

BASICS OF PETROLEUM REMEDICATION - 101

Lance I. Robinson, PE

November 6, 2009



REMEDIATION PROCESS



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

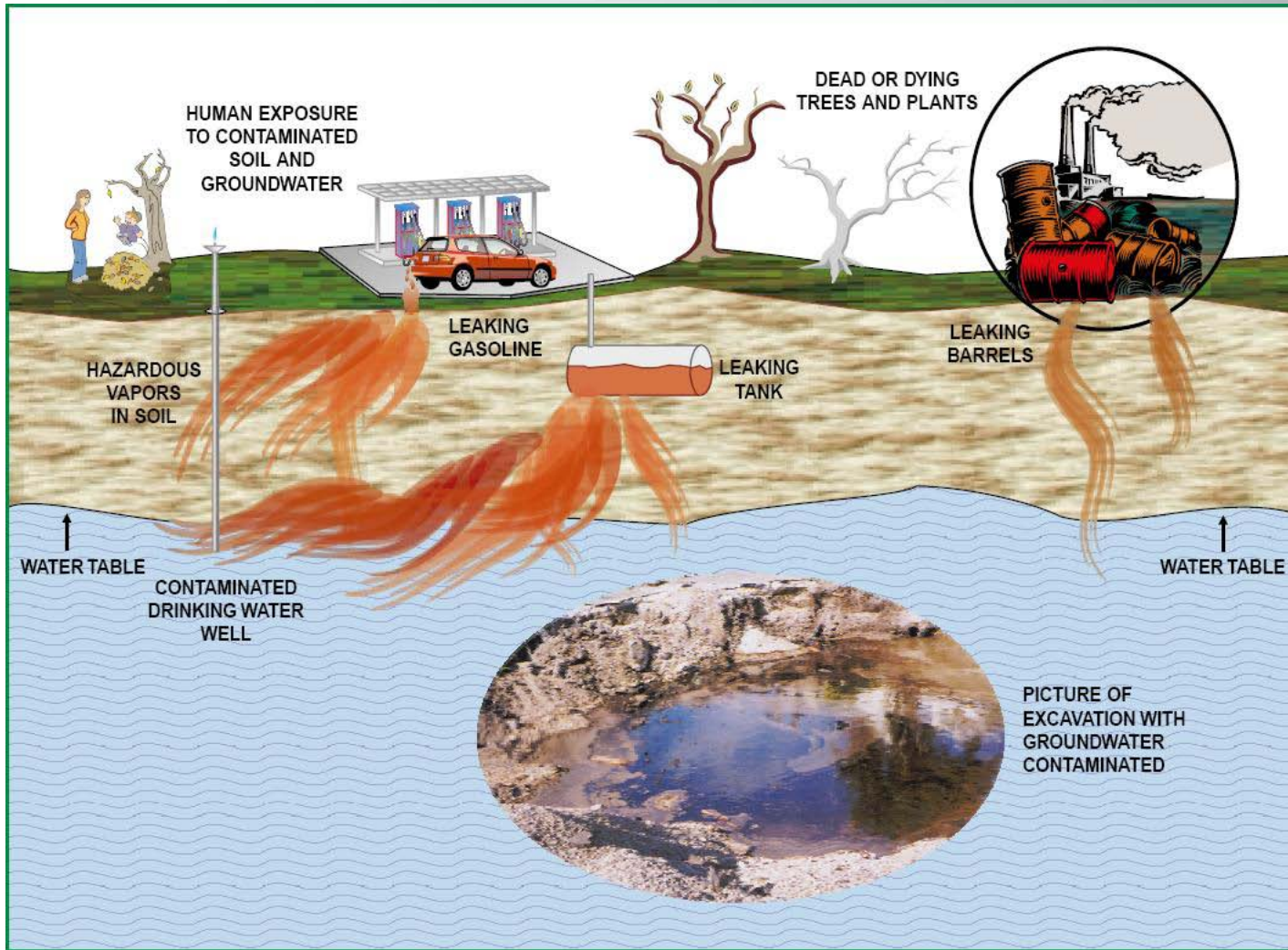


ASSESSMENT PROCESS

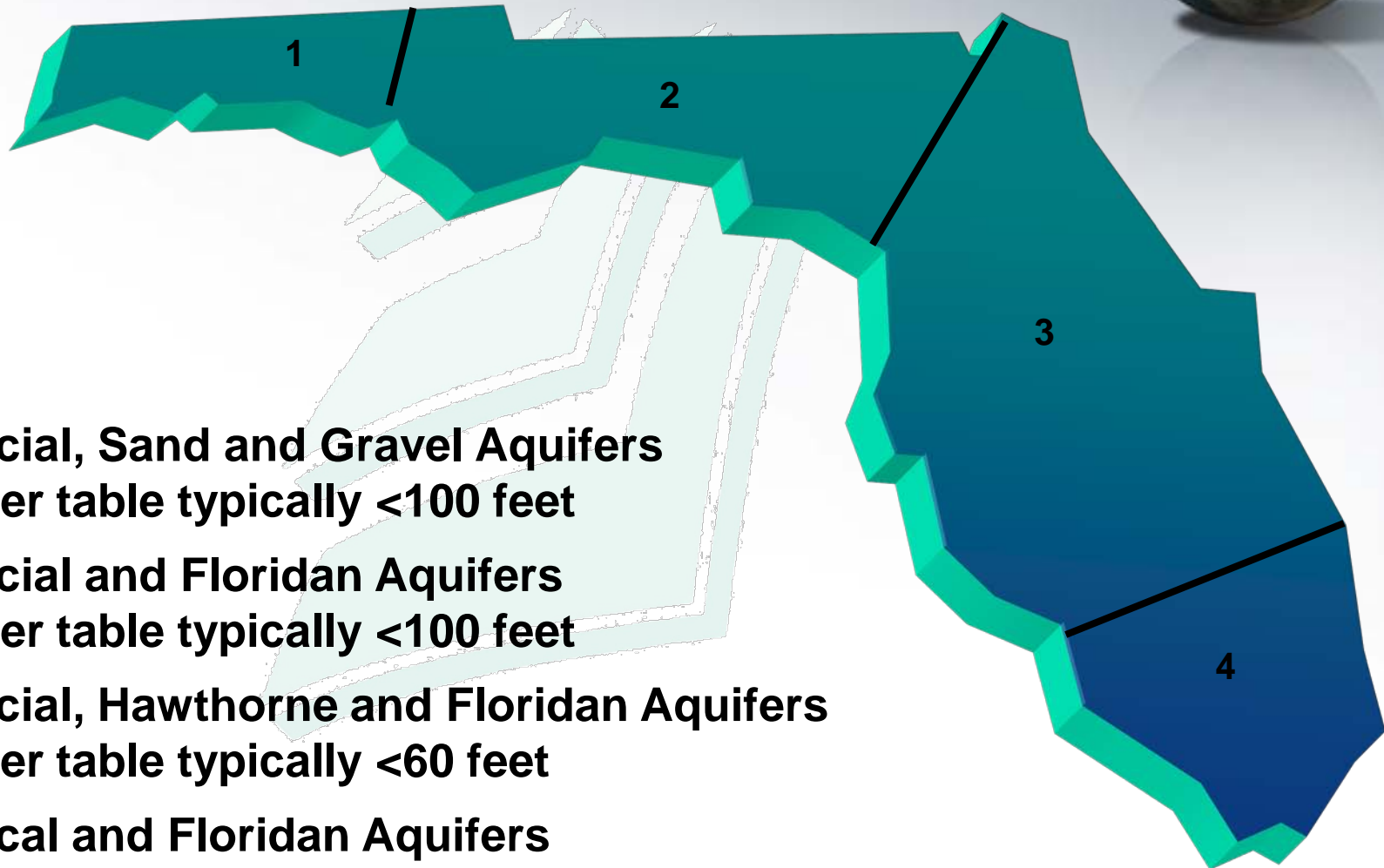


- Identify Sources
- Define Horizontal And Vertical Extent Of All Contamination
 - Free Product
 - Soil
 - Water (Groundwater And Surface Water)
 - Vapors
- Know The Regulations
- On Site Days To Weeks In Phases
- Total Duration Of Months To Years

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

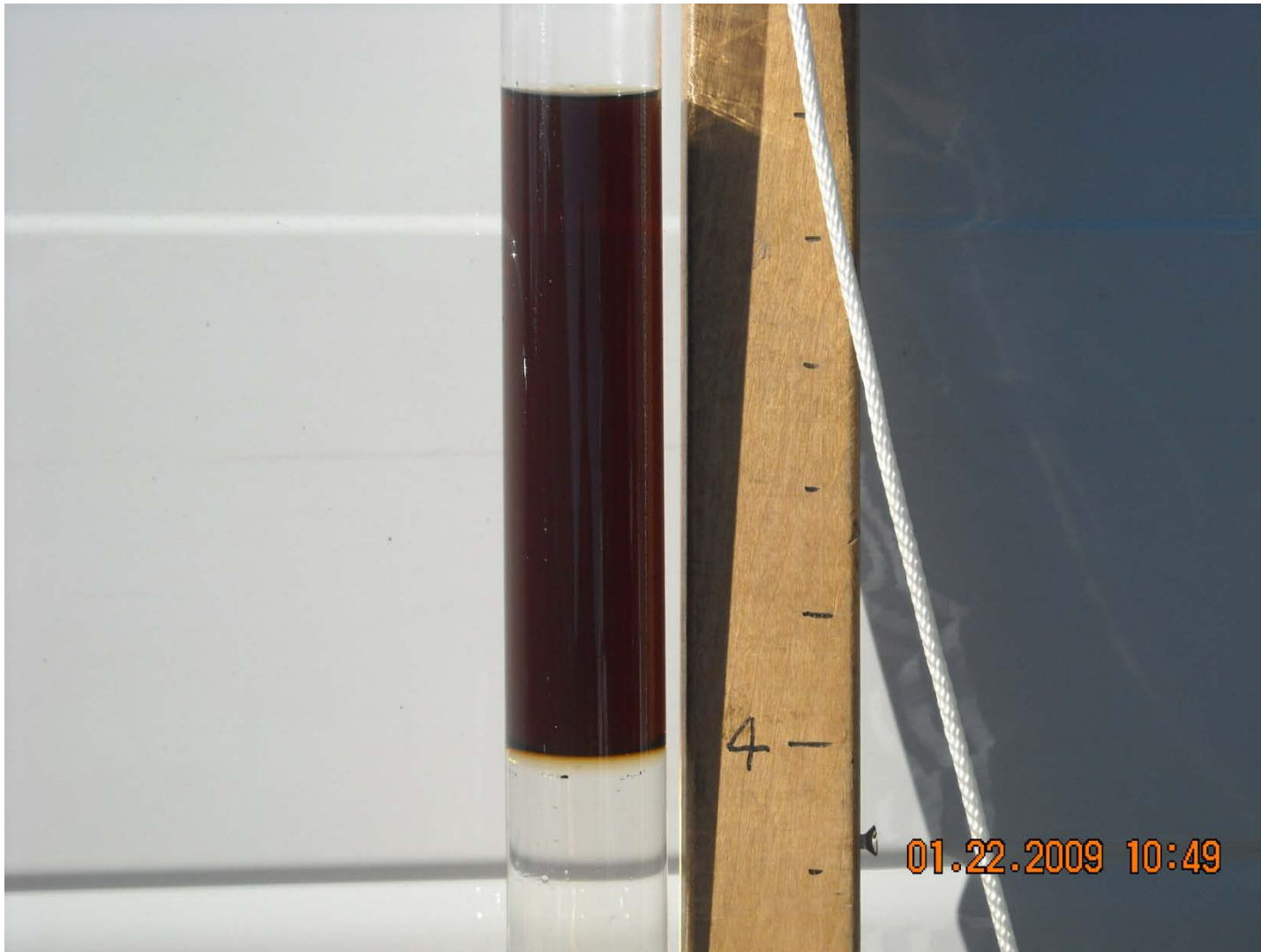
FREE PRODUCT REMEDIATION



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



Bailer With Free Product



Sorbents And Passive Skimmer



Solar Powered Skimmer



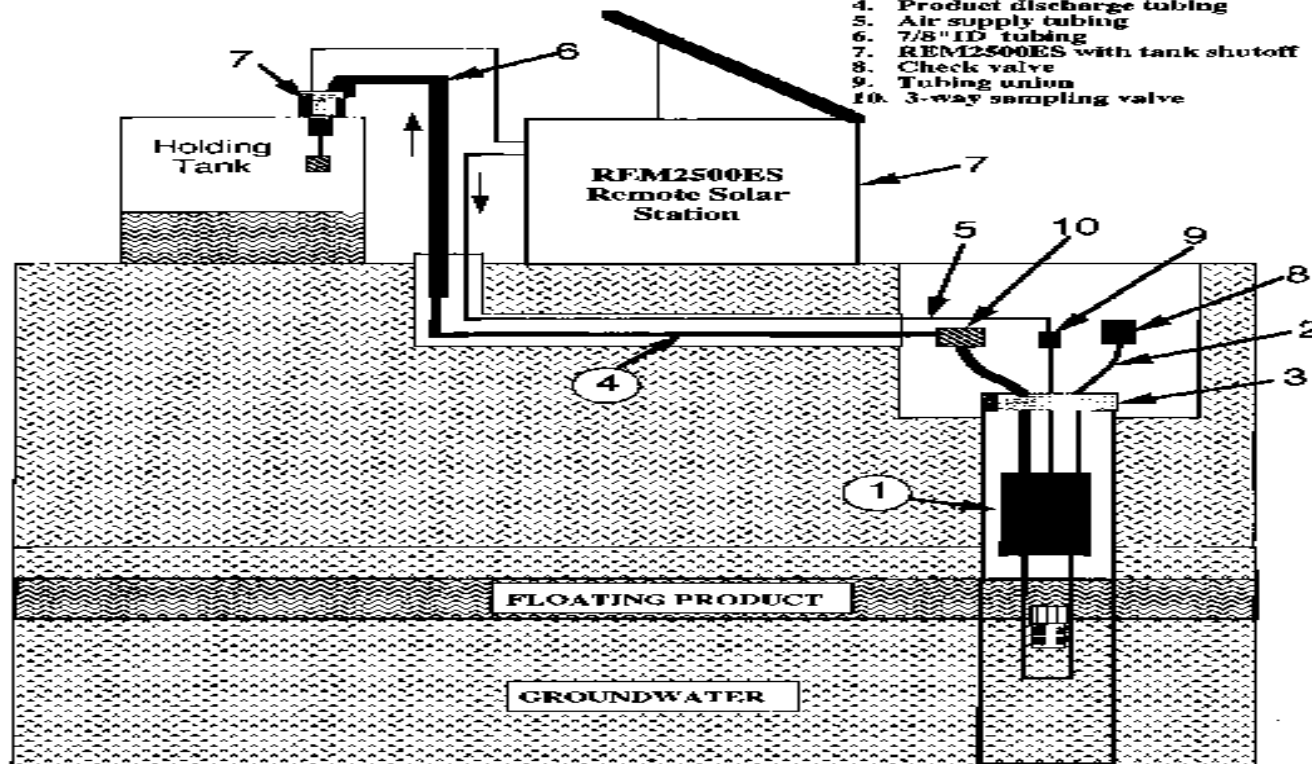
Solar Skimmer Schematic



Single Well Using REM2500ES Remote Solar Station

EQUIPMENT LIST:

1. Xitech skimmer
2. Air exhaust tubing
3. Well cap
4. Product discharge tubing
5. Air supply tubing
6. 7/8" ID tubing
7. REM2500ES with tank shutoff
8. Check valve
9. Tubing union
10. 3-way sampling valve



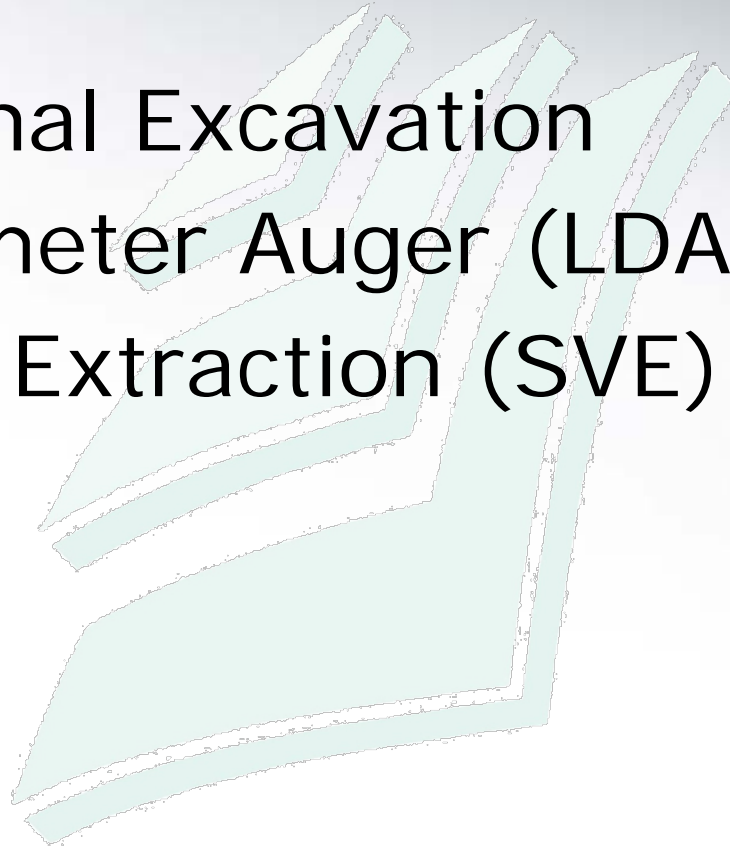
Vacuum Truck



Soil Remediation



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



CONVENTIONAL EXCAVATION



SHEET PILING



SHEET PILING INSTALLED



LDA SUPPORT COLUMNS



LARGE DIAMETER AUGER



PORTABLE CONCRETE PLANT



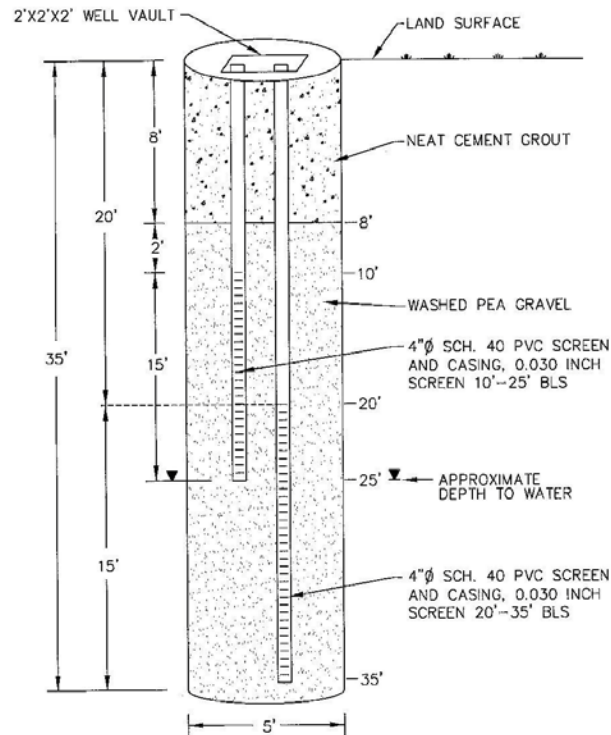
FILLING WITH FLOWABLE FILL



OVERLAPPING LDA HOLES



LDA BORING CONVERTED TO WELL



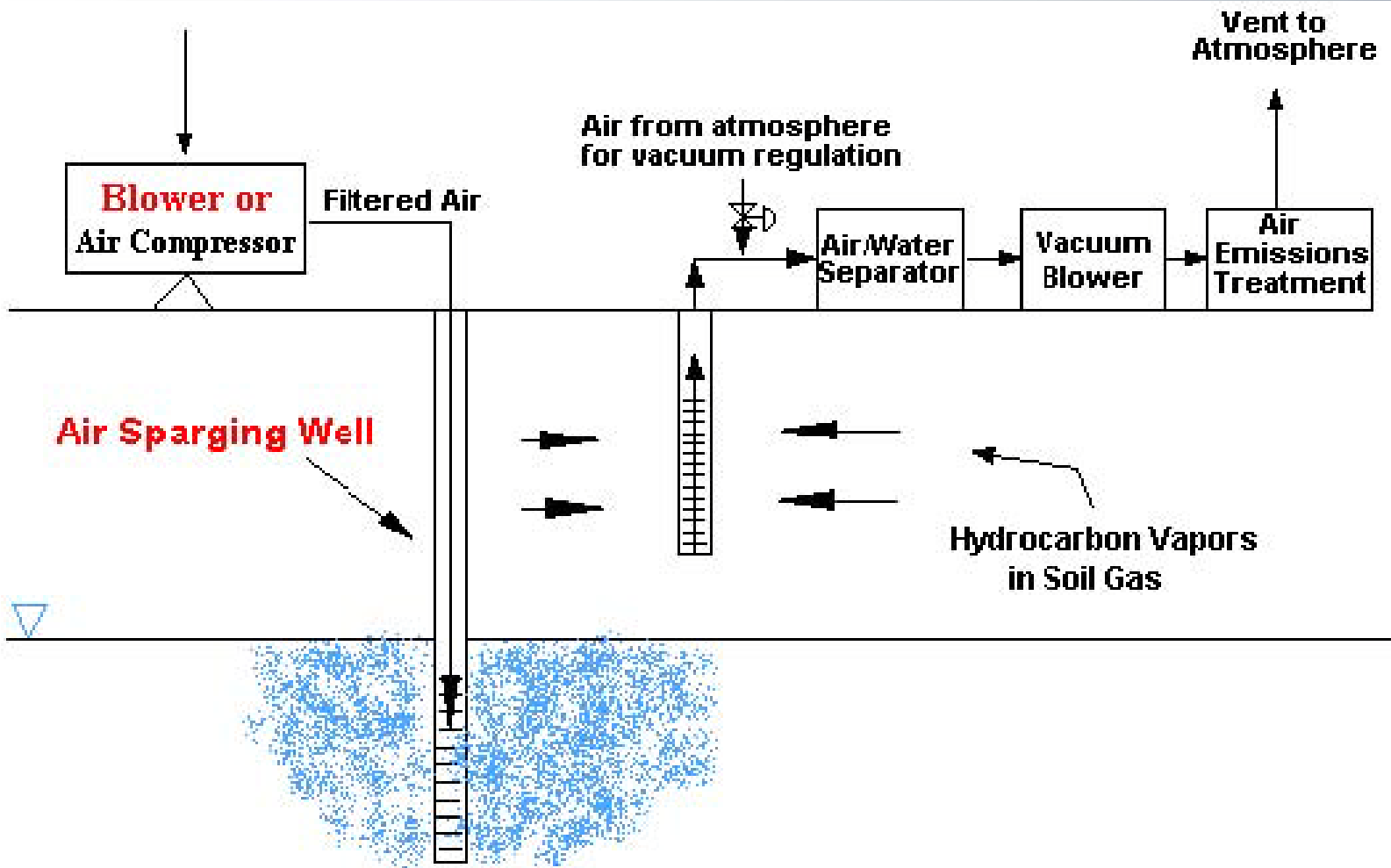
WELL CONSTRUCTION DETAIL
NS

GROUNDWATER REMEDIATION



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

AIR SPARGING AND SOIL VAPOR EXTRACTION SCHEMATIC



SVE SYSTEM



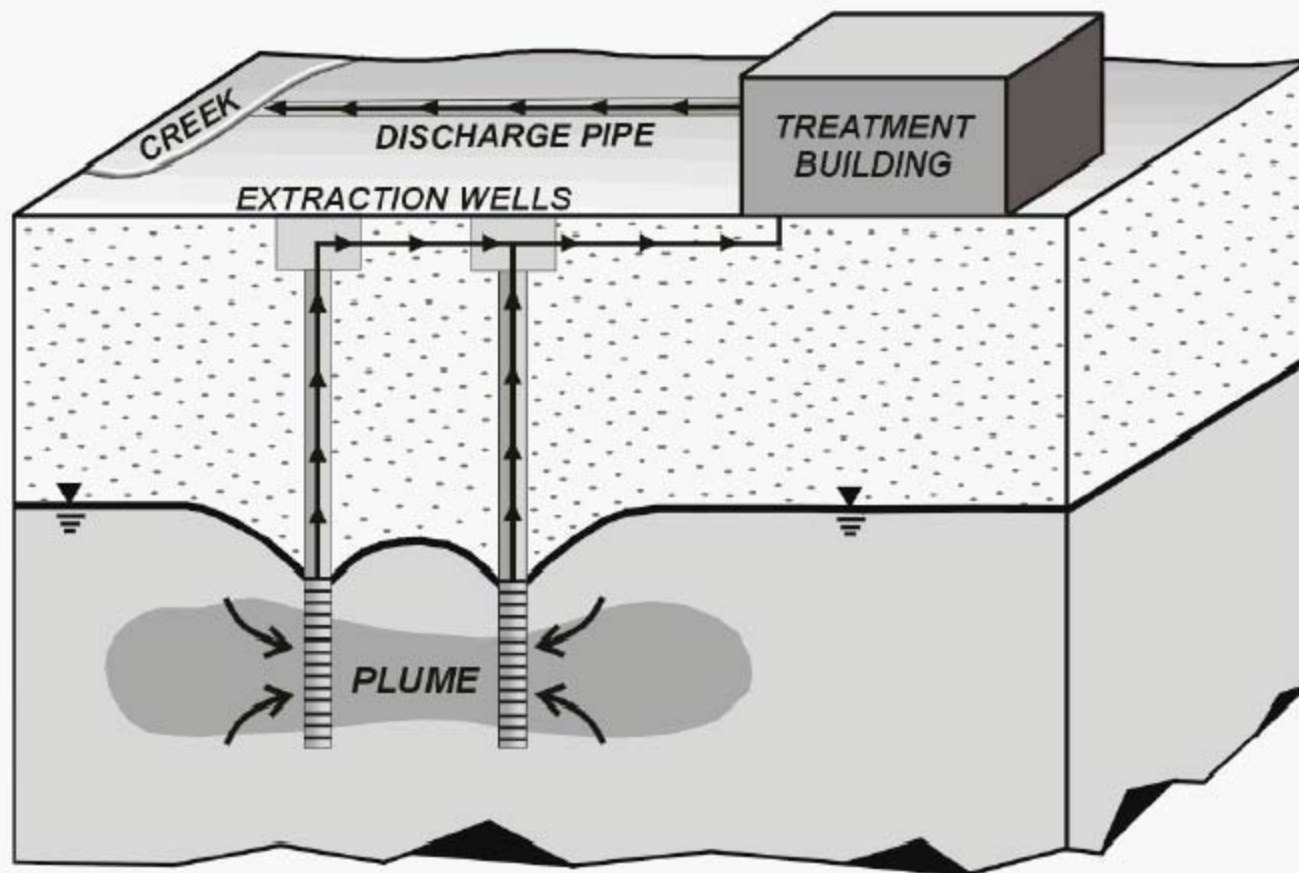
AIR SPARGE SYSTEM



TREATMENT SYSTEM TRAILER



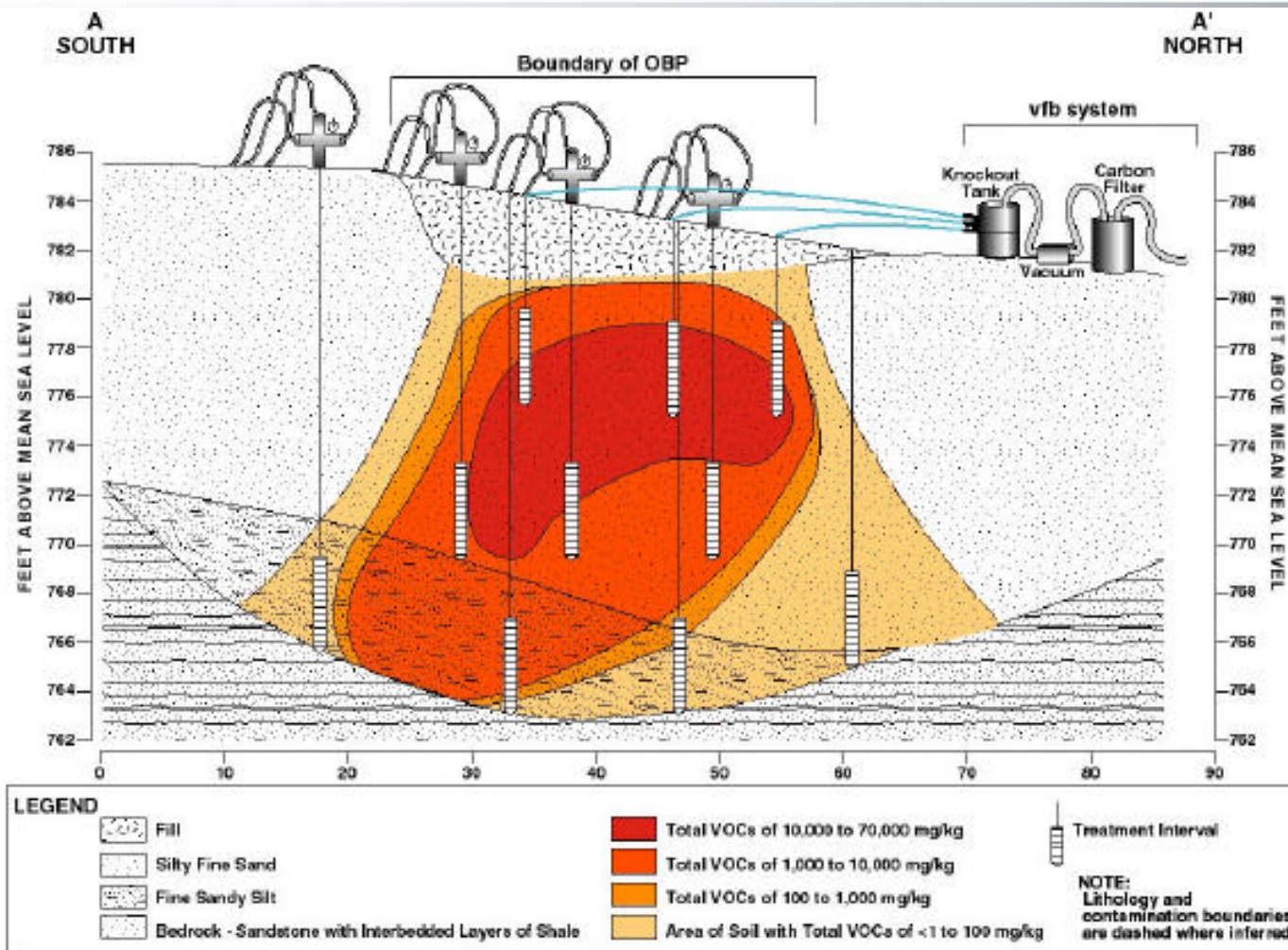
GROUNDWATER EXTRACTION SCHEMATIC



TREATMENT SYSTEM WITH TRAY STRIPPER



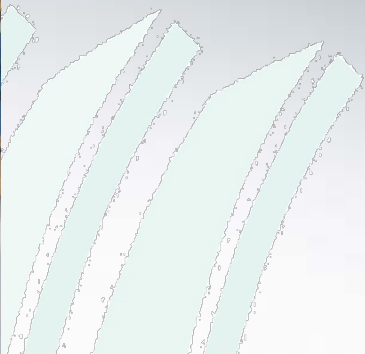
CHEMICAL OXIDATION OR BIOREMEDIATION SCHEMATIC



99P-1392

**SCHEMATIC OF SOIL VADOSE ZONE INJECTION SYSTEM WITHIN THE OIL BURN PIT
LETTERKENNY ARMY DEPOT**

CHEMICAL INJECTION SYSTEM



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/Magnesium Peroxide

POTASSIUM PERMANGANATE



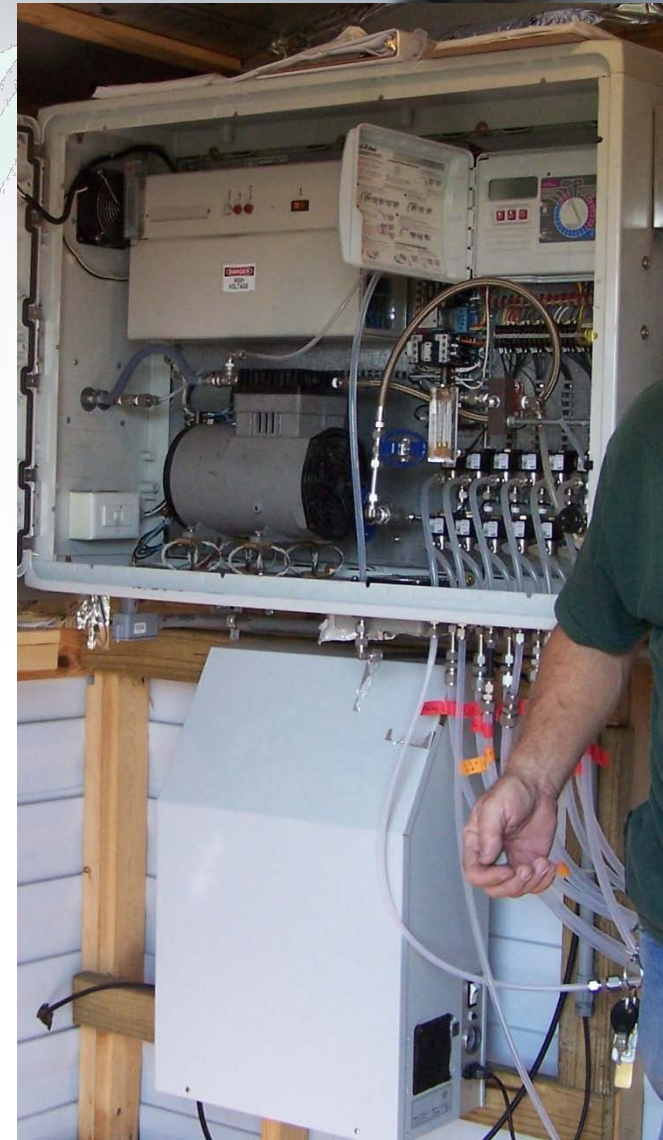
HYDROGEN PEROXIDE



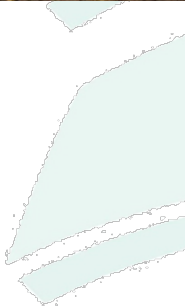
OTHER CHEMICAL OXIDATION



- 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



BIO INJECTION SYSTEM



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**

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



*Your Full Service Local
Engineering Firm*

Lance I. Robinson, PE

lrobinson@mactec.com

813-289-0750