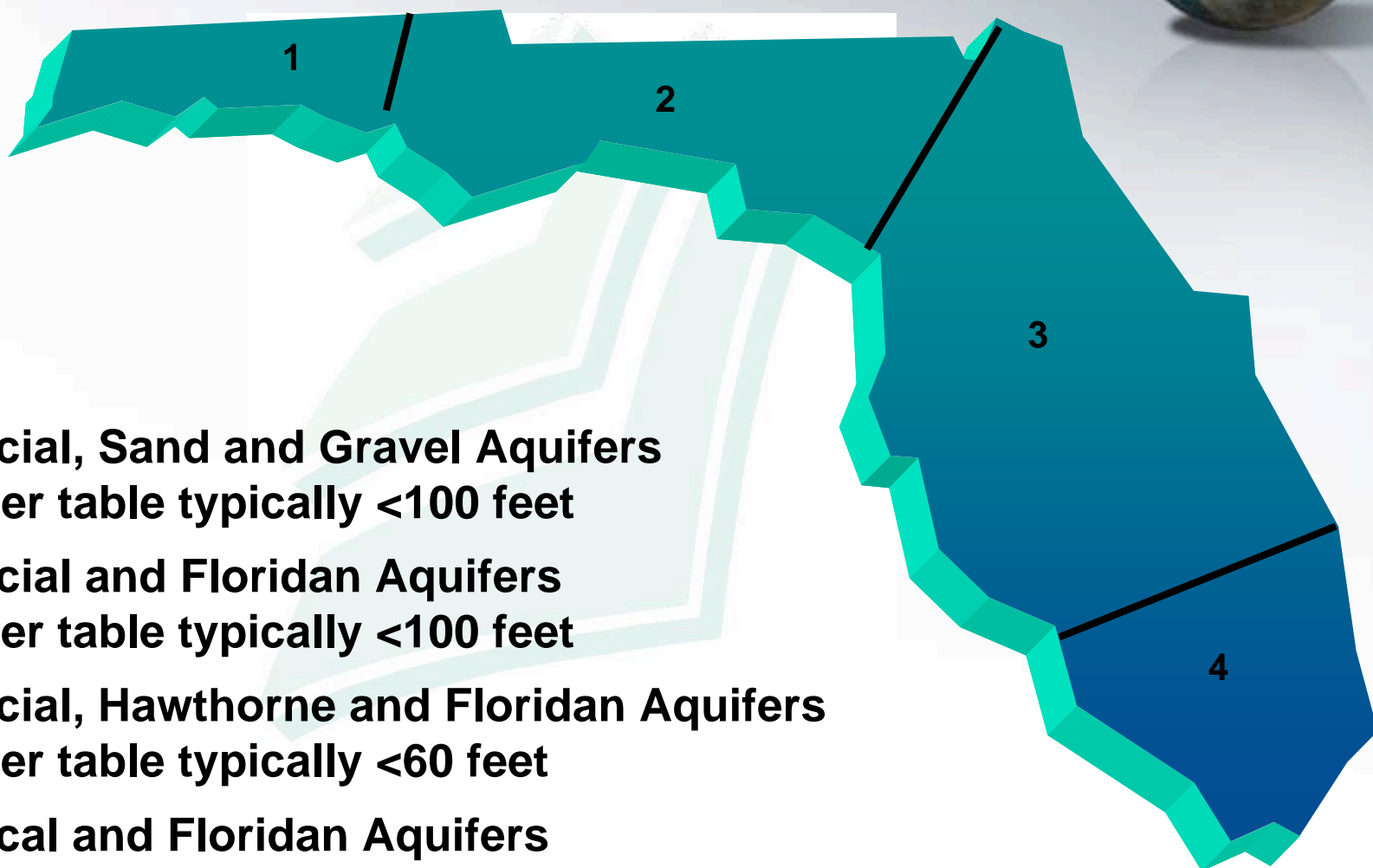
- Identify Sources
- Define Horizontal And Vertical Extent Of All Contamination
 - Free Product
 - Soil
 - Water (Groundwater And Surface Water)
 - Vapors
- Know The Regulations
- On Site Days To Weeks In Phases
- Total Duration Of Months To Years



IDENTIFY SOURCES



FLORIDA'S UNIQUE HYDROGEOLOGY



- 1 – Surficial, Sand and Gravel Aquifers**
Water table typically <100 feet
- 2 – Surficial and Floridan Aquifers**
Water table typically <100 feet
- 3 – Surficial, Hawthorne and Floridan Aquifers**
Water table typically <60 feet
- 4 – Surficial and Floridan Aquifers**
Water table typically <15 feet

PRESUMPTIVE REMEDY ZONE 1



- Typical Cost \$500K to \$800K
- Conventional Excavation for Source Removal
- Large Dimensional Auger (LDA) Excavations for Source Removal
 - Clayey areas with deep water table
- Air Sparge (AS) – Soil Vapor Extraction (SVE)
- Multi-Phase Extraction when product present
- Biosparge
- Chemical & Biological Injections

PRESUMPTIVE REMEDY ZONE 2 & 3



- Typical Cost \$500K to \$1M
- LDA Excavations for Source Removal
 - Clayey areas with deep water table
- Conventional Excavations for Source Removal
 - Shallow water table and coastal areas
- AS – SVE and MPE when product present
- Horizontal Wells
- Chemical & Biological Injections
- Biosparge

PRESUMPTIVE REMEDY ZONE 4



- Typical Cost \$400K
- Conventional Excavations for Source Removal
 - Shallow water table and coastal areas
- AS – SVE
- MPE when product present
- Biosparge
- Chemical & Biological Injections

DESIGN



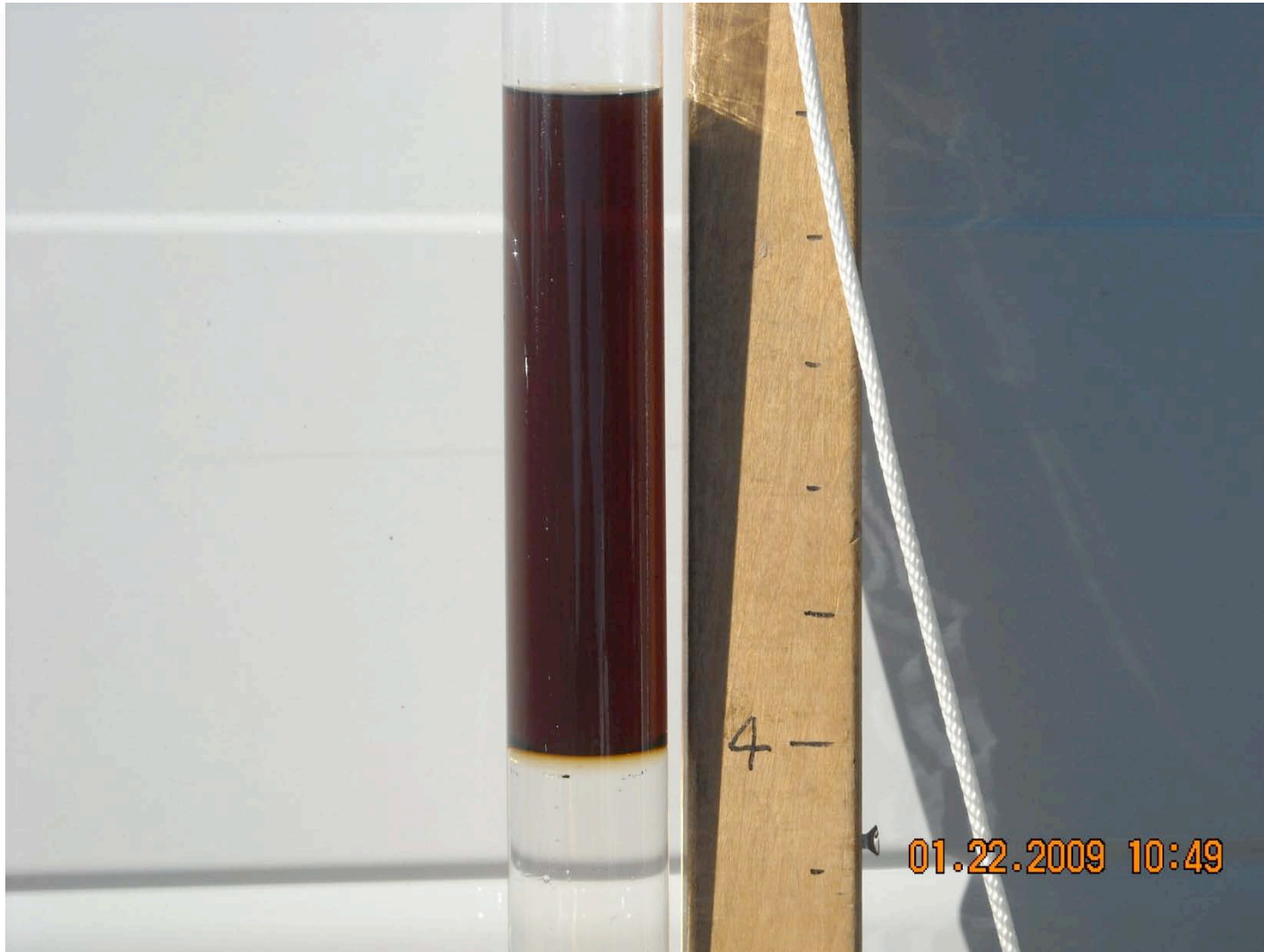
- Pilot Testing
- Additional Sampling
- Incorporate Site Specific Considerations
 - Regulatory Requirements For Each Media
 - Active Systems
 - Passive Systems
 - System Location
- On Site Zero To A Few Days

FREE PRODUCT REMEDIATION

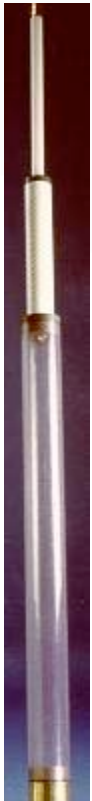


- Bailer
- Sorbents
- Skimmers
- Vacuum Truck
- Multi-Phase Extraction

Bailer With Free Product



Sorbents And Passive Skimmer



Solar Powered Skimmer



Solar Powered Skimmer



Vacuum Truck



Soil Remediation



- Conventional Excavation
- Large Diameter Auger (LDA) Excavation
- Soil Vapor Extraction (SVE)

SHEET PILING



SHEET PILING INSTALLED



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CONVENTIONAL EXCAVATION



LARGE DIAMETER AUGER



PORTABLE CONCRETE PLANT



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FILLING WITH FLOWABLE FILL



08/08/2007

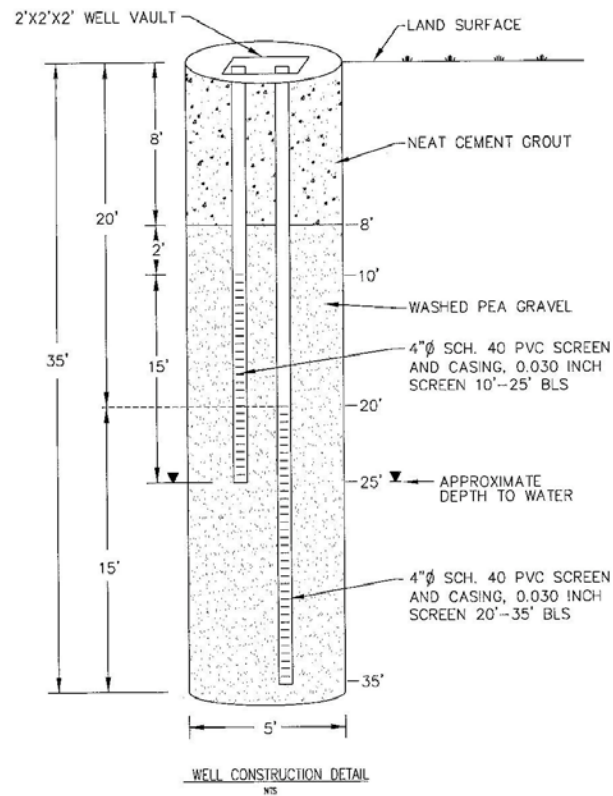
OVERLAPPING LDA HOLES



LDA SUPPORT COLUMNS



LDA BORING CONVERTED TO WELL

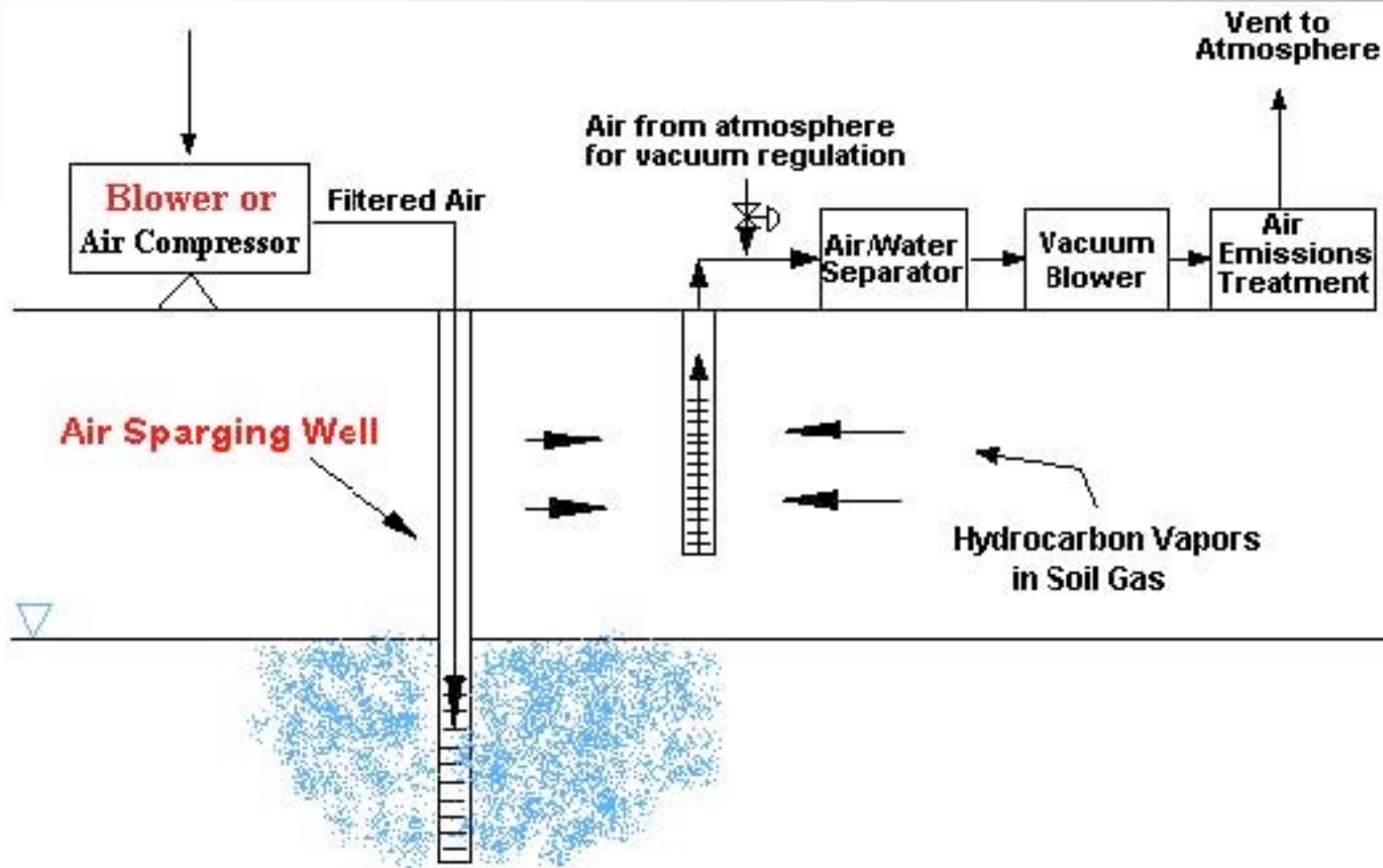


GROUNDWATER REMEDIATION



- Air Sparge and Vapor Extraction
- Pump and Treat
- Bioremediation
- Chemical Oxidation

AIR SPARGING AND SOIL VAPOR EXTRACTION SCHEMATIC



AIR SPARGE AND SVE SYSTEM

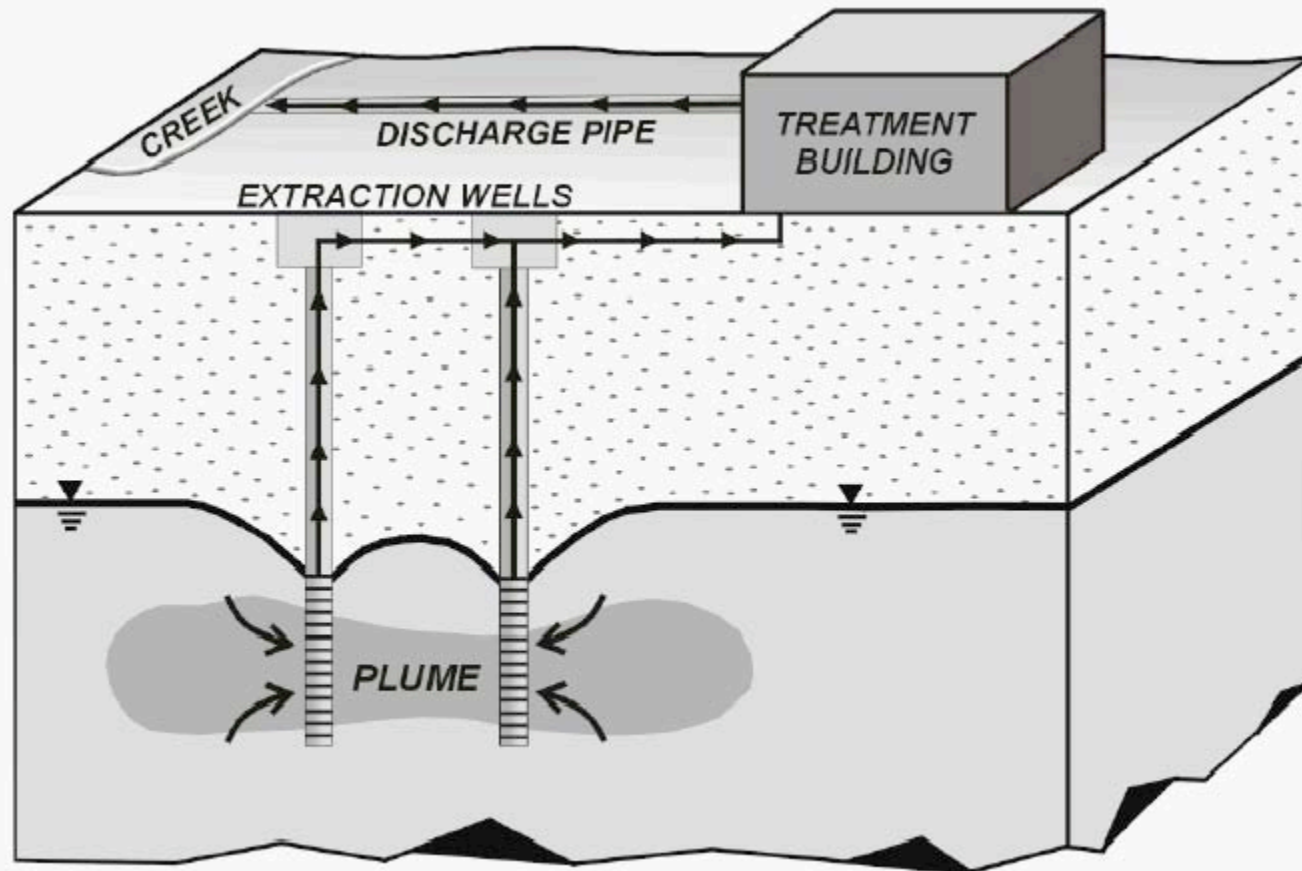


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TREATMENT SYSTEM TRAILER



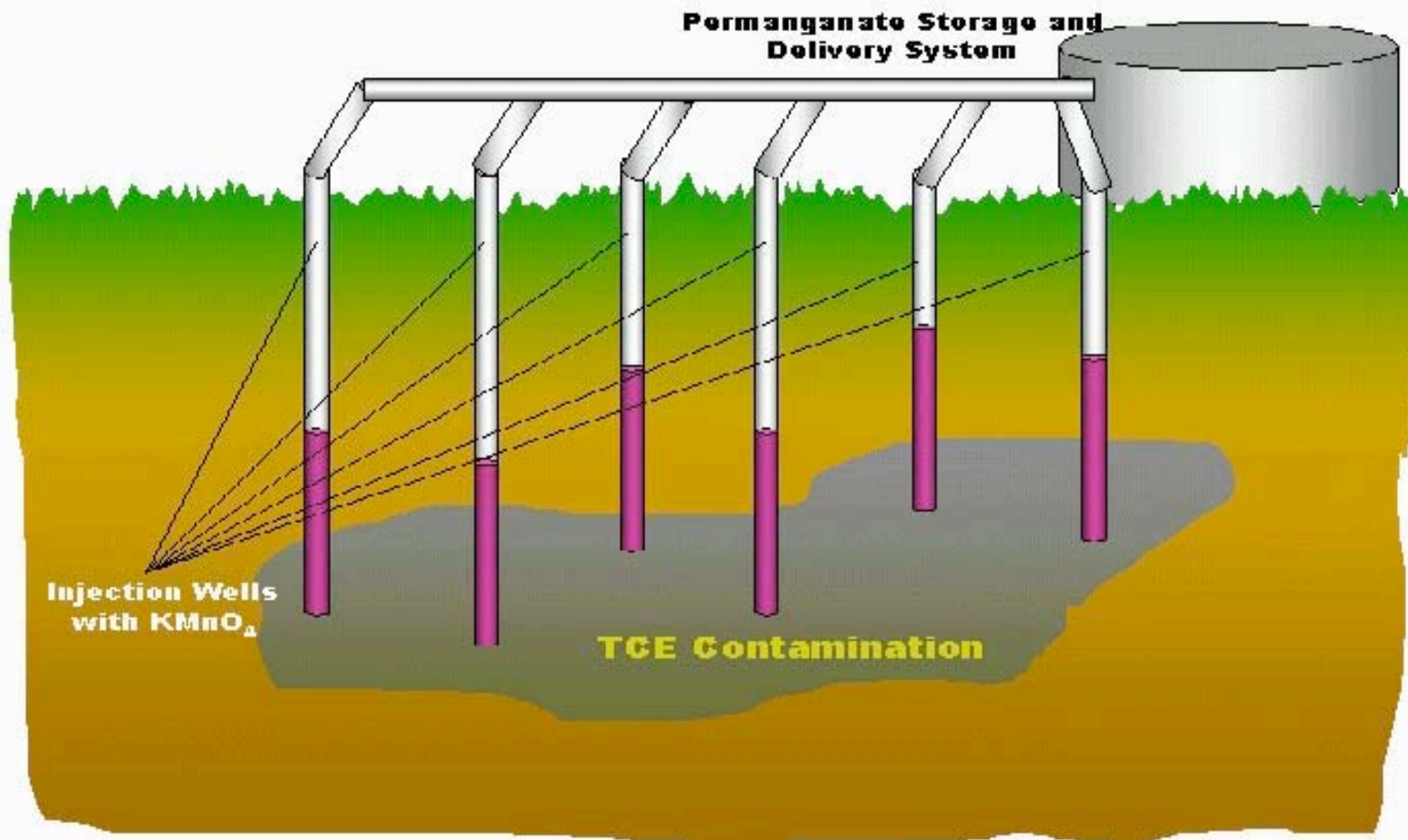
PUMP AND TREAT SCHEMATIC



TREATMENT SYSTEM WITH TRAY STRIPPER



CHEMICAL OXIDATION OR BIOREMEDIATION SCHEMATIC



CHEMICAL INJECTION SYSTEM



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BIOREMEDIATION



- Aerobic vs. Anaerobic
- Biostimulation
 - Add nutrients, oxygen, etc. to stimulate existing microbes
 - Molasses, edible oil, lactate, magnesium peroxide
- Bioaugmentation
 - Add microbes, either natural or genetically engineered
 - Dehalococcoides, gene expression factor
- Natural Attenuation

IN-SITU CHEMICAL OXIDATION



- Hydrogen Peroxide/Fenton's Reagent
- Hydrogen Peroxide/Chelated Iron Catalyst
- Potassium or Sodium Permanganate
- Sodium Persulfate
- Ozone/Hydrogen Peroxide plus Ozone
- Calcium Peroxide

HYDROGEN PEROXIDE



POTASSIUM PERMANGANATE



OTHER CHEMICAL OXIDATION



- Sodium Persulfate

- Activated with heat or ferrous salts
- Relatively long lasting (hours to weeks)

- Ozone

- Gas generated on site
- Short life span (minutes to hours)

- Calcium Peroxide

- Works at neutral to basic pH
- Very long lasting (weeks to months)
- Encourages biological activity

MONITORING



- Typically Quarterly site visits to collect system and groundwater samples
- During remediation to evaluate progress
- One year post remediation to demonstrate target levels are achieved
- System Restart/Reinjection if concentrations rebound

CLOSURE



- Typically one to five years to achieve
- \$20,000 to \$5 million
- Closure with Conditions
- Clean Closure
- Regulatory Approval Order



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THANK YOU 😊