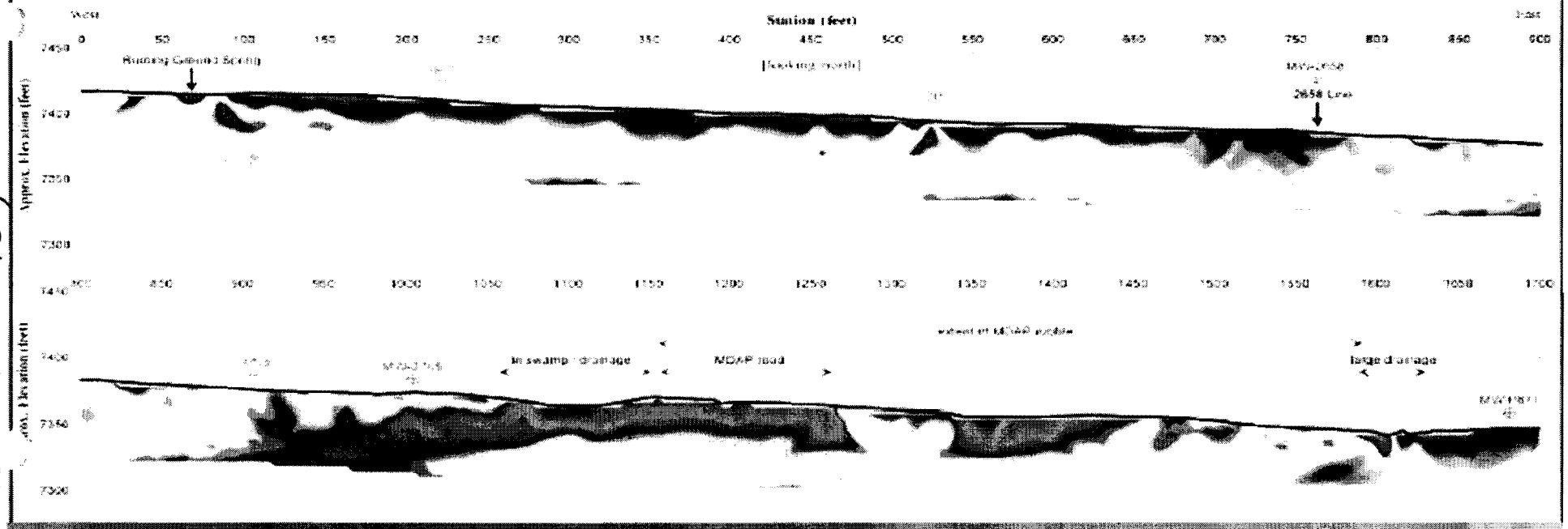
Update on PRB Performance Presentation to the HPT November 21, 2005

High Resolution Resistivity
1st Longitudinal Line



Shaw
Shaw Environmental & Infrastructure, Inc.

TA-16 / SWMU 16-021(c)

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esentation Objectives

- Literature review of PRB performance
- Focused look at the Cornhusker PRB
- Comparison of Cañon de Valle and Martin Spring geochemistry with Cornhusker
- Performance review of Dupont barium PRB
- Focused look at the Mortandad PRB
- Lessons learned and design approach
- Update of CMS comparison between PRBs and pump and treat

Literature Review of PRB Performance

- Permeable Reactive Barriers: Lessons Learned/New Directions, Prepared by The Interstate Technology & Regulatory Council, Permeable Reactive Barriers Team, February 2005
- Permeable Reactive Barriers for Inorganic and Radionuclide Contamination, Kate Bronstein National Network of Environmental Management Studies Fellow, U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Office of Superfund Remediation and Technology Innovation Washington, DC www.epa.gov http://www.clu-in.org, August 2005
- Degradation of Explosives at Cornhusker Army Ammunition Plant, Rick Johnson, Paul Tratnyek, Brad Thoms (Oregon Health & Science University) and Tom Krug, (GeoSyntec Inc.), August 2004

Literature Review of PRB Performance

- Since the 1994 introduction of the first zero-valent iron PRB in the United States, this technology has developed from innovative to accepted standard practice (ITRC, 2005)
- More than 200 sites worldwide, including 72 full-scale installations to treat chlorinated solvent compounds. The vast majority of these PRBs are operating as intended (ITRC, 2005)
- Research has shown that PRBs can be expected to last an estimated 10–30 years depending on the rate of flow through the system and the levels of total dissolved solids (ITRC, 2005).

Ammunition PRB for HE - Overview

- **After 9 months of operation, the PRB continues to be effective for TNT and RDX (Johnson et al 2004)**

TNT (ug/L)	8	10	11	12	14	16	18
-5.7	112	0	0	0	0	0	0
-6.3	109	0	0	0	0	0	0
-6.9	58	0	0	0	0	0	0
-7.5	97	0	0	0	0	0	0
-8.1	12	0	0	0	0	0	0
-8.7	65	0	0	0	0	0	0
-9.3	27	0	0	0	0	0	0
-9.9	20	0	0	0	12	7	4

- **RDX data not published yet**

Husker PRB for HE - Overview

- Tracer test data from 9 months after installation indicate that water is still flowing through the PRB
- There is growing evidence that there is some plugging of the PRB (this evidence comes primarily from geochemical and tracer data and does not come from hydraulic head differences, which are still too small to measure)

Hanford PRB for HE – Fouling?

- Evidence suggests sulfate reduction to sulfide and precipitation in the PRB. Probably exacerbated by use of guar gum (high TOC) and resulting sulfate reducing bacterial populations
- Sulfate concentrations of groundwater are high 100-400 mg/L
- Possible calcium carbonate precipitation due to elevated alkalinity 200-300 mg/L in groundwater and elevated pH in the PRB (as a result of iron dissolution)

Comparison with CdV and MSC

Sulfate, mg/L	100-400	3-16	10-74
Alkalinity, mg/L	200-300	60-222	16-86
Carbon Load	High (guar)	Low	Low

- Potential for sulfide and carbonate fouling low at CdV and MSC

Barium PRB

- ZVI/calcium sulfate PRB for removal of zinc and barium
- Configuration is similar to the ZVI/calcium sulfate option proposed for CdV
- System has been effective in meeting goals

Analyte	Initial Concentration (ppb)	Effluent Concentration (ppb)
Zinc	100 - 1,000	< 9
Barium	4,000 - 8,000	1,000

- A thicker PRB may be required to consistently meet NMWQCC barium goal
- No fouling problems reported to date

ortandad Canyon PRB

- Multicomponent PRB showed effective treatment for nitrate, perchlorate, arsenic and uranium
- Alluvium saturated thicknesses decreased to zero because of the drought
- PRB suffered wash out damage from storm water runoff in the Spring of 2005

Lessons Learned and Design Approach

- Majority of PRBs approximately ten years old still functioning as designed, reason is that despite some fouling PRBs have much greater permeability than native aquifer and huge reactive capacity
- Accelerated aging studies in the lab show design life of 10 to 80 years, depending on local conditions
- Evaluate geochemistry

  - some PRBs have shown fouling because of sulfate, carbonate and passivation of iron

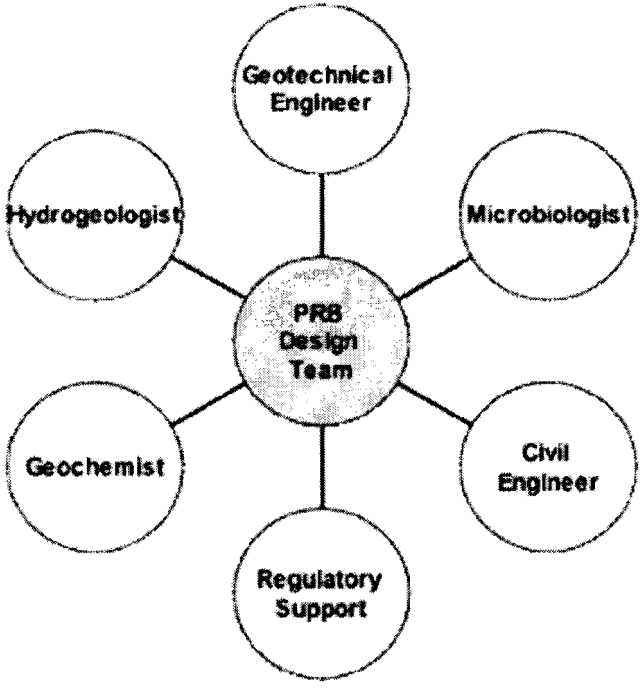
- Construction methods are important

Lessons Learned and Design Approach

- Hydrogeology: permeability, groundwater flux, potential for bypass through underlying fractured rock
- Facilitate PRB bed replacement by using rigid cells with perforated walls
- Design PRBs to withstand water runoff erosion (lesson learned from Mortandad)
- Conduct laboratory testing to determine best media

  -for CdV, carbon versus ZVI, calcium sulfate versus other sorbants

Lessons Learned and Design Approach



Update of CMS Comparison between PRBs and Pump and Treat

- General reliability of PRBs (after approximately ten years) looks good
- Advantage of Pump and Treat is that flexibility of ex situ treatment is high
- Installation of series of interceptor trenches, injection wells, and utility trenches will have significant short-term impact to the canyons. Impact of PRB installation is lower
- Groundwater/surface water balance may be difficult to maintain with pump and treat. Perennial reach may disappear

Update of CMS Comparison between NBs and Pump and Treat

- Generally more permitting issues with Pump and Treat:

  - Groundwater discharge (naturally occurring manganese is above secondary standard, possibly aluminum and arsenic also)

  -NPDES will be required if an outfall is part of the discharge system