



# Recent Field Experience with Velocity and Directional Sensors

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RTDF Permeable Reactive Barriers (PRB)  
Action Team Meeting



Capital Hilton, Washington, D.C.,  
November 6–7, 2002



**Battelle**

# DoD Project Supporting Organizations

## ■ **Three-year NFESC/Battelle project funded by:**

- SERDP/ESTCP
- Naval Facilities Engineering Service Center (Charles Reeter)

## ■ **Other participating DoD organizations:**

- Army Corps of Engineers (Steve White), and ITRC (Matt Turner)
- Air Force Research Laboratory (Timothy McHale)
- AFCEE Representative (Robert Edwards)

## ■ **DoD on-site field support:**

- Lowry AFB (Bill Gallant - Versar, Inc.)
- Dover AFB - Base Civil Engineering (Greg Jackson) and ORNL (Nic Korte)
- Seneca Army Depot - Parsons Engineering and DEH (Steve Absolom)
- Former NAS Moffett Field (Gary Munekawa, Navy-Southwest Div; Tim Mower, TetraTech EMI)

# Variability and Uncertainty in Hydraulic Assessment of a PRB Site

- Groundwater velocity,  $v = (K \cdot i) / n$
- Variability in conductivity: K typically varies up to a factor of 10 at even the most “homogeneous” site
- Uncertainty in gradient, i, because of very localized scale of measurements
- Design challenge: For a given residence time, the design thickness of the PRB could vary by a factor of 5 to 10
- At most sites, designs have been based on average values. Seasonal high velocities may lead to inadequate residence time.
- How much certainty in site hydraulic characteristics is needed and will a few localized data be beneficial?


# Variety of Site Characteristics

Site	NAS Alameda	Dover AFB	Lowry AFB	Former NAS Moffett Field	Seneca Army Depot
<b>Aquifer Type</b>	Unconfined	Unconfined	Unconfined	Semi-confined	Unconfined
<b>Aquifer Material</b>	Artificial Fill	Silty Sand	Silty Sand, Sand and Gravel	Sand Channel	Glacial Till
<b>Aquifer Thickness (ft)</b>	14	20	11	20	8
<b>Aquifer Porosity</b>	0.35	0.31	0.30	0.30	0.18
<b>Aquifer Permeability (ft/d)</b>	221	7.4	6.0	30	25
<b>Aquifer Gradient (ft/ft)</b>	0.007	0.0018	0.035	0.007	0.01
<b>Groundwater Flow Velocity (ft/d)</b>	4.4	0.04	0.7	0.7	1.4

# Hydraulic Assessment Tools for Site Characterization and Design

- Water level surveys
- Downhole heat pulse sensor (developed by KV-Associates)
- In situ HydroTechnics™ sensor (developed by Sandia National Laboratory)
- Colloidal borescope (developed by U.S. DOE)
- Tracer tests (e.g., bromide tracer)
- Flow and solute transport modeling





# Hydraulic Assessment Tools for Site Characterization and Design

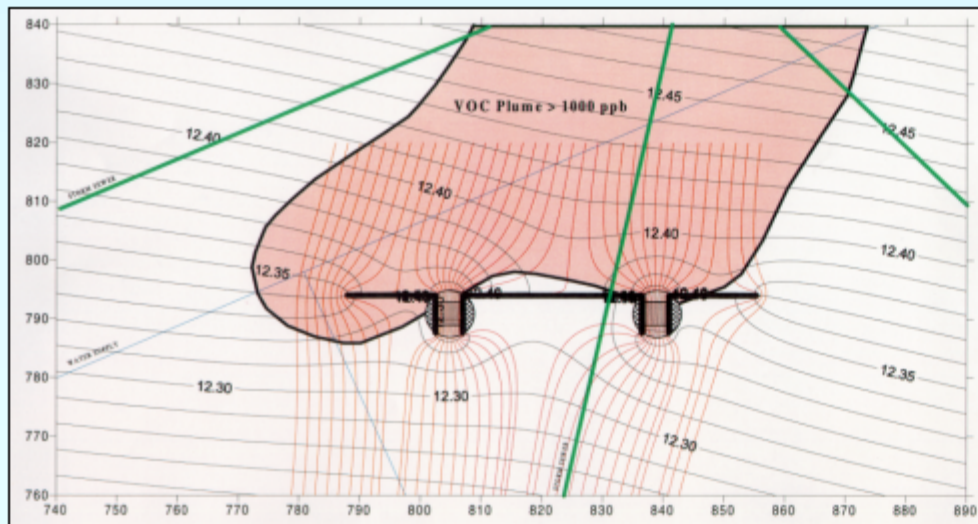
During a three-year-long study for ESTCP and SERDP, HydroTechnics™ sensors and Colloidal Borescope were deployed at:

- Dover AFB (Delaware)
  - 2 sensors in ZVI barriers
  - 2 sensors upgradient of funnel and gate
- Former Lowry AFB (Colorado)
  - 2 sensors upgradient of funnel and gate

# SERDP Demo Project Dover AFB, DE

## Funnel-and-Gate System

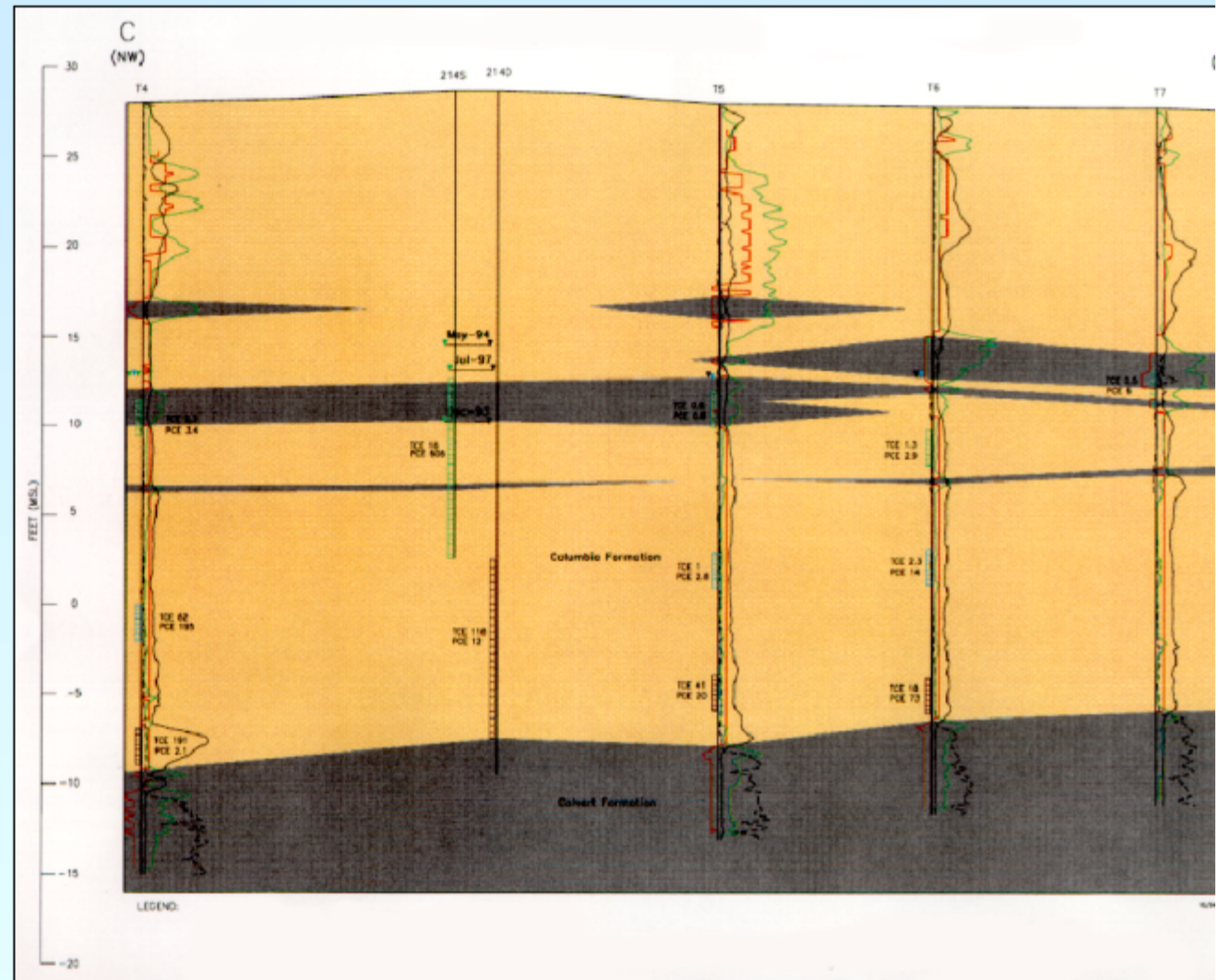
Dual Gates  
Varied Dispersion Zones  
Caisson Construction



- Installed December 1997
- Lower treatment depths (38 ft)
- Outflow treated to below MCLs

# Geologic Cross Section Through Dover AFB – Area 5

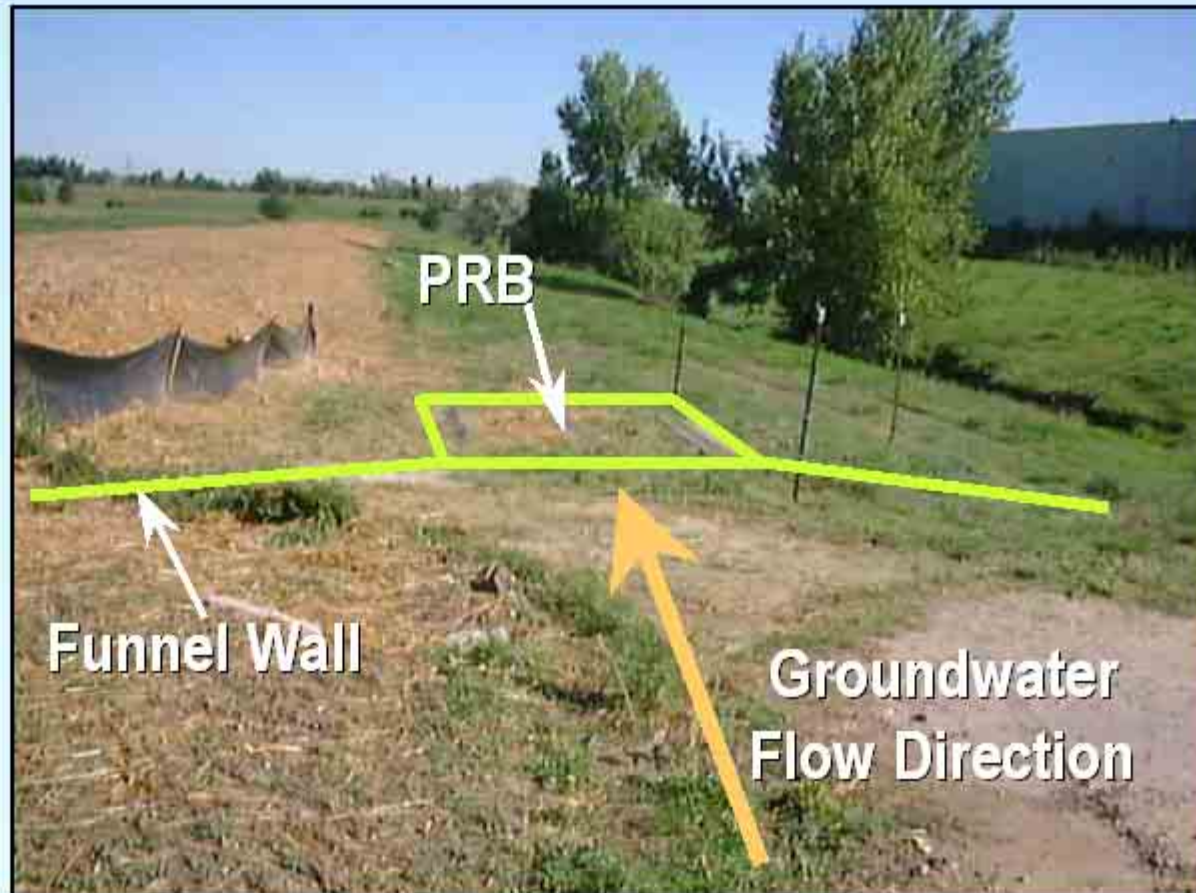
- Site characterized by sandy relatively homogeneous aquifer
- However, slug tests results in local wells showed K varied by around half order of magnitude.





# Lowry AFB, Colorado

6-ft-tall berm and irrigation area west of barrier



Small stream flows east of barrier

Groundwater flow near barrier is affected by local perturbations