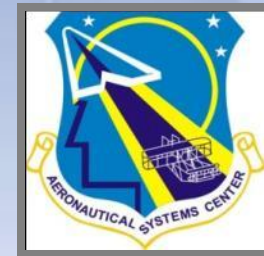




# Installation and Operation of an Air Sparge and SVE System Using Horizontal Directionally Drilled Wells



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and Remediation Technology  
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# Presentation Topics

- **Site History**
- **Treatment Objectives**
- **Lithology**
- **AS/SVE Design**
- **AS/SVE Installation**
- **Tracer Testing**
- **Performance Results**
- **Conclusions and Path Forward**

# Air Force Plant 6, Marietta, Georgia

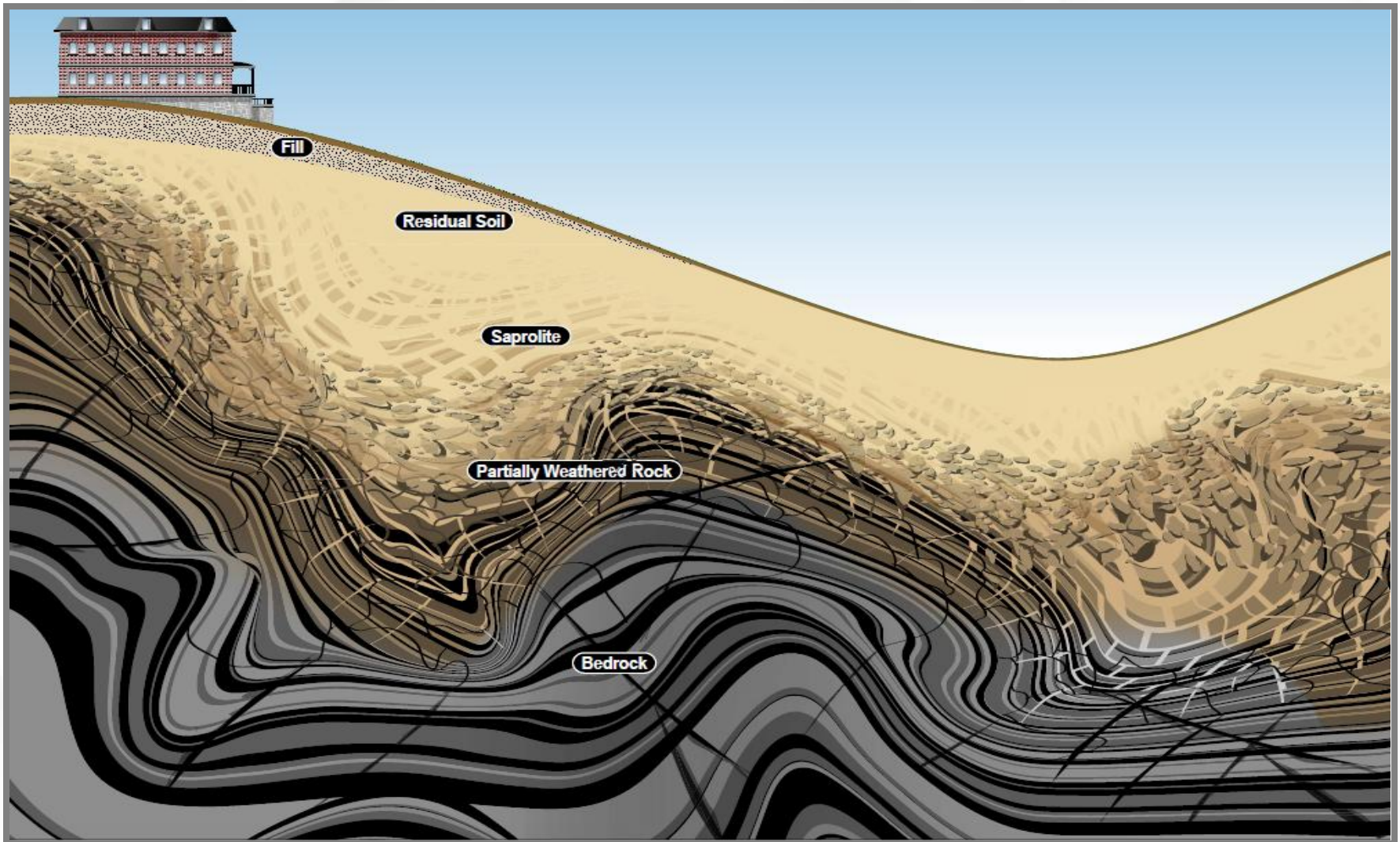


# Site History: Air Force Plant 6

- **Air Force Aviation Manufacturing and Maintenance Facility (1942 to Present)**
- **Government Owned Contractor Operated (GOCO) facility leased to Lockheed Martin Aeronautics Company (LM Aero)**
- **Site Contaminants – Trichloroethylene (TCE) and Daughter Products**
  - 1,100 Gallon TCE Spill
- **Depth to Groundwater – 15 to 20 ft bls at Property Boundary**

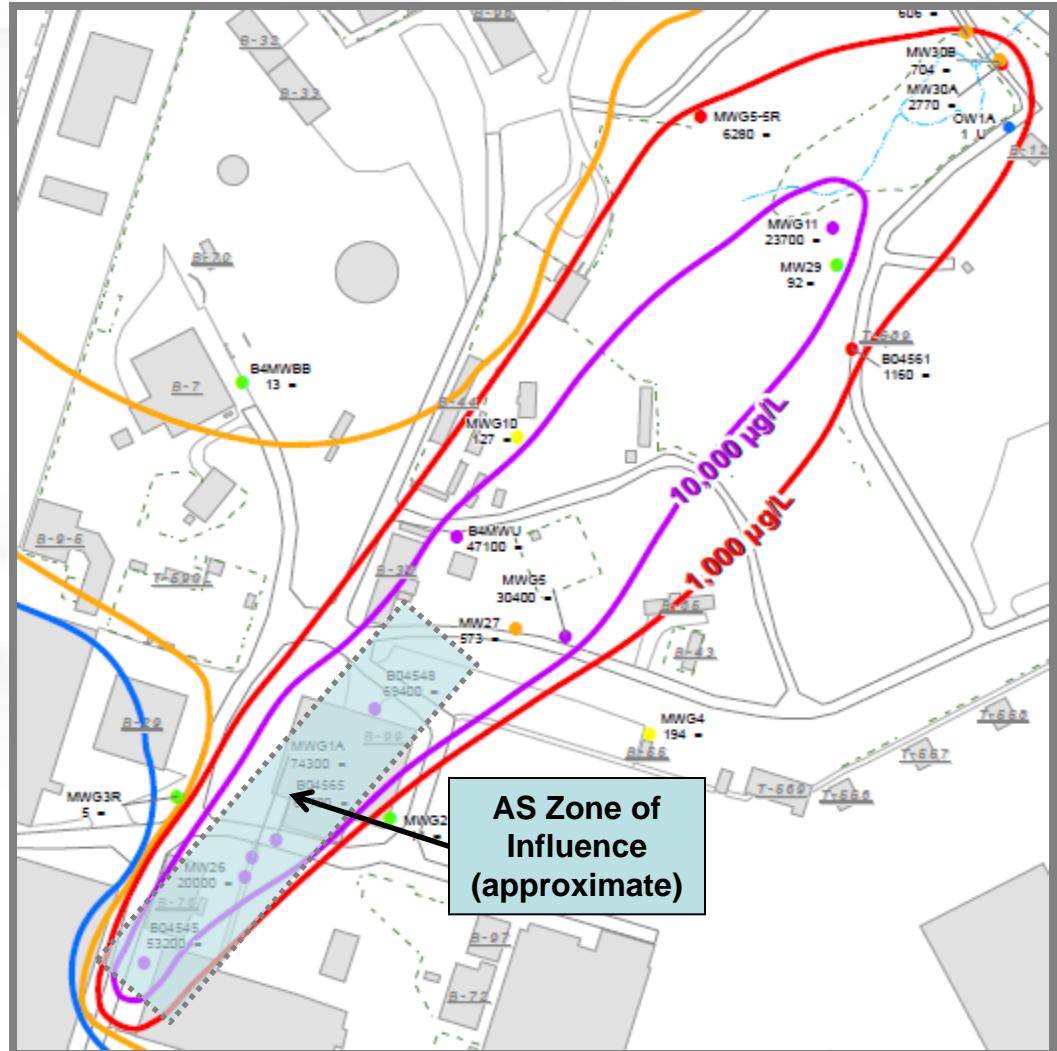


# Site Geologic Model



# Source Area Treatment Objectives

- 1) Volatize TCE in groundwater and collect vapors with SVE under buildings
- 2) Reduce mass flux in saturated residuum soil by 50%
- 3) Achieve MCLs within 30 years

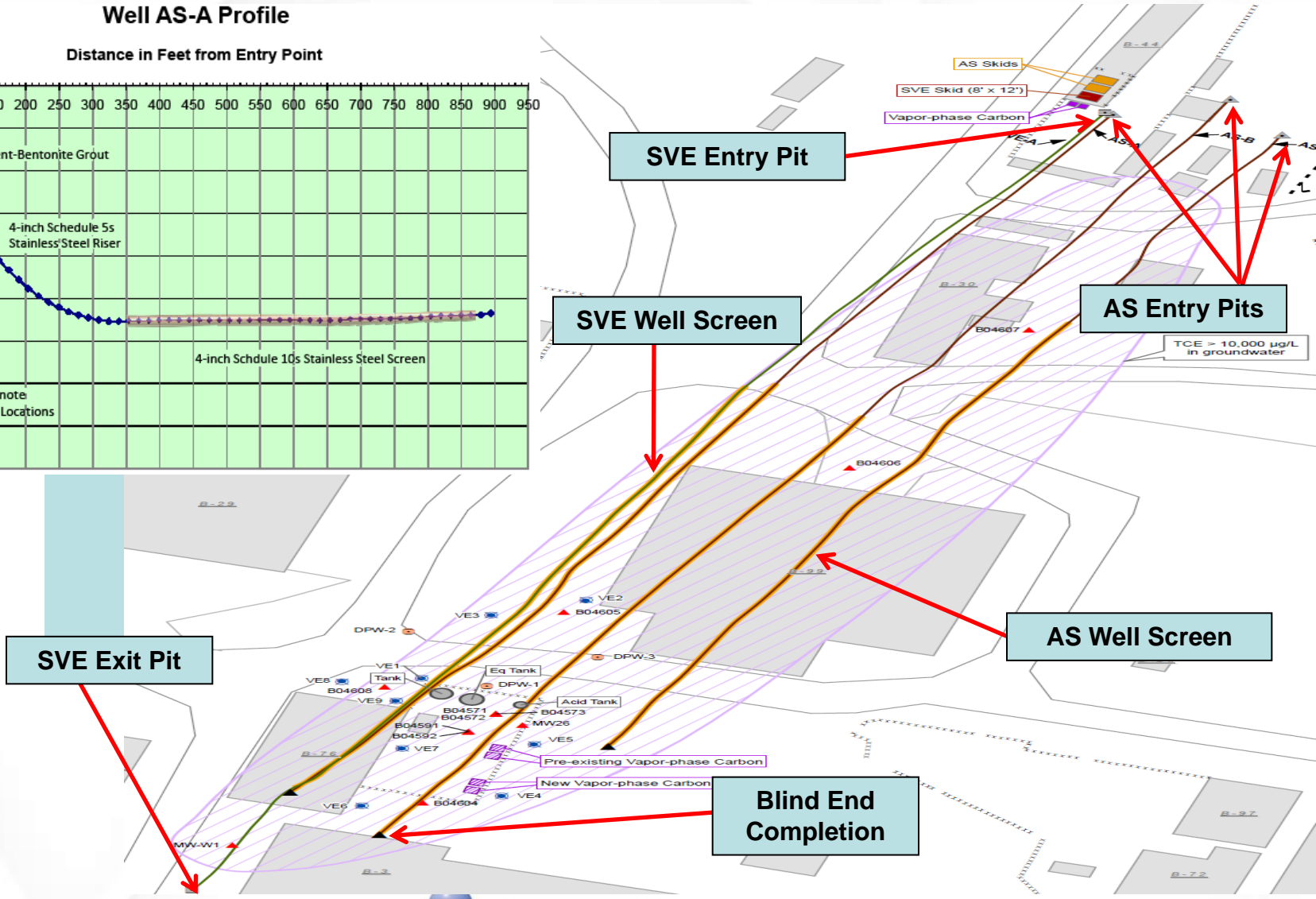
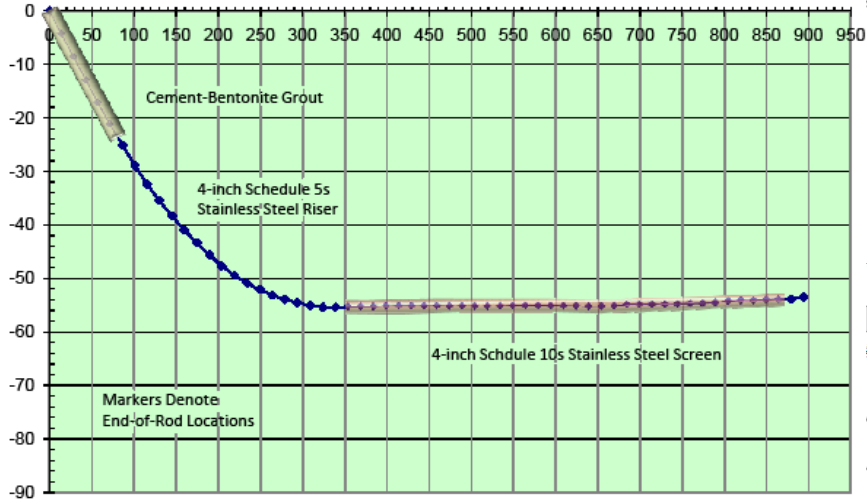


# AS/SVE Layout

## Well AS-A Profile

Distance in Feet from Entry Point

Vertical Depth in Feet from Ground Surface at Rig



# AS/SVE System Design

| WELL ID                 | SCREEN DEPTH | TOTAL LENGTH | SCREEN LENGTH | DIAMETER |
|-------------------------|--------------|--------------|---------------|----------|
| <b>Horizontal Wells</b> |              |              |               |          |
| AS-A                    | 70'          | 880'         | 520'          | 4"       |
| AS-B                    | 86'          | 940'         | 540'          | 4"       |
| AS-C                    | 68'          | 750'         | 520'          | 4"       |
| SVE-A                   | 20'          | 1000'        | 600'          | 6"       |
| <b>Vertical Wells</b>   |              |              |               |          |
| VE1 – VE10              | 20 – 30'     | 30' (deep)   | 10'           | 4"       |

- **Designed for uniform distribution of air using finite difference model**
- **Input: formation characteristics, pipe specifications and operation parameters**
- **Output: air flow distribution, pressure drop, and slot shape and distribution**
- **Blind end construction of AS wells; entry-exit SVE well**



# Horizontal Well Construction Details

- **6-inch pilot boring reamed to 10-inch diameter using Vermeer® D80X100 Series II Navigator HDD rig**
- **Bentonite and polymer (No-Sag® and Quick-Trol® LV) drilling mud to keep boring open and remove cuttings**
- **Battery-operated and wire-line tracking used to for cutting head location**
- **Phosphate-free liquid polymer dispersant solution (Aquaclear PFD™) used to develop wells**



# AS/SVE System Equipment



## B44 AS/SVE System

- 3 horizontal AS wells
- One horizontal SVE well
- Two air compressors
  - 250 cfm @ 100 psi
  - 500 cfm @ 100 psi
- PD Blower - 600 cfm @ 8" Hg
- 10,000 lb GAC



## B76 SVE System

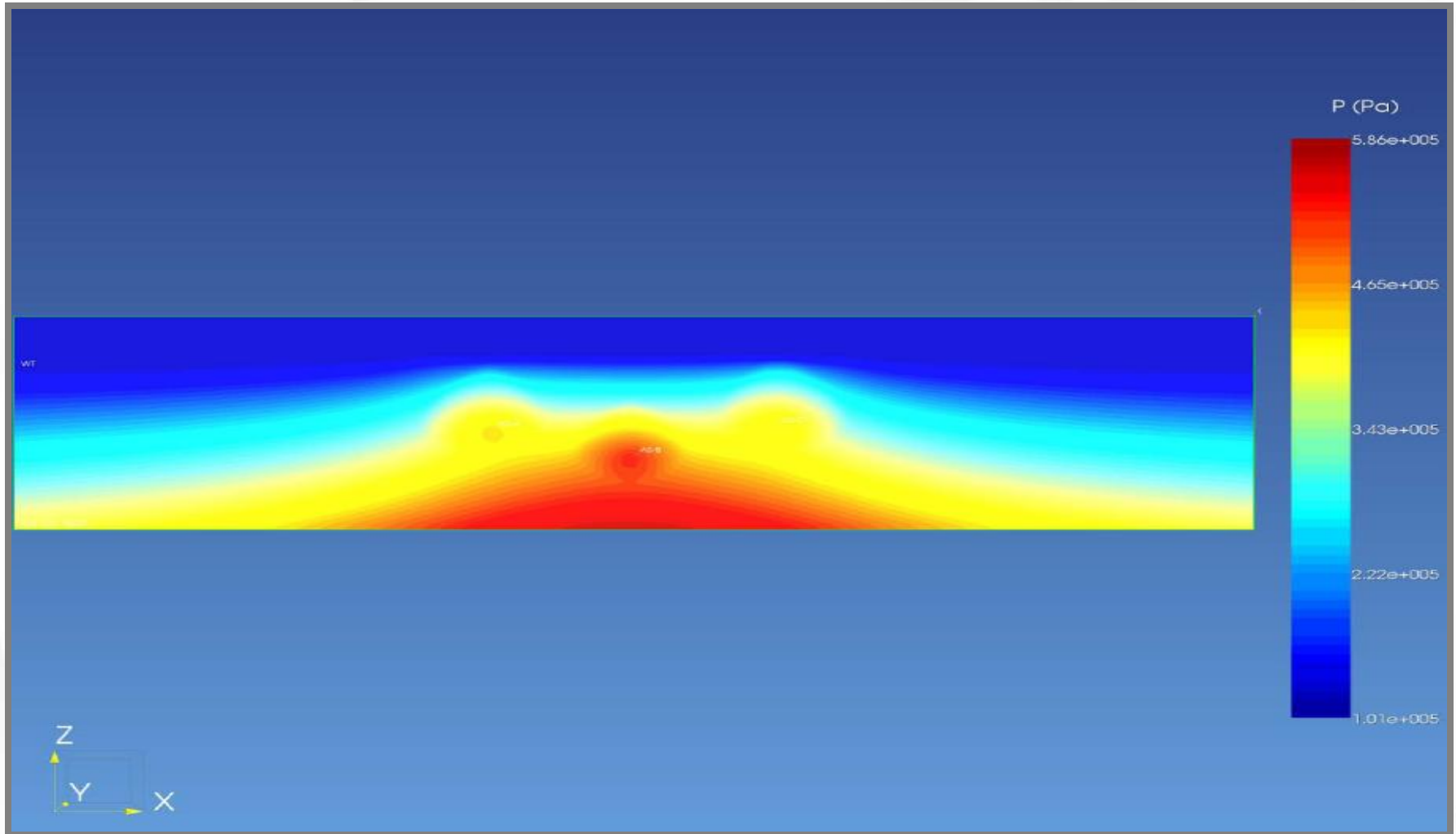
- 10 vertical SVE wells
- PD Blower - 600 cfm @ 6" Hg
- 10,000 lb GAC



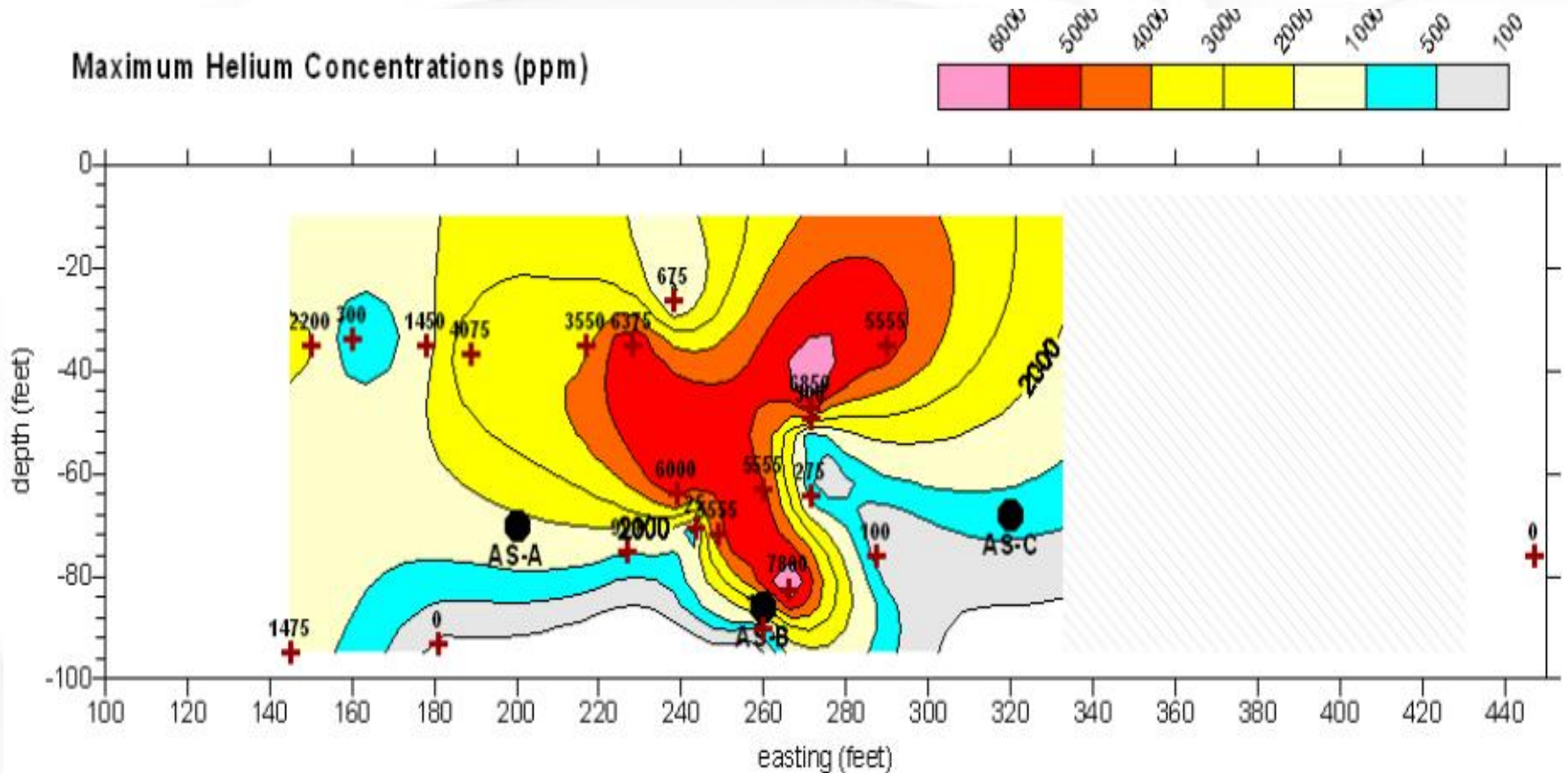
# Air-Sparge Tracer Study

- **Water level transducers in vertical observation wells**
- **Wellhead pressures in observation wells**
- **Varied injection flowrates**
  - **150, 200, 250 scfm**
- **Helium tracer**
  - **5% of injection flow – one hour**
  - **Monitored helium concentrations using field instrumentation**
- **Sulfur Hexafluoride tracer**
  - **0.1% of injection flow – 24 hours**
  - **Collected groundwater samples and analyzed for SF6 concentration**

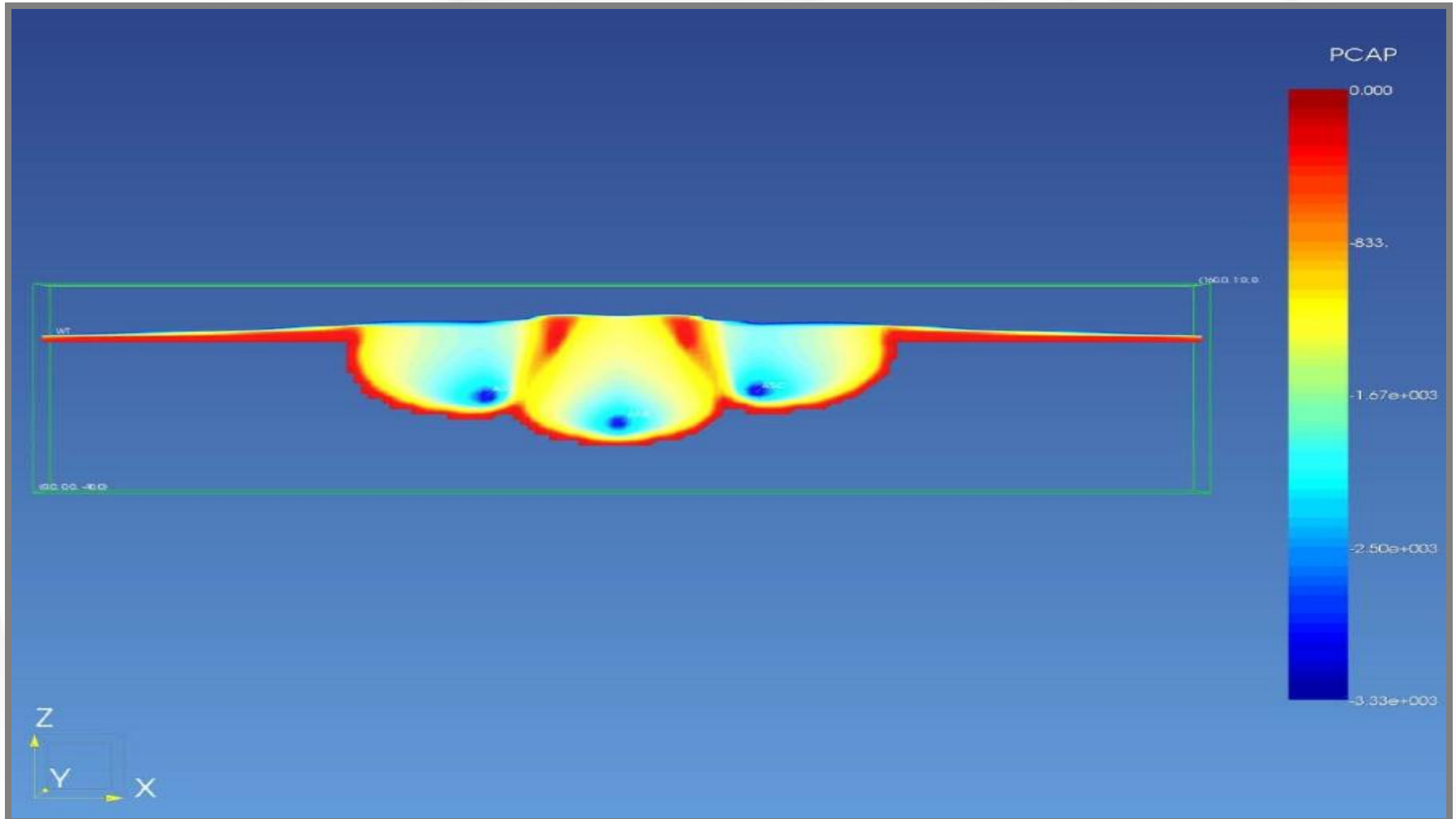
# Pressure Distribution



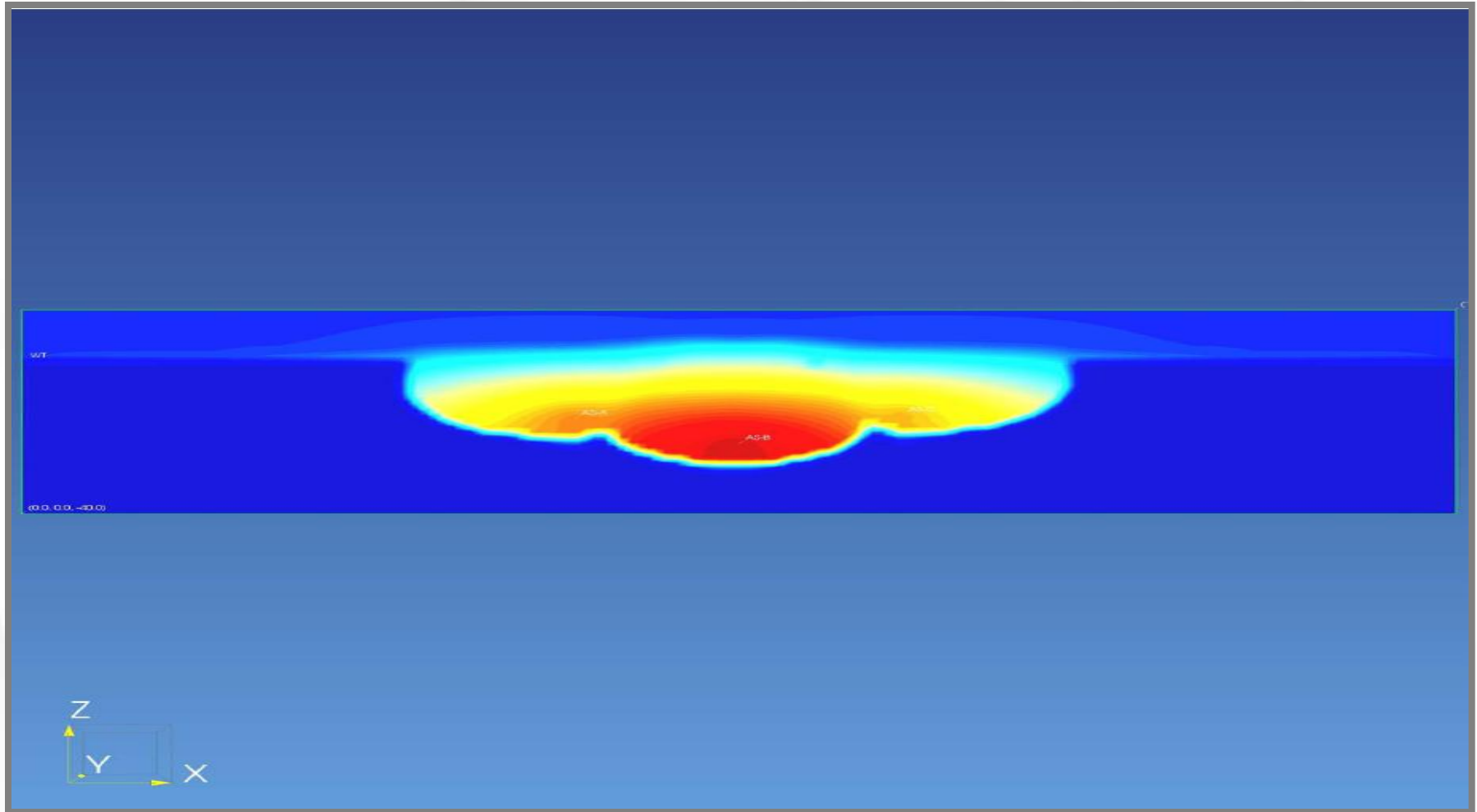
# Helium Distribution



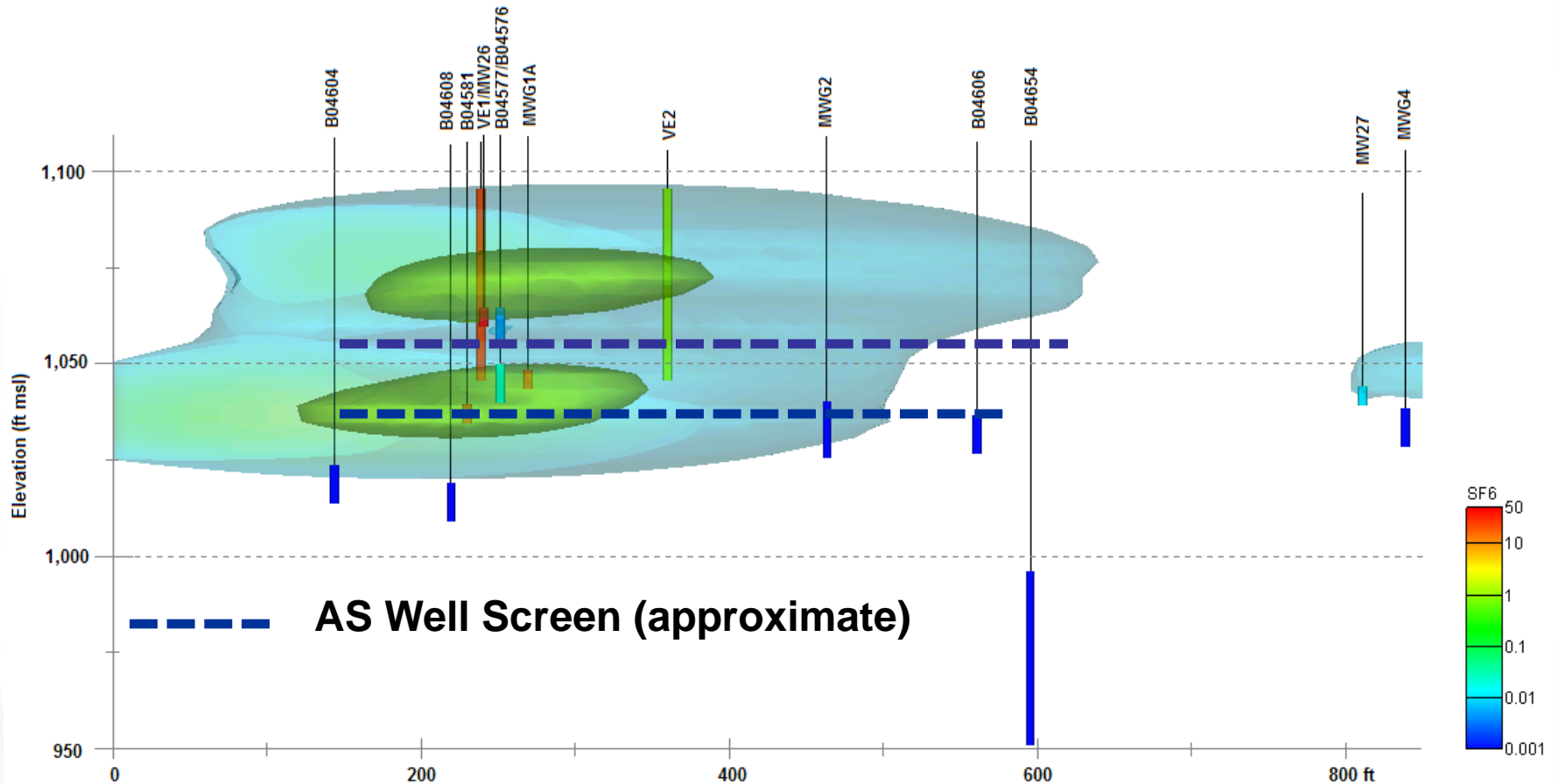
# Capillary Pressure



# Dissolved Air in Groundwater



# Sulfur Hexafluoride Distribution



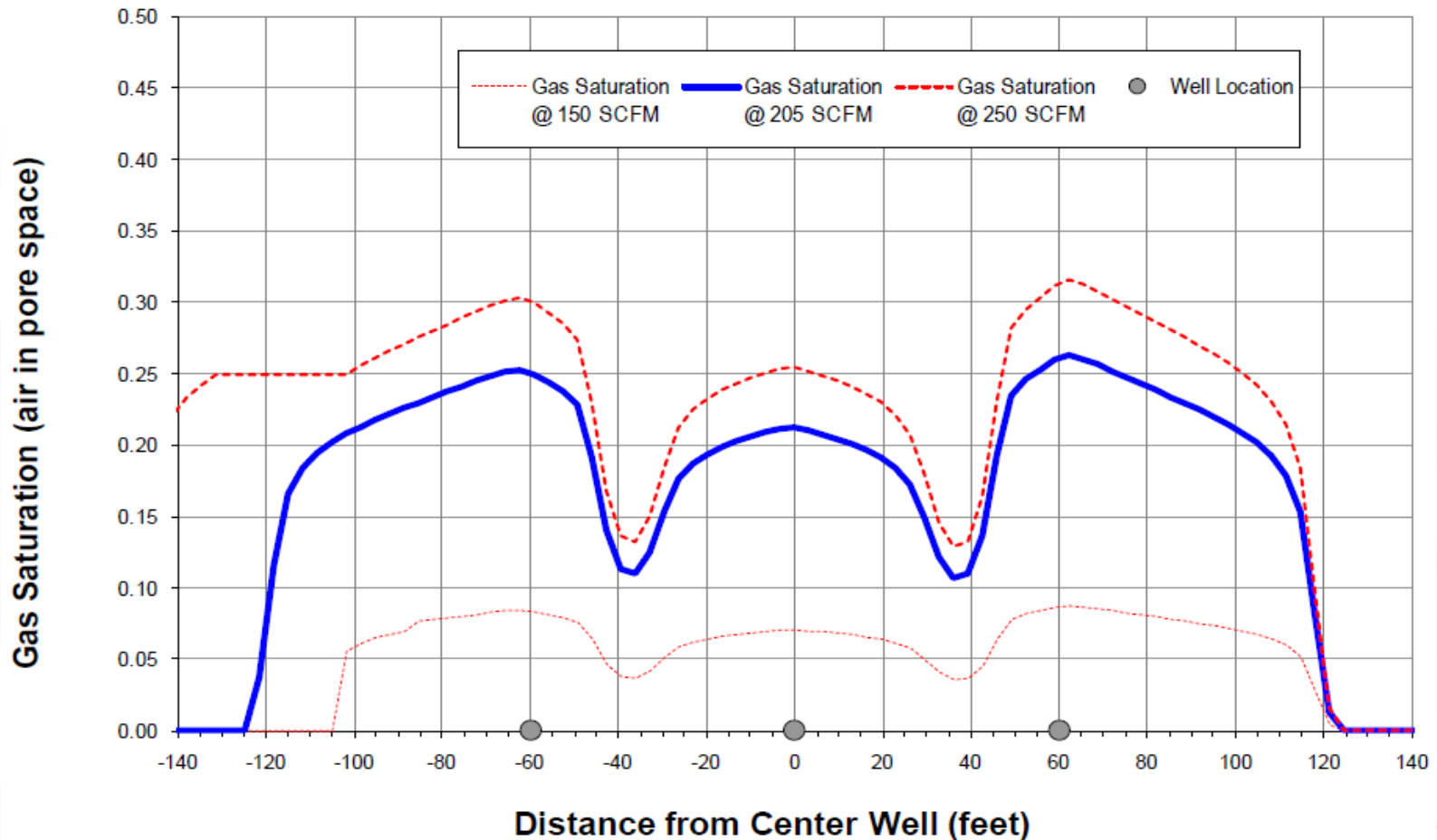
**AS Well Screen (approximate)**

SF6 Concentration Above 1 (Green) and 0.01 (Blue)  
January 28, 2010

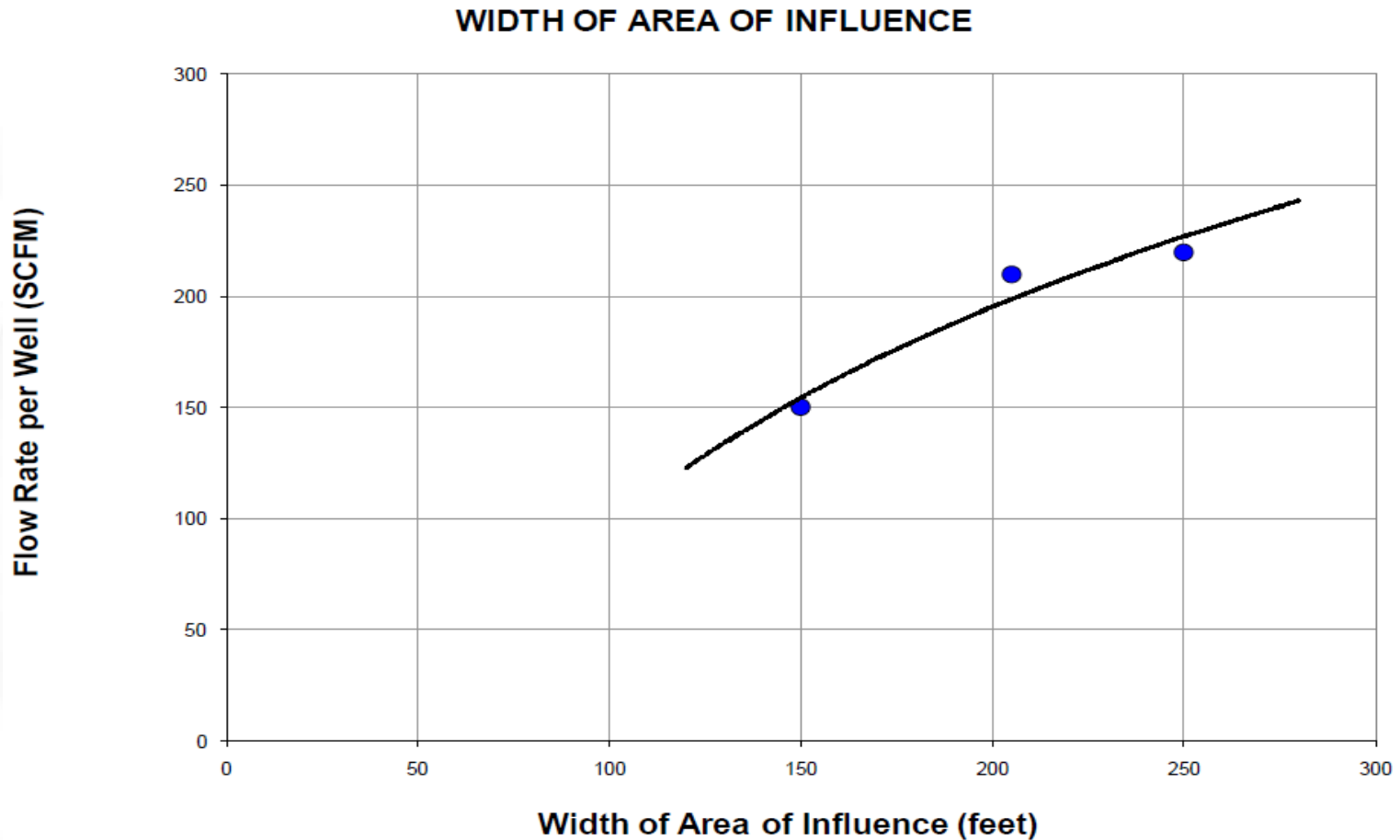


# Area of Influence vs. Lateral Distance

## AREA OF INFLUENCE BASED ON GAS SATURATION



# Area of Influence vs. Flow

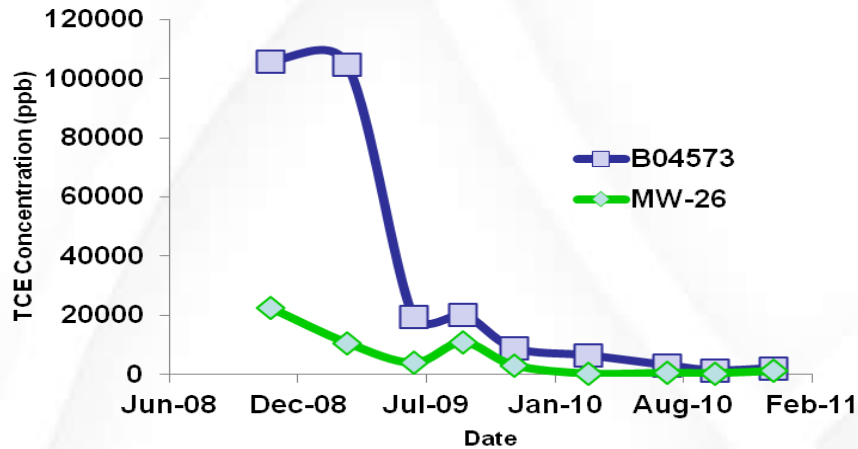


# Tracer Test Findings

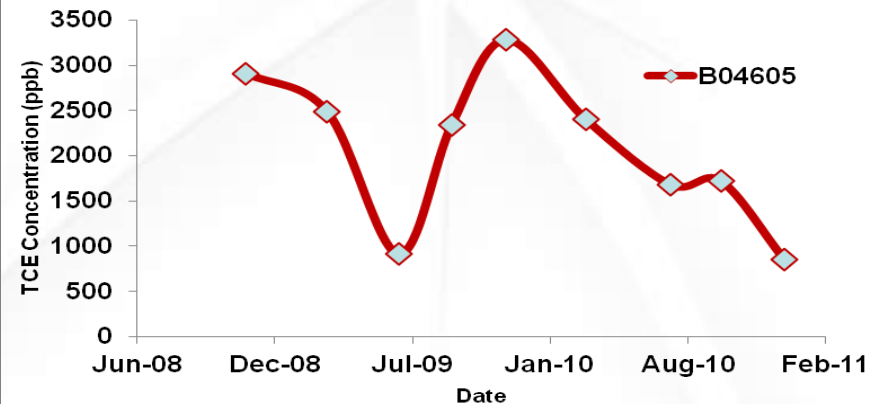
- **SF6, helium, and wellhead pressure data indicate elliptical zone of influence develops 50 feet from the wells within 3 hours of injection**
  - Numerical model indicates diminishing rate of growth of zone of influence after 3 hours of operation
  - Numerical model indicates that zone of influence is not significantly improved by increasing air injection rate above 200 scfm
- **Evidence of air distribution along entire screen length of AS-B and AS-C**
- **AS wells exhibit cumulative effect of injection**

# Monitoring Well Performance: Source Area

## Wells Screened 45-65 ft bgs

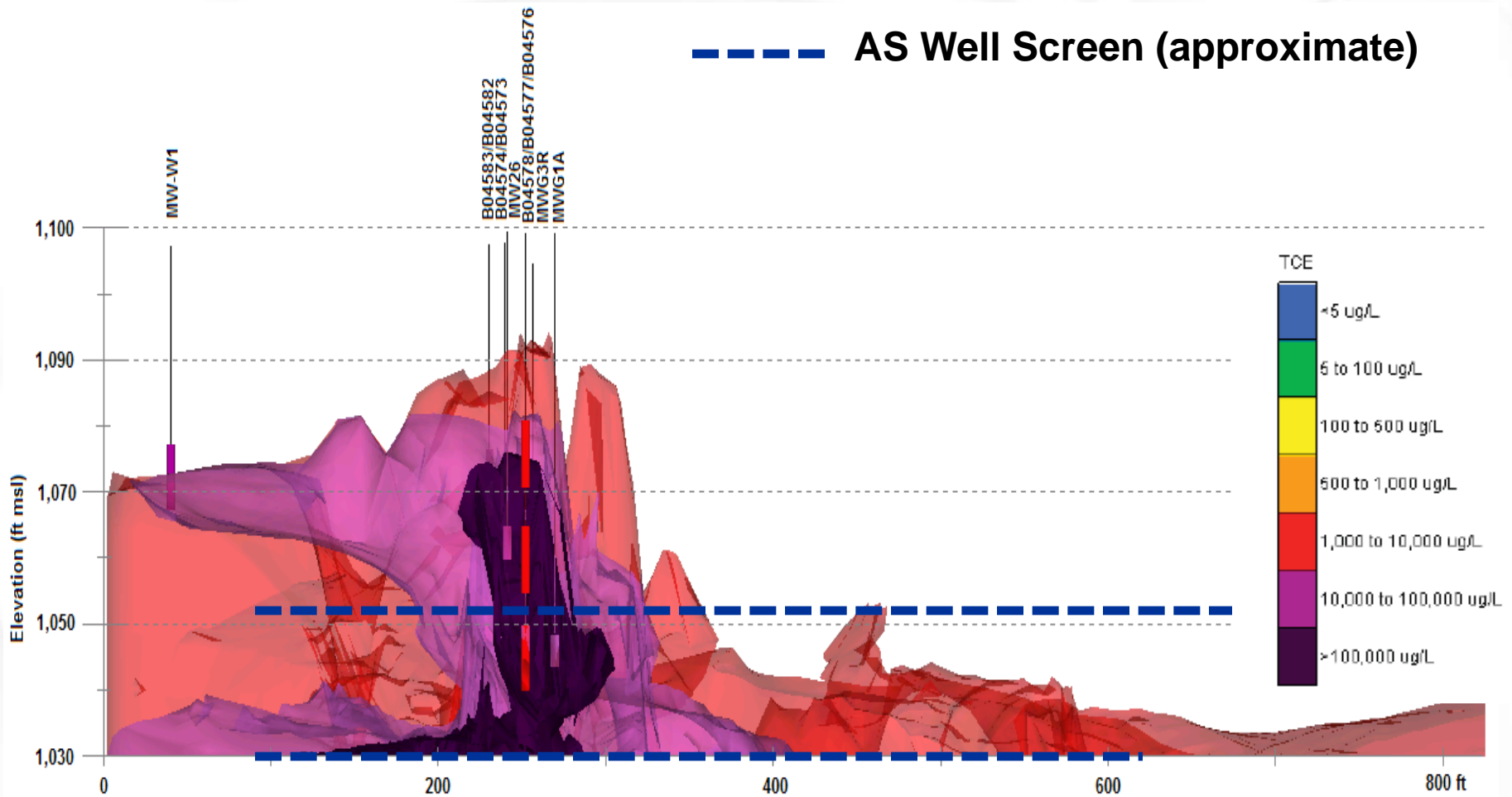


## Well Screened 65-85 ft bgs

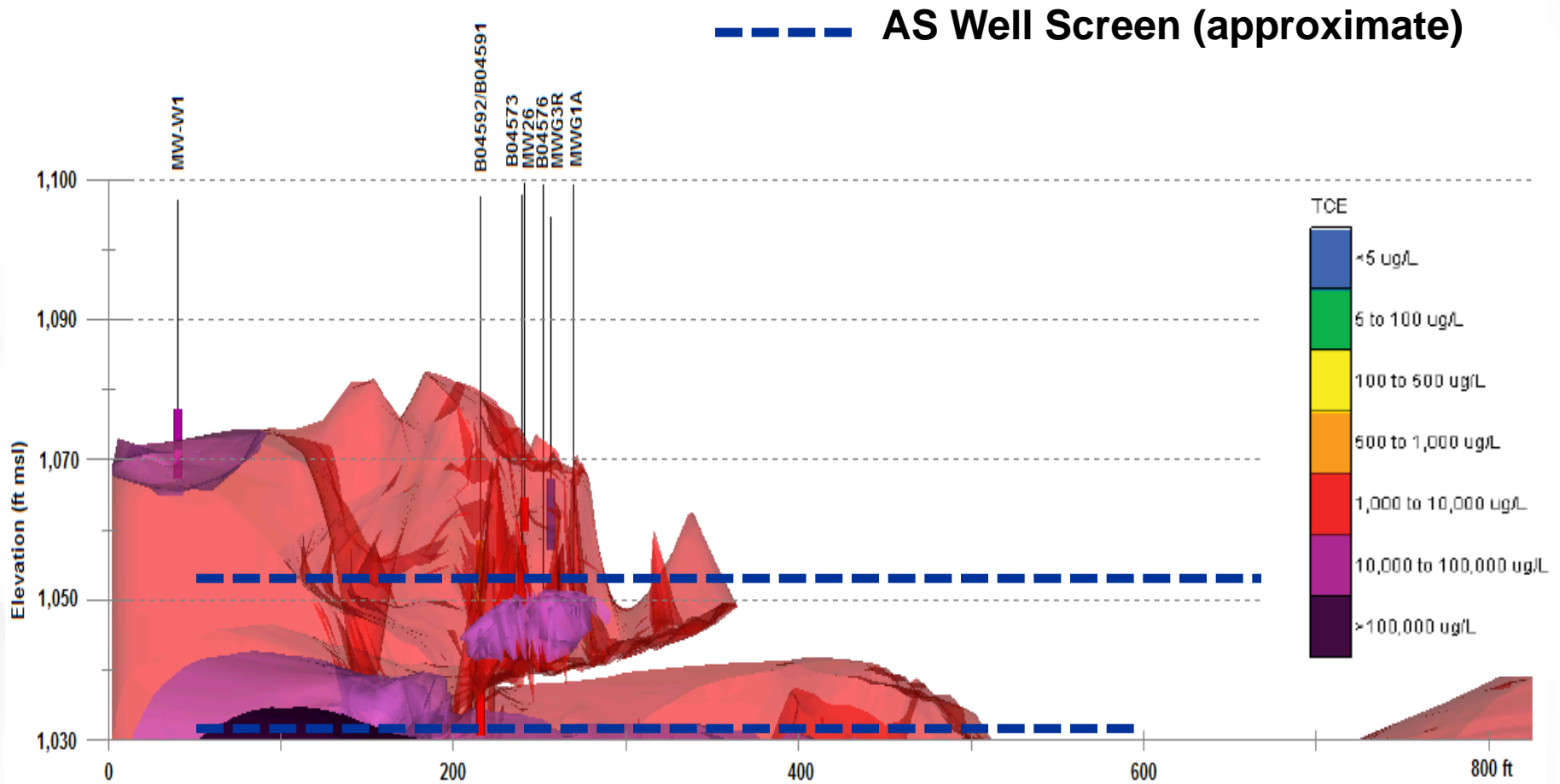


- 1-2 order of magnitude reductions at 45-65 ft bgs
- 60% concentration reductions at 65-85 ft bgs

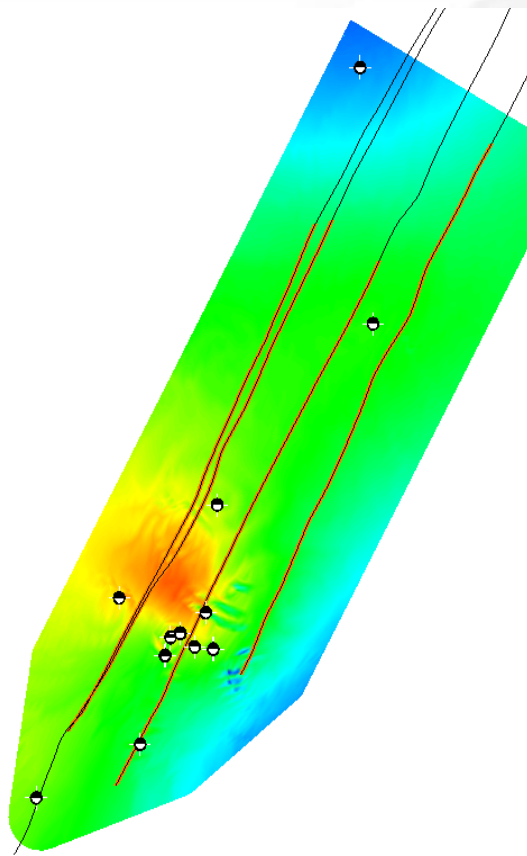
# Performance Results Pre-Treatment



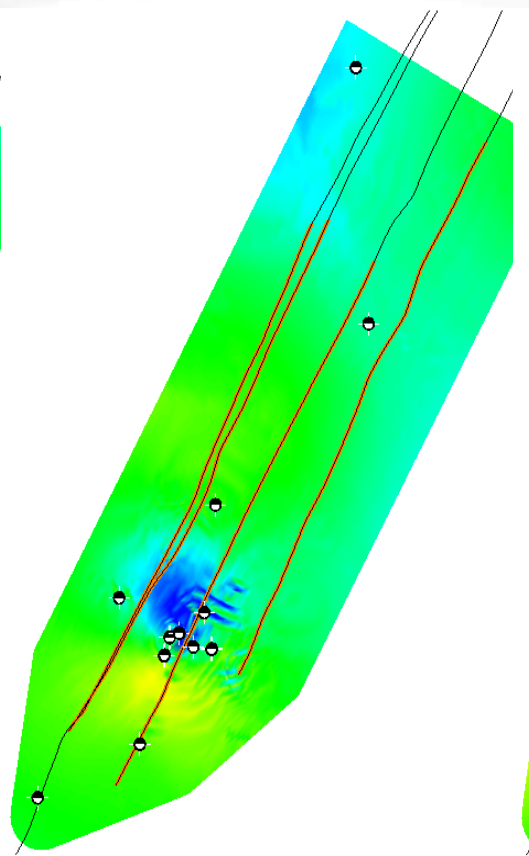
# Performance Results Q4 2010



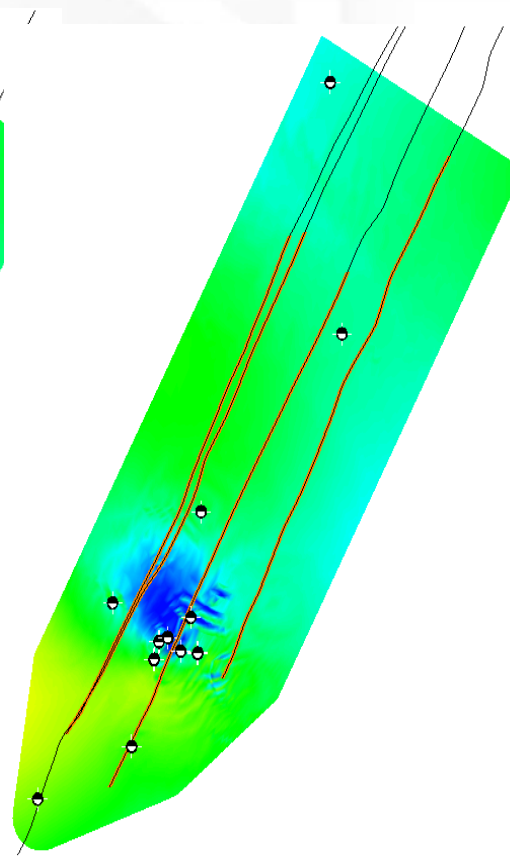
# System Performance (50 ft bgs)



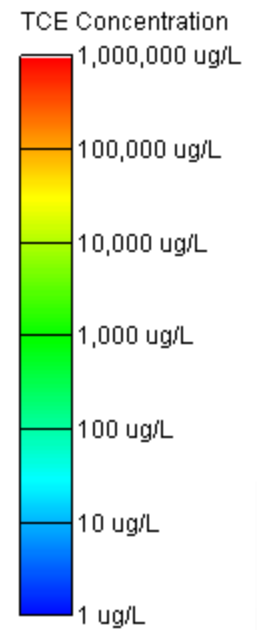
**Q4 2008  
(Pre-Treatment)**



**Q4 2009**



**Q4 2010**



# Conclusions and Path Forward

- **Heterogeneity influences well installation process and air distribution**
- **Optimized AS system**
  - **Raised injection rate to 200 scfm per well**
  - **Adopted 3 hour pulsing schedule**
- **Order of magnitude reduction in TCE concentrations**
- **Expand monitoring well network**



# Questions?

- **Special thanks to contributors**
  - **Tim Clendenin, Aeronautical Systems Center (ASC) – Acquisition Environmental Safety and Health**
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