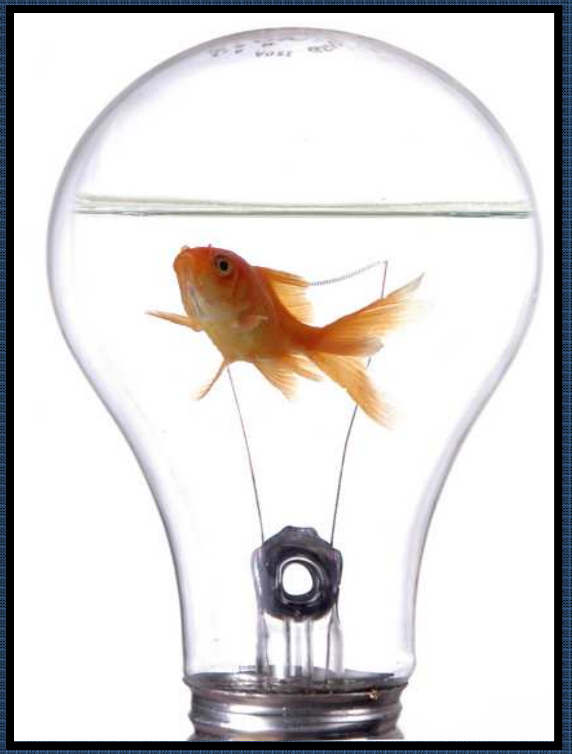
FULL - SCALE IMPLEMENTATION OF A PULSED AIR SPARGE AND SVE SYSTEM FOR TREATMENT OF VOCS, SVOCS, AND ARSENIC



Authors:

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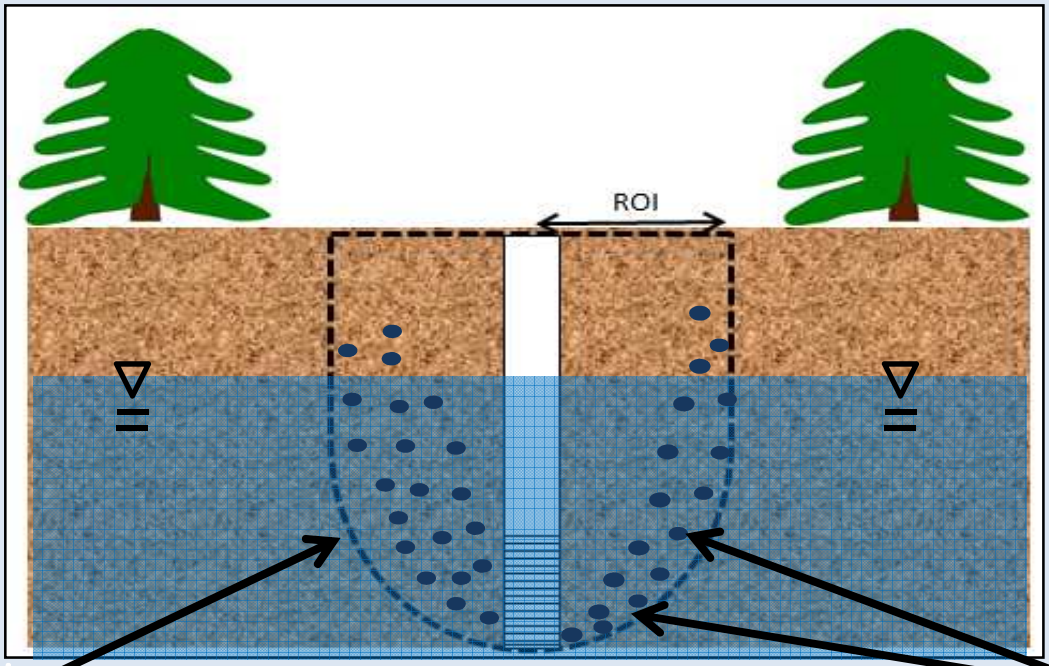
Presentation Outline

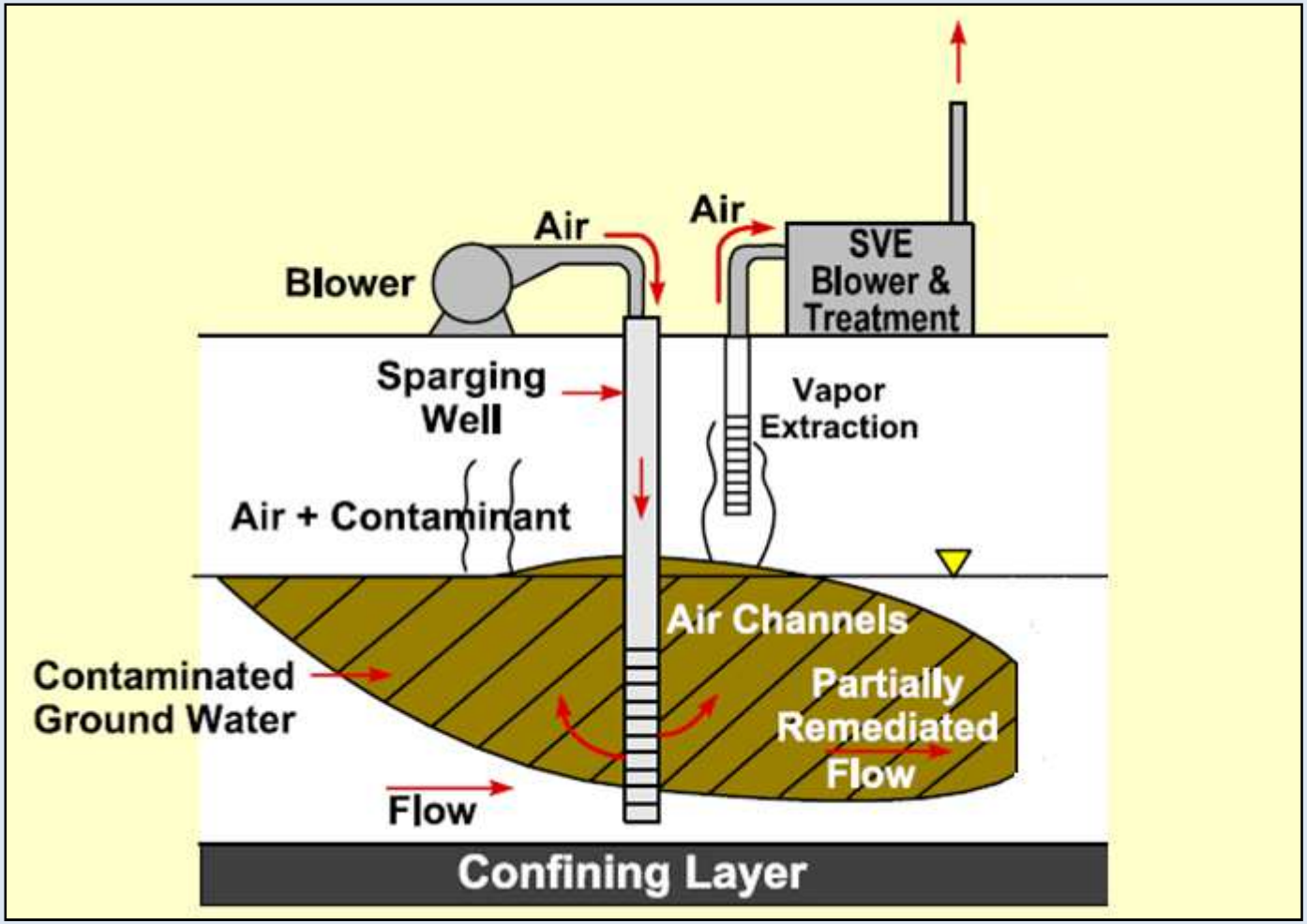
- Intro to Air Sparging
- Former Lagoon Area [FLA], Northern NJ
    - Background
    - Why Air Sparging?
    - Pilot Testing Activities
    - Modeling Results/Considerations
    - Final Design
    - System Implementation

What is Air Sparging?

An in-situ remedial technology that reduces concentrations of VOCs dissolved in groundwater or adsorbed to soils through volatilization and bioremediation by the injection of air.



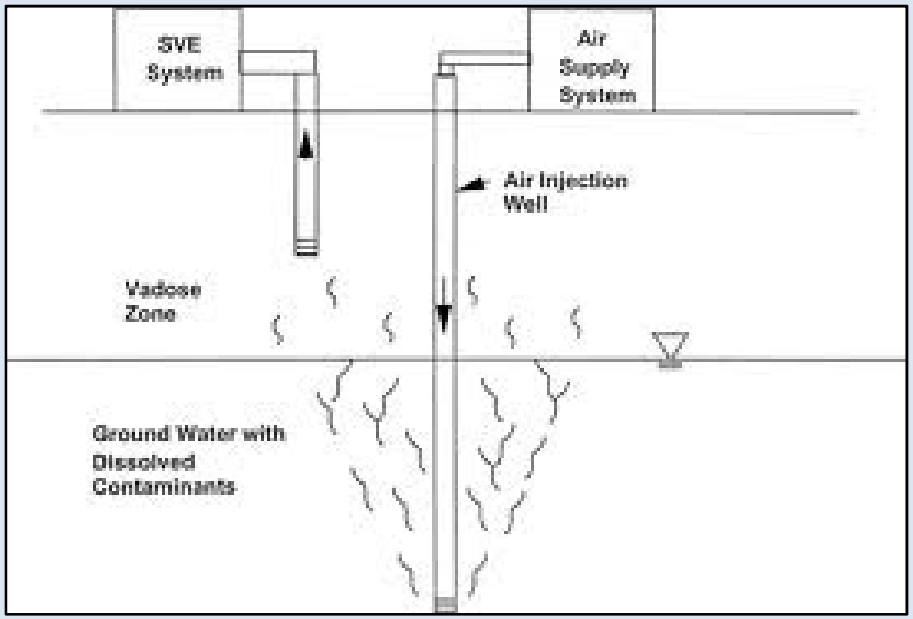
What is Air Sparging?



http://www.clu-in.org/download/techfocus/air-sparging/ABR09-4-AS.pdf

How Air Sparging Works?

- In-situ air stripping of dissolved VOCs in groundwater
- Volatilization of trapped and adsorbed VOCs in soils:
- Precipitation of metals in groundwater:
- Biosparging versus Air Sparging
  - Aerobic biodegradation



eeg.geoscienceworld.org

Design Considerations

- Radius of Influence
- Target Interval
- Subsurface Conditions
- Contaminants of Concern
- Air flow rate and pressure

Former Lagoon Area [FLA]

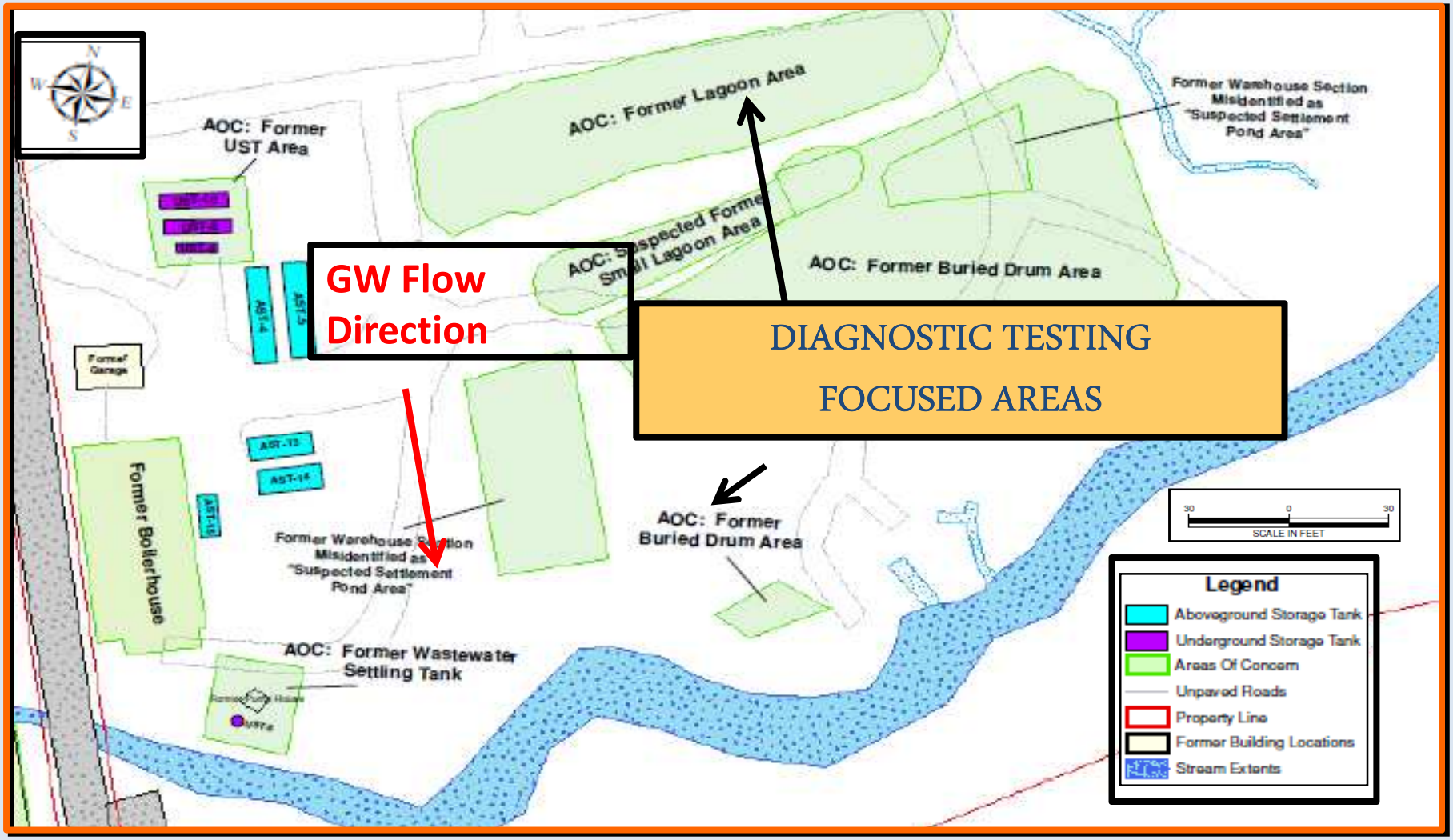
Northern New Jersey

Site Background

- Former manufacturing facility with active lagoon operations through 1967
- Benzene, VOCs, SVOCs, and heavy metals in soil and groundwater
- Former biosparge system operation from 2002 through 2012

  - Model predicted cleanup time frames over 50 years!

Site Layout



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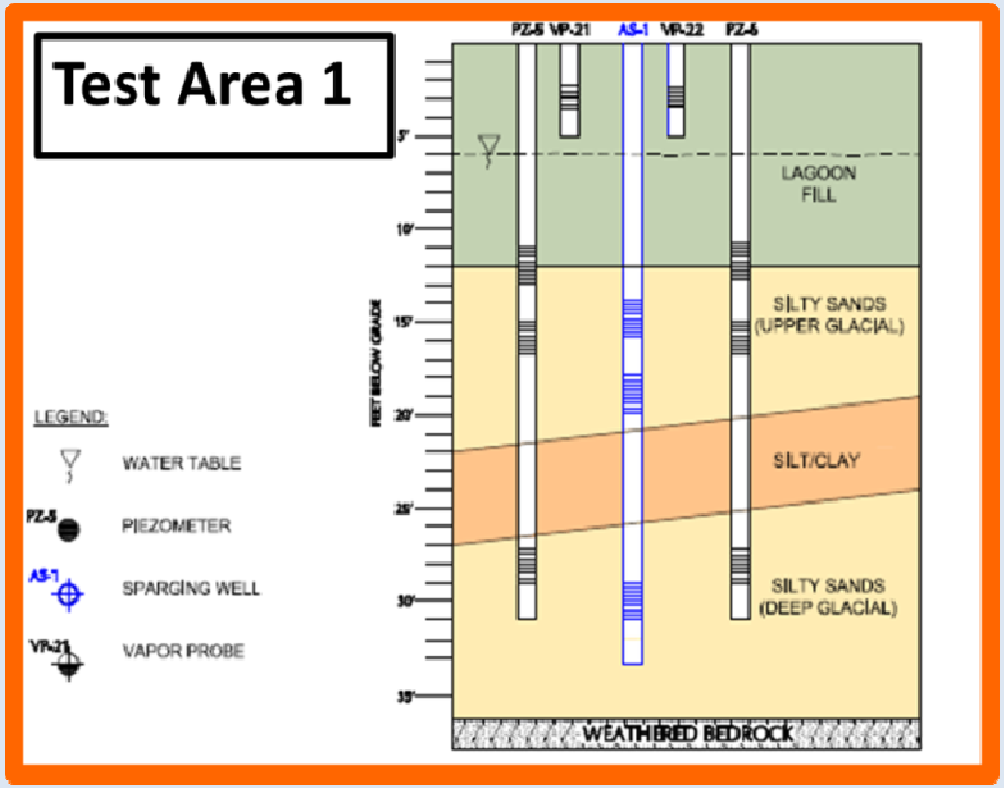
FLA – Background

- Former textile mills/pharmaceuticals manufacturing plant
- Primary COCs :
  - Benzene up to 20,900 ug/L
  - Phenol up to 12,800 ug/L
  - Arsenic up to 31.2 ug/L
- Geology
  - Fill layer
  - Alluvium layer
  - Glacial Till layer
- Hydrogeology
  - Groundwater table ranges approximately 1.5 to 6.5 feet bgs

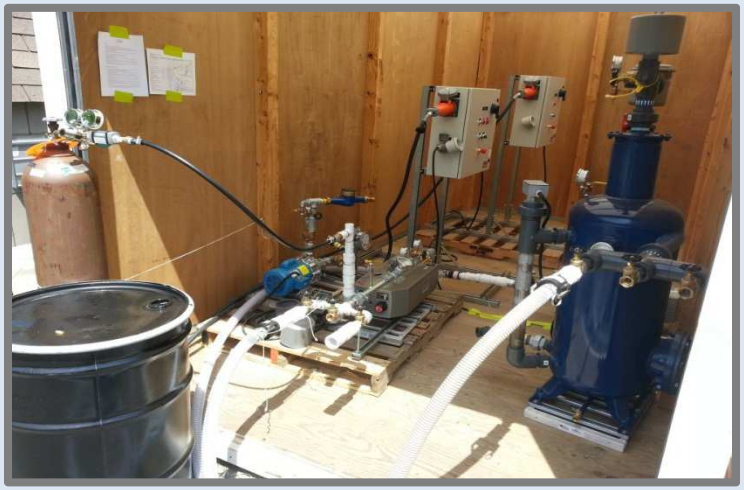


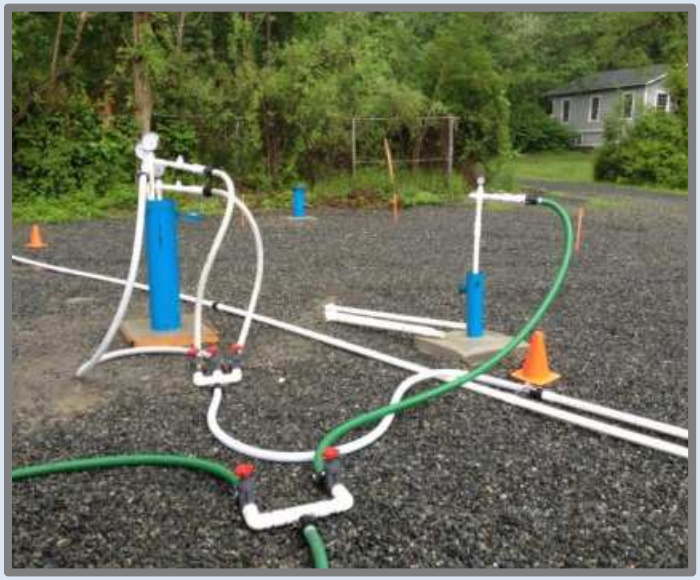
FLA – Why Air Sparging?

- Past Remediation Efforts:
  - Biosparge
  - Excavation
- Primary COC
- Size of Potential Treatment Area
- Source/Concentrations

FLA-Pilot Testing

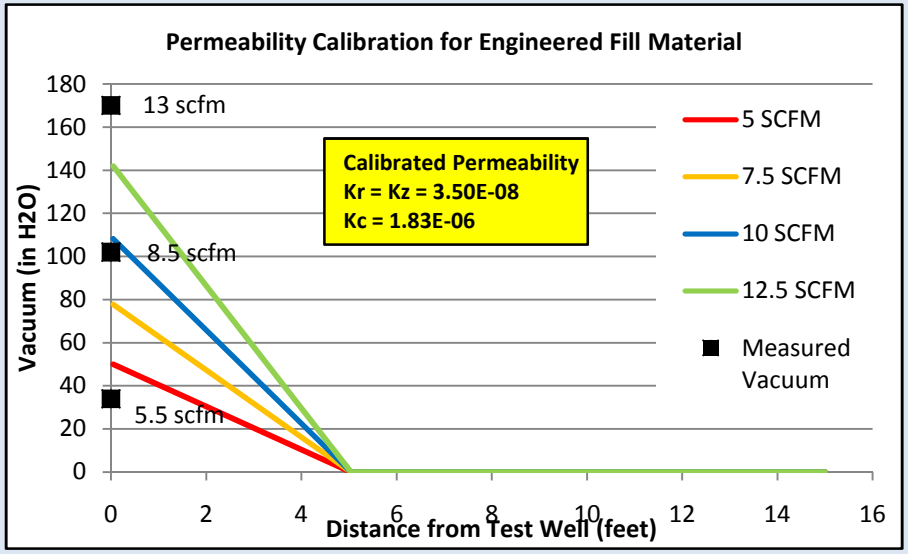
- Testing Methods
  - SVE/Point Permeability
  - Air Sparge/Helium Tracer
- Parameters of Interest
  - Air flow rate
  - Pressure
  - Vacuum

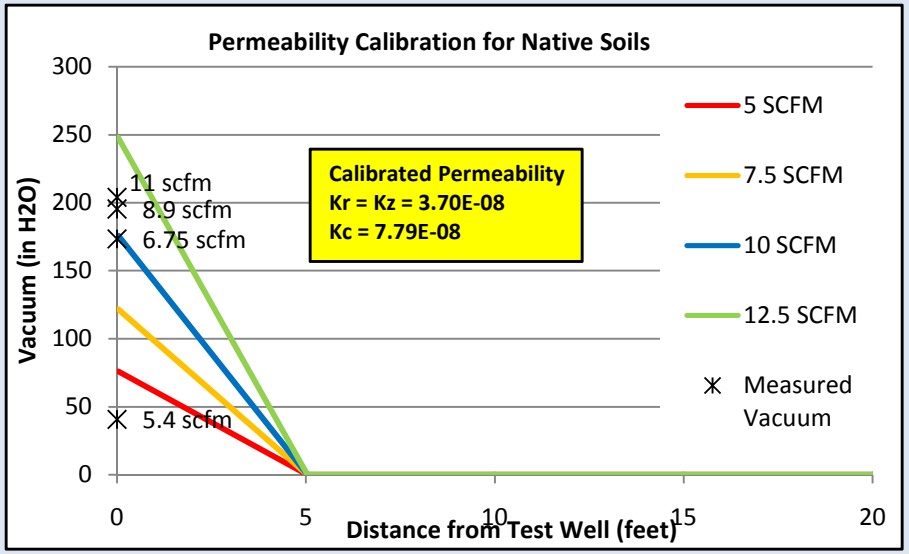




FLA – Pneumatic Modeling Results/Considerations

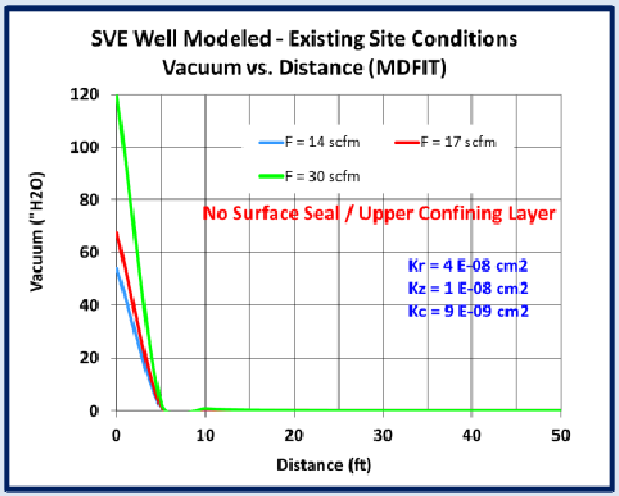
MDFIT – Computer Pneumatic Modeling Program

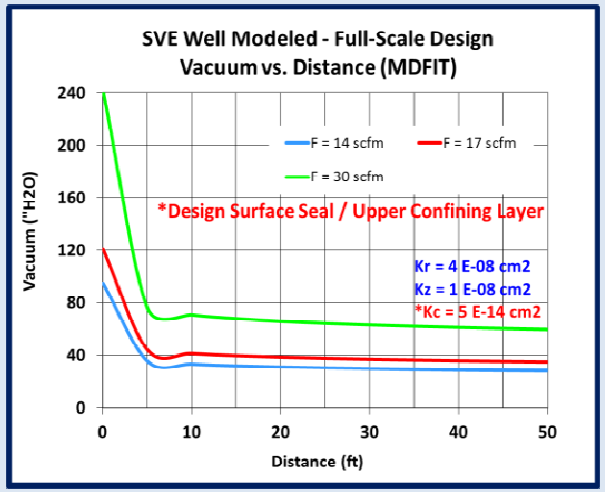


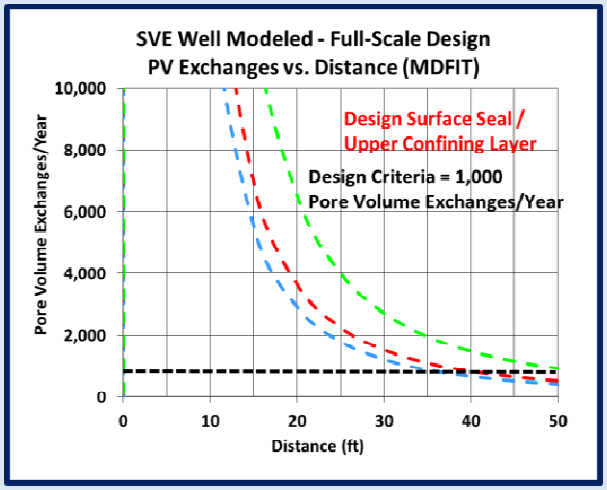


- Leaky Confining Layer
- Low Permeable Vadose Zone
- Shallow Water Table

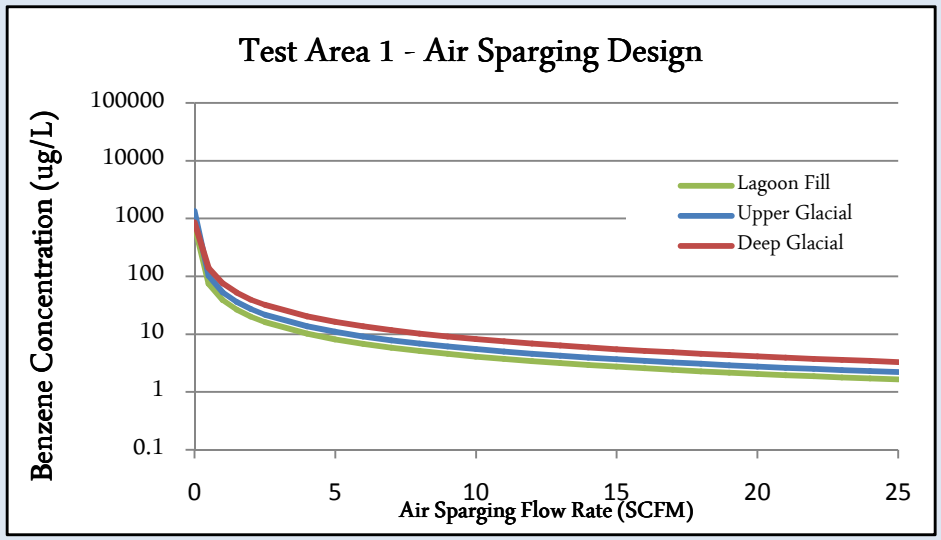
MDFIT

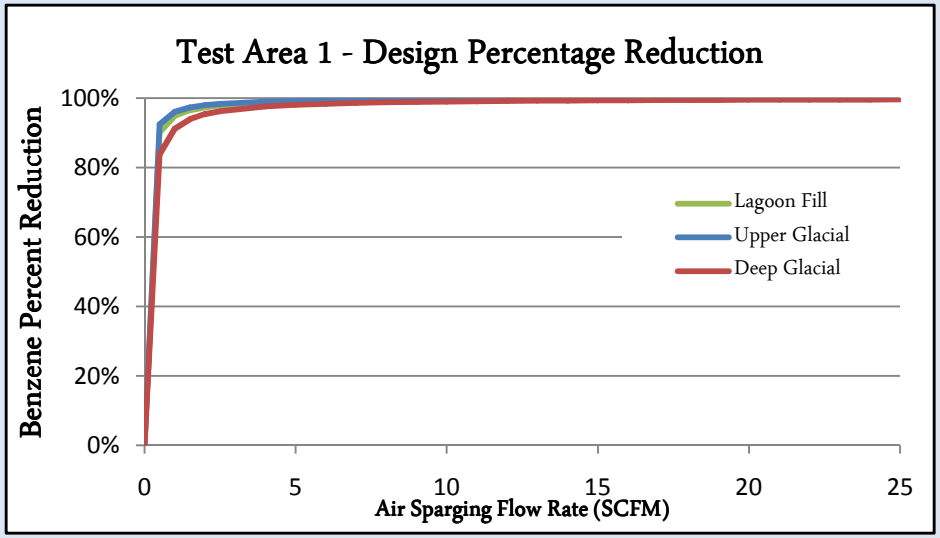

SVE Well Modeled - Existing Site Conditions
Vacuum vs. Distance (MDFIT)
Vacuum ("H2O)
Distance (ft)
F = 14 scfm
F = 17 scfm
F = 30 scfm
No Surface Seal / Upper Confining Layer
Kr = 4 E-08 cm2
Kz = 1 E-08 cm2
Kc = 9 E-09 cm2


SVE Well Modeled - Full-Scale Design
Vacuum vs. Distance (MDFIT)
Vacuum ("H2O)
Distance (ft)
F = 14 scfm
F = 17 scfm
F = 30 scfm
*Design Surface Seal / Upper Confining Layer
Kr = 4 E-08 cm2
Kz = 1 E-08 cm2
*Kc = 5 E-14 cm2


SVE Well Modeled - Full-Scale Design
PV Exchanges vs. Distance (MDFIT)
Pore Volume Exchanges/Year
Distance (ft)
Design Surface Seal /
Upper Confining Layer
Design Criteria = 1,000
Pore Volume Exchanges/Year

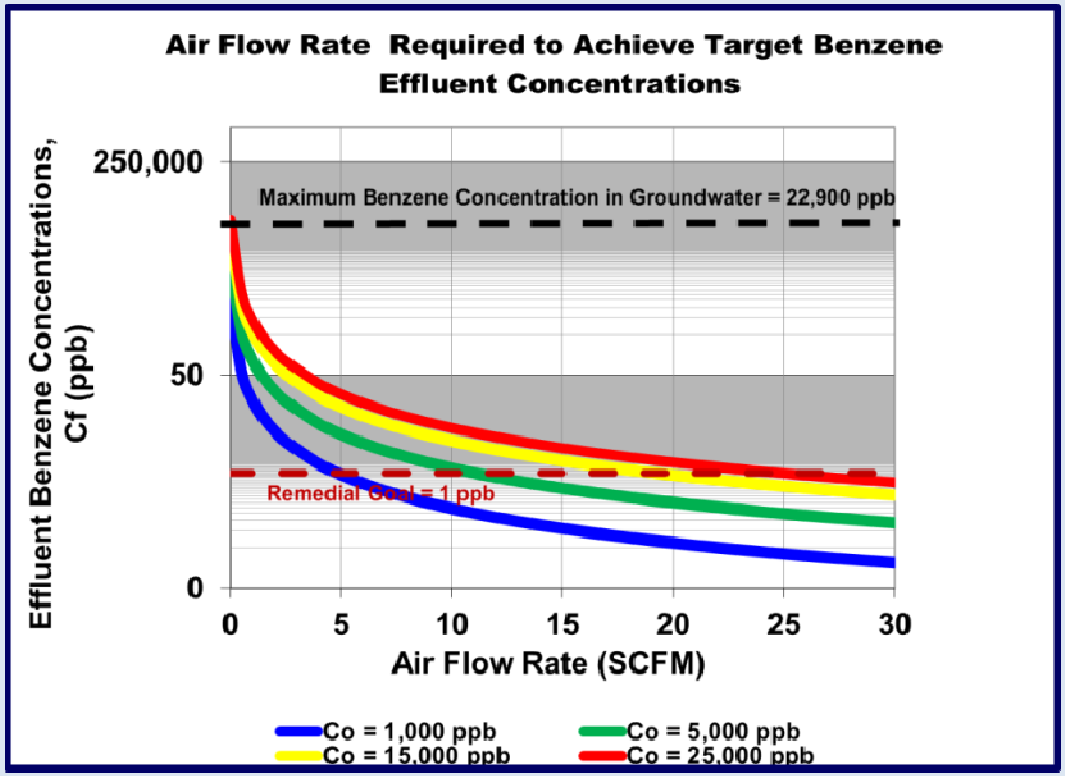
FLA – Air Sparge Modeling Results/Considerations

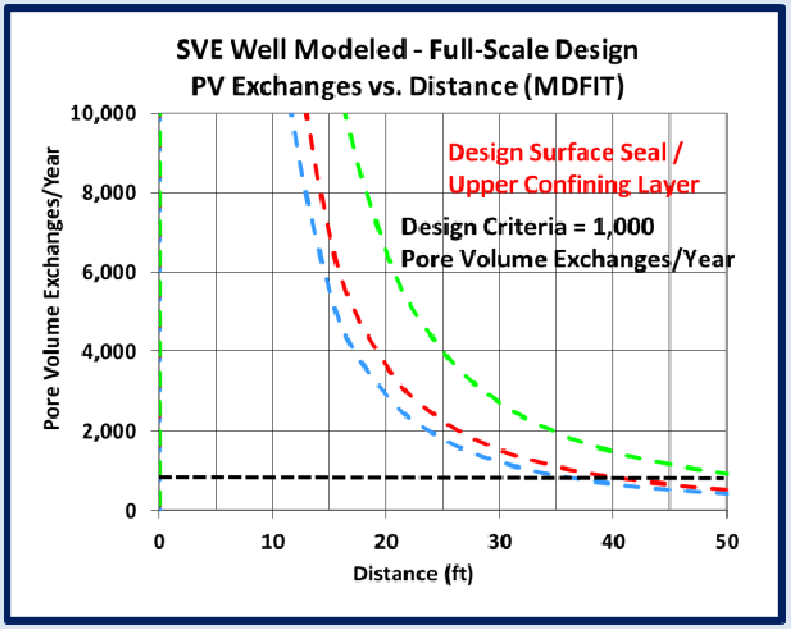




- Mass removal rate for each COC
- Target Interval

Air Stripping Modeling





Modeling resulted in a more cost-effective optimization strategy.

$$1-\frac{C_{L,e}}{C_{L,i}}=1-\left[1+\frac{Q_g}{Q_L}\left(Hc\left(1-e^{-\phi}\right)\right)\right]^{-1}$$

Where:

$C_{L,e}$ = COC concentration in reactor/trench effluent (ug/L),

$C_{L,i}$ = COC concentration in reactor/trench influent (ug/L),

Q_g = Gas or air flow rate (ft3/day),

Q_L = Liquid or groundwater flow rate per unit length (ft3/day),

Hc = Henry's law constant (unitless), and

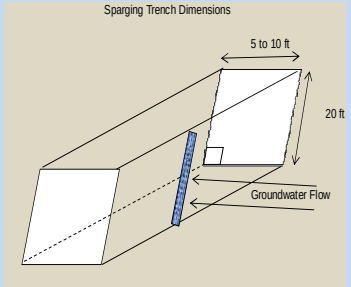
φ = Saturation parameter

$$\phi=\frac{(K_L a)_{COC}\cdot V}{H_C\cdot Q_g}$$

Where:

$K_{(La)COC}$ = Mass transfer coefficient for COCs (1/day), and

V = Volume of reactor per unit length/porosity (ft3).



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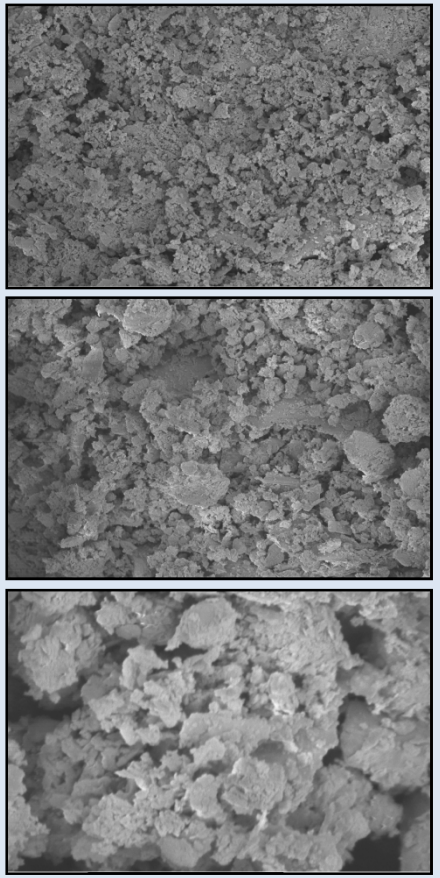
Remedial Strategy

EXCAVATION

- Removal and disposal of 2,200 tons of NAPL impacted soil

PULSED AIR SPARGE SYSTEM

- VOCs /BTEX
  - Volatilization/Stripping
  - Aerobic biodegradation
- PHARMACEUTICALS (Phenol) and ALCOHOLS (Ethanol)
  - Aerobic biodegradation
- METALS (Arsenic)
  - Sorption on metal/iron oxy-hydroxides

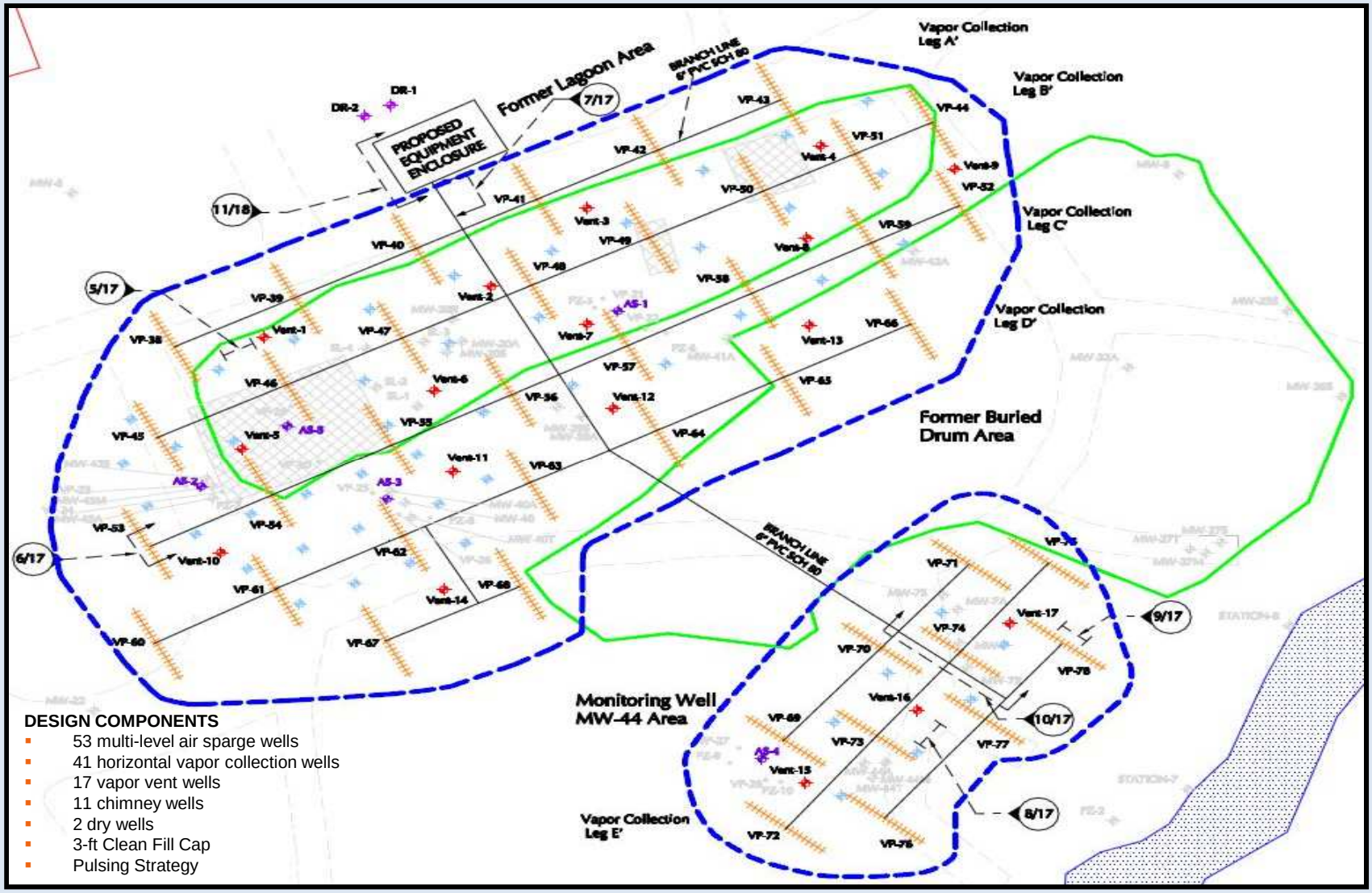


SEM images of Fe-Al-Si oxy-hydroxide precipitate formed in groundwater (EDS analytical spectra)

FLA – Final Design

- High Water Table
  - Artificial Cap
  - Horizontal Vapor Collection
- Leaky Confining Layer
  - Impermeable Membrane
- ROI
  - 10-15 feet ⟶ 53 air sparge wells
  - 15 feet ⟶ 41 vapor collection wells
- Prevent Over Pressurization
  - Pulsing Strategy
  - Chimney Wells

System Design



DESIGN COMPONENTS

- 53 multi-level air sparge wells
- 41 horizontal vapor collection wells
- 17 vapor vent wells
- 11 chimney wells
- 2 dry wells
- 3-ft Clean Fill Cap
- Pulsing Strategy

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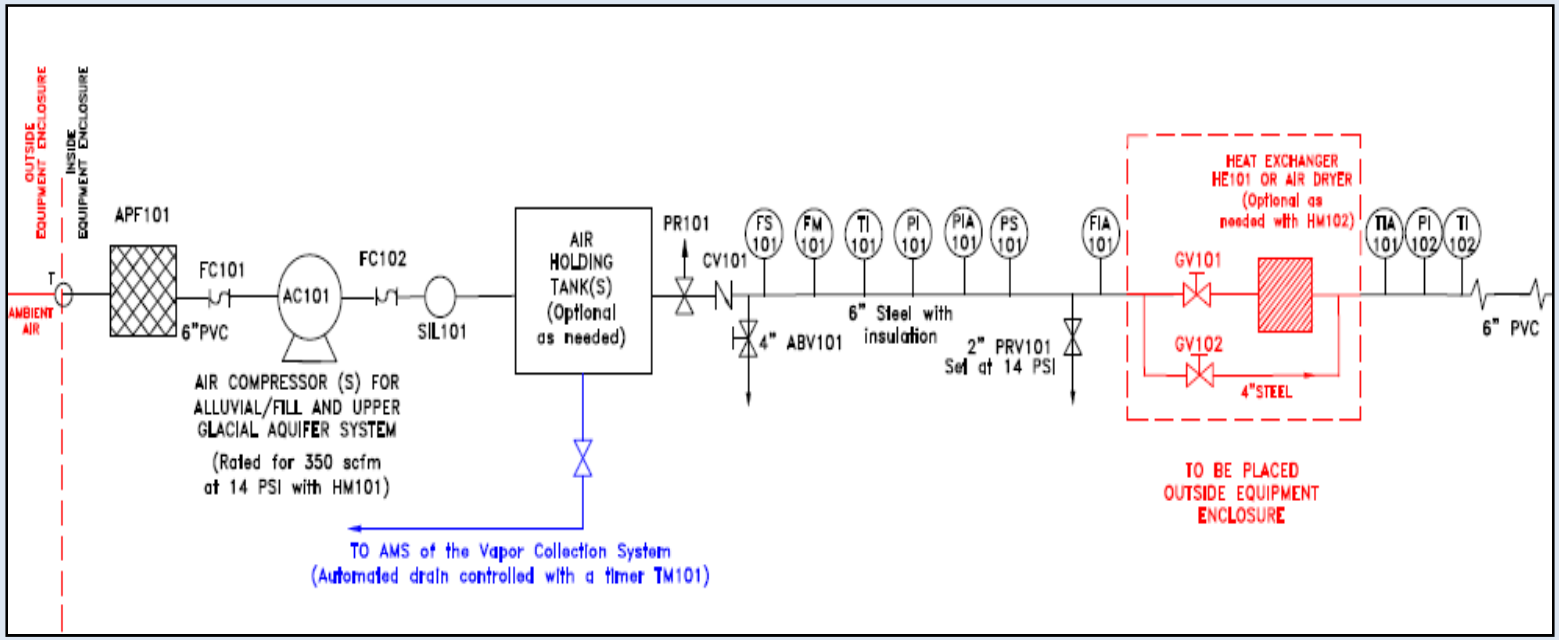
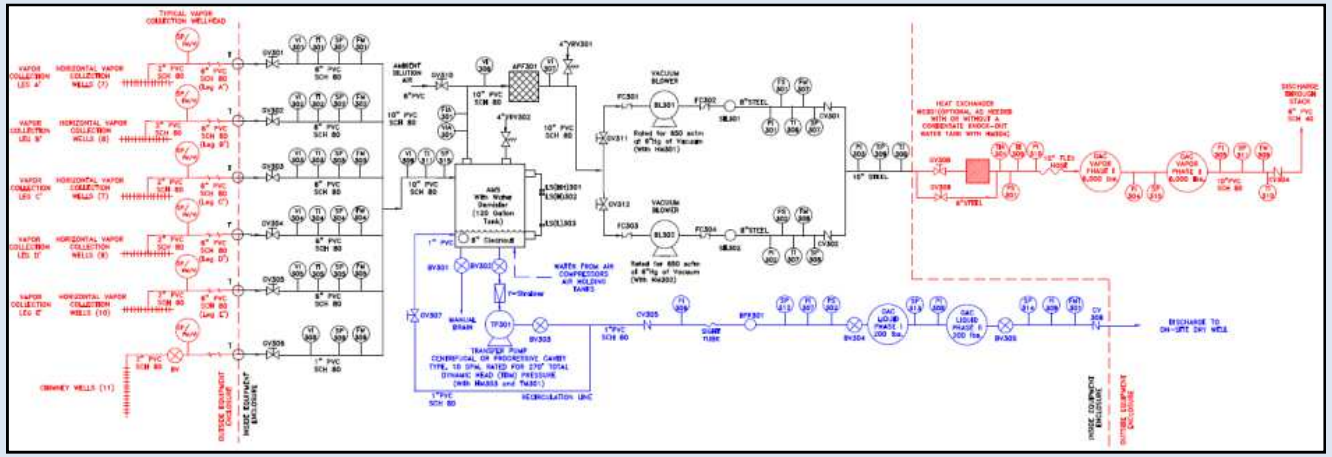
Engineering Design





System Implementation

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Strategy Benefits

- System Construction Ongoing
- Startup planned for January 2016
- Anticipated Cleanup Timeframe - 3 to 5 years

- **Reduced Cleanup Timeframe**
- **Cost Savings**
- **More innovative, cost effective, and sustainable in-situ remediation technology than excavation**

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