Pilot Demonstrations of Arsenic Removal Technologies

NMEHC, Arsenic Vendor's Forum
"Meeting the New Drinking Water Standard for Arsenic"
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Outline

- The Arsenic Water Technology Partnership
- Site selection
- Concepts for Pilot Demonstration Tests
- Initial Tests in New Mexico
  - Socorro, Anthony, Rio Rancho
- Summary

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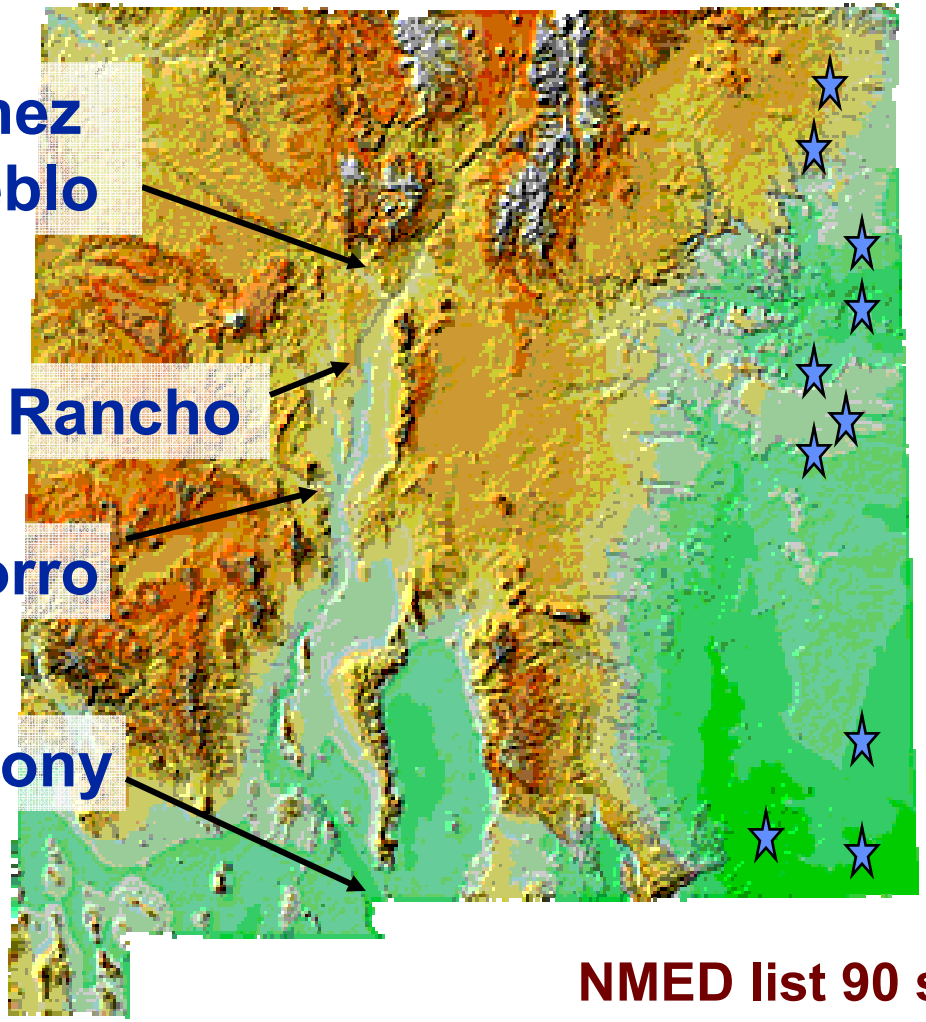
Potential Sites in New Mexico



NMED list 90 sites >10 ppb in state

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Things we look for in a pilot site

- As concentration (>10 ppb)
- Example ground water composition that will help other communities
  - pH, TDS, foulants such as Fe, Mn, silica, and organics
  - As(III)/As(V)
  - Competing ions (V, SO_4, etc.)
  - Other contaminants of concern/benefit (e.g, Ra, U, ClO_4, F)
- Small size of system to be treated (< 10,000 users)
- Community support facilitates rapid deployment
  - Water utility
  - Municipal government
- Ability to deal with residuals/treated effluent
- Rural and Native American communities that would benefit from assistance

Current Arsenic Treatment Alternatives

- Sorption treatment processes
  - Ion exchange
  - Activated alumina
  - Iron-based sorbents
  - Resins
  - Metal oxide sorbents
  - Other sorbents
- Non sorption treatment processes
  - Reverse-osmosis
  - Precipitation/filtration processes
    - Conventional gravity coagulation/filtration
    - Coagulation-assisted microfiltration
    - Enhanced lime softening
    - Oxidation/filtration

Sandia Pilot Test Concepts

- Side-by-side demonstrations of technologies tested by AwwaRF bench-scale program, WERC design contest, or commercial technologies vetted through Vendor Forums
  - Test duration: 3 – 9 months
  - Test size: 0.3 – 10 gpm
  - Different technology classes: adsorptive media, Coagulation/Filtration, membranes, electrochemical
- Cooperative effort between Sandia, Technology Owner and Site Owner
- Test Protocols developed with help from NSF International , academia, industry during 2004-2005

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Pilot Test Configurations

- Pump house
- Skid Mount or container
- Mobile unit

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Pilot Test Design

- The adsorption columns are designed based on
  - Information on particle size
  - Desired hydraulic loading rate
  - Optimum Empty Bed Contact Times supplied by the vendors
- Each column can operate independently of the others
- Manual operation
- Data loggers for flow, pressure, temperature measurements

Pilot Test Design

- **Adsorption Media types:**
  - **Iron oxy/hydroxides, Zr-oxides, Ti-oxides, La-coated DE, Resins**
- **Size Range:**
  - **Smallest: Less than 5 μm**
  - **Largest: 2 mm x 1 mm**
- **Typical Parameters:**
  - **Hydraulic Loading Rate 4-6 gpm/ft^2**
  - **Empty Bed Contact Time 2-5 minutes (3 min typical)**
  - **Flow Rate 0.3 gpm**
  - **Backwash Flow Rate 0.2-0.6 gpm**
  - **Free board 30-50% of media height**

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New Mexico Pilot Summary – Water Quality

Site	Total As/As(III)	V (ppb)	SO_4 (ppm)	Fe (ppm)	pH
Socorro	42 ppb / 0 ppb	11	29	0.4	8.0
Anthony	20 ppb / 18 ppb	2	180	0.15	7.7
Rio Rancho	19 ppb / < 1 ppb	15	100	<0.10	7.7
Jemez Pueblo	20 ppb / 19 ppb	<1	24	1.2	7.5

Site	Cond. (μS/cm)	TOC (ppm)	Ca Hard (ppm $CaCO_3$)	Alkalinity (ppm $CaCO_3$)	SiO_2 (ppm)
Socorro	360	0.5	44	120	25
Anthony	1380	0.8	66	180	37
Rio Rancho	630	ND	62.5	184	22
Jemez Pueblo	770	2.0	155	290	50

First Community Pilot: Socorro, NM

- 100% groundwater source for drinking water
- Warm springs (90°F) provide 500 gpm, 20 – 40 ppb As by gravity flow.
- Formerly site of tap for bottled water company; optimal F
- Phase 1: Feb-Oct 2005
  - Tested 2 IBS, 1 ZrO_2, 1 TiO_2, 1 resin
- Phase 2: Late Fall 2005 start
  - Will test pH adjustment, potentially non-adsorption treament methods

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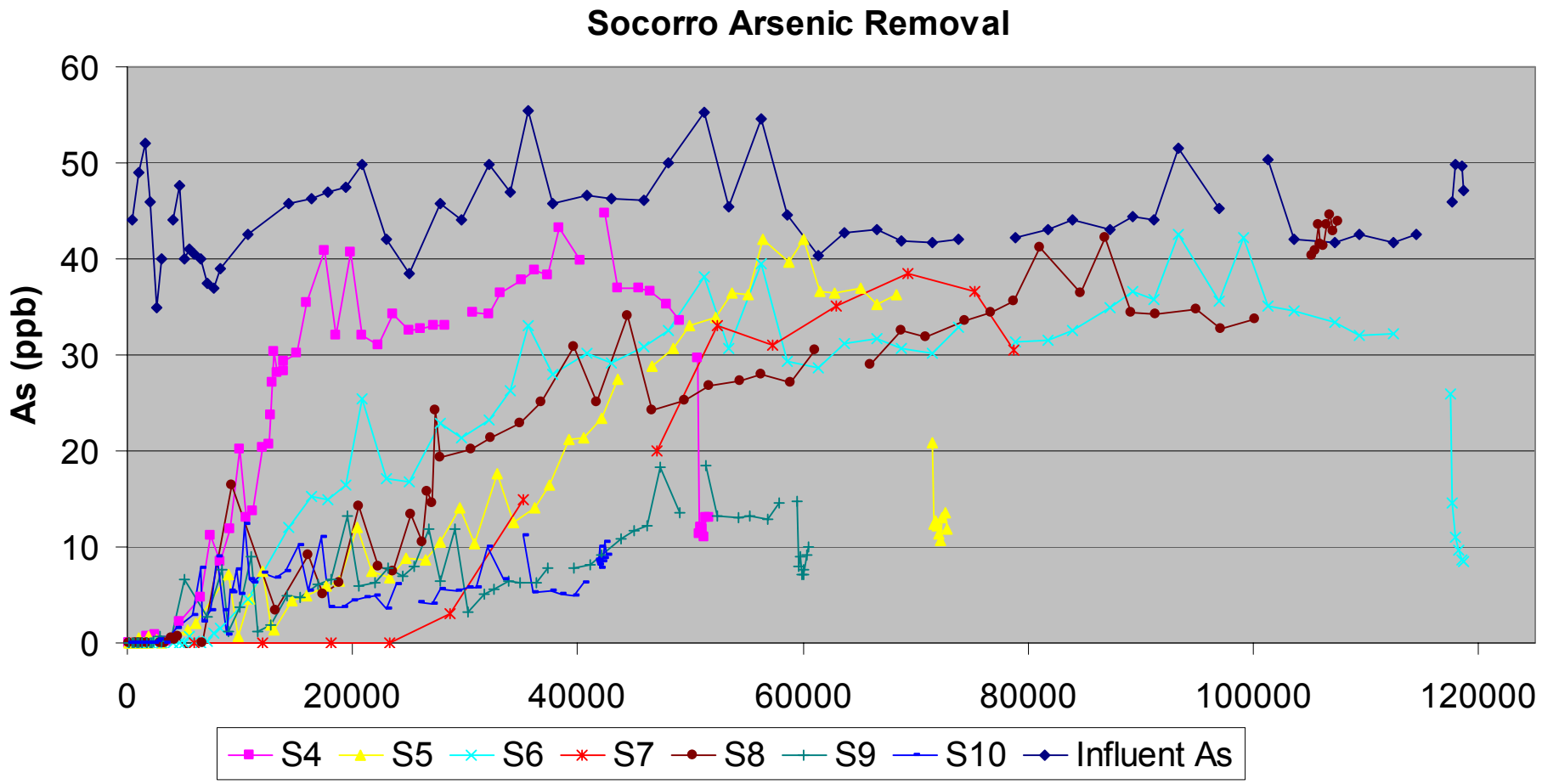
First Community Pilot: Socorro, NM



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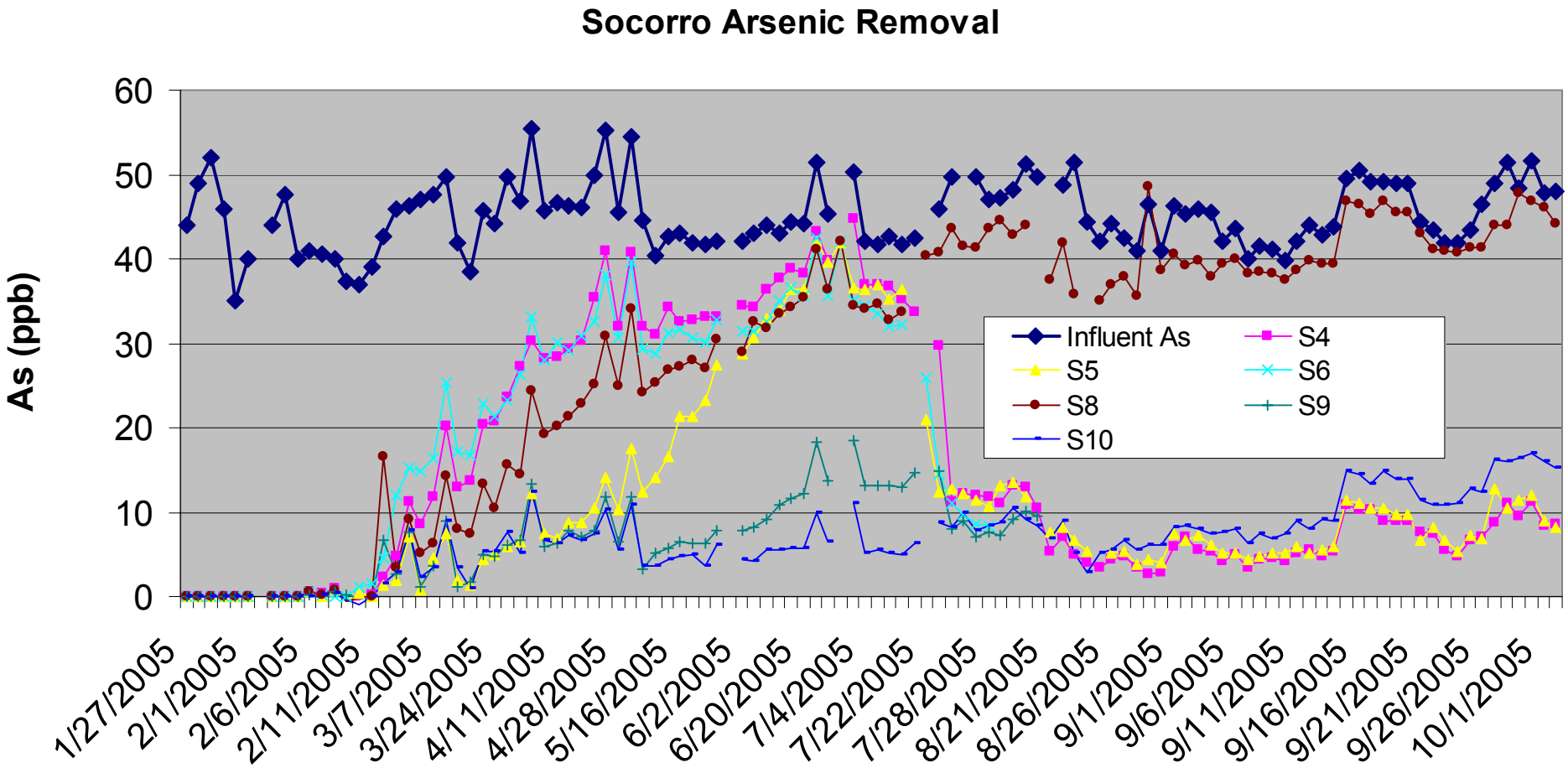
First Community Pilot: Socorro, NM



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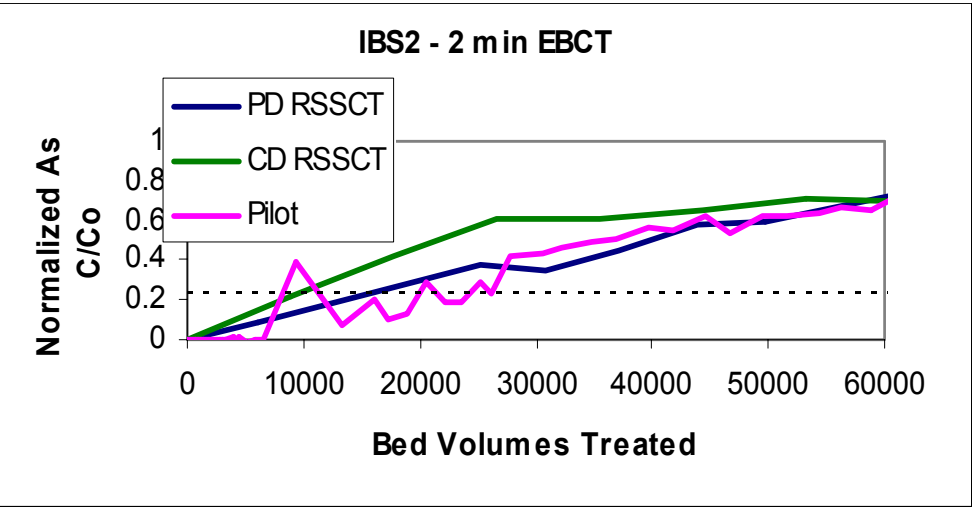
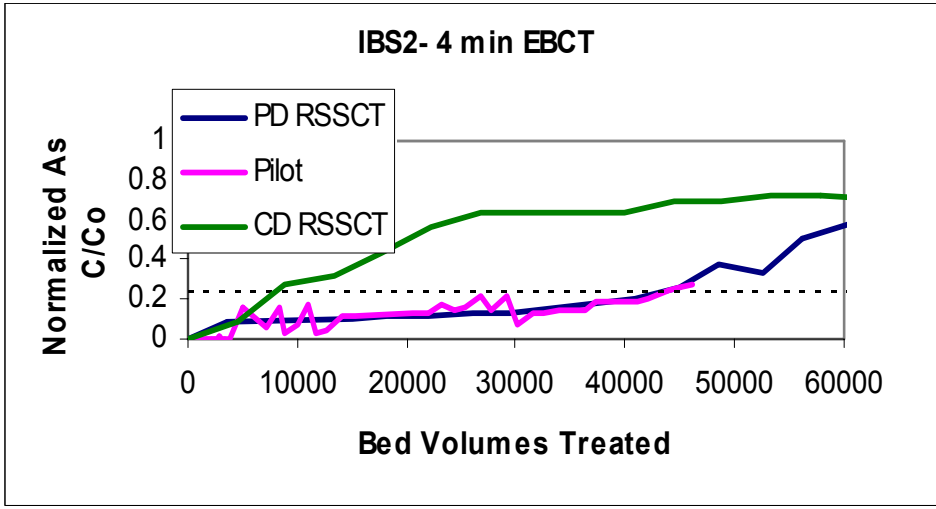
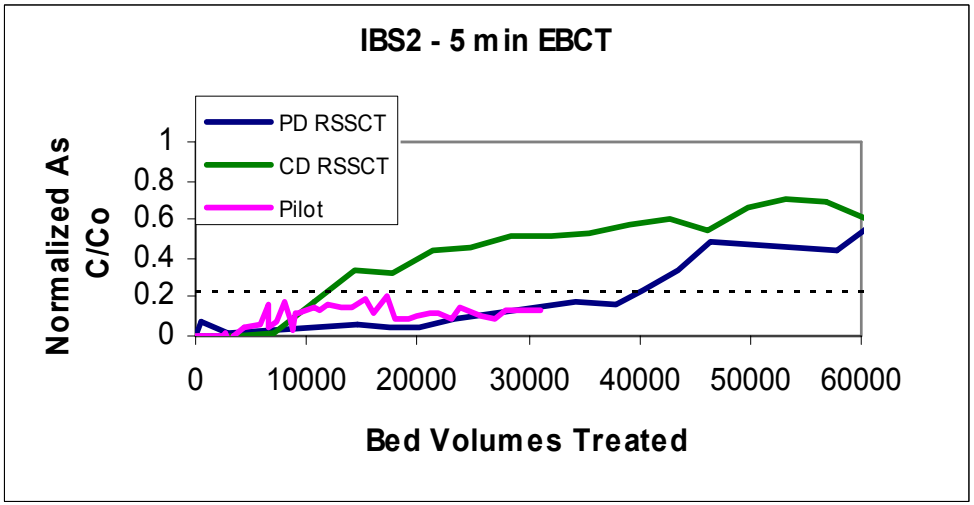
First Community Pilot: Socorro, NM







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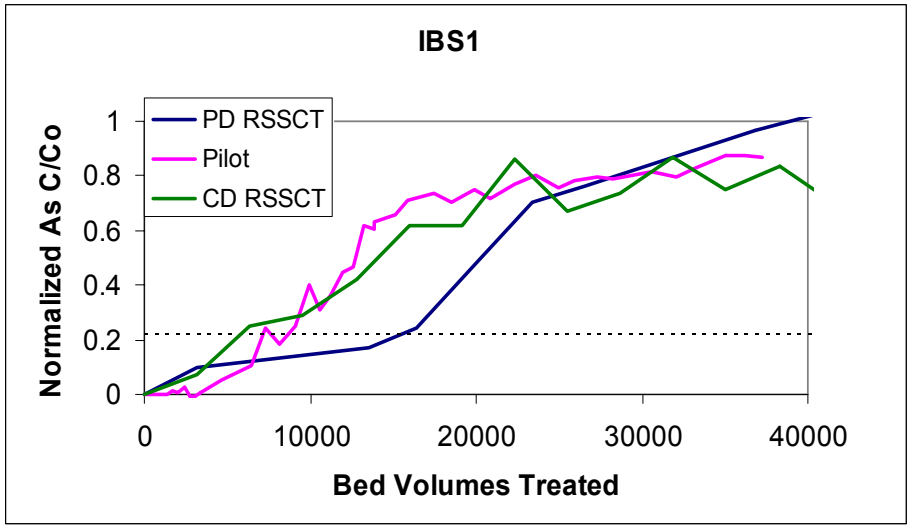
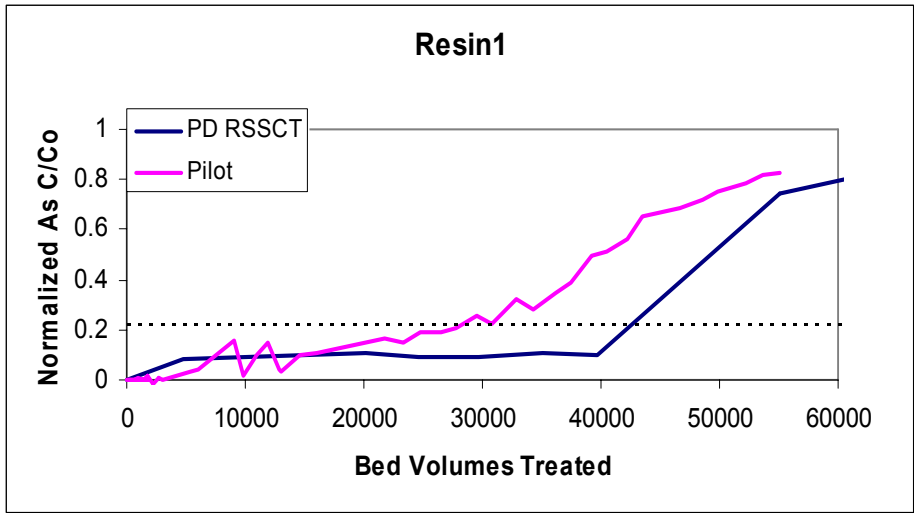
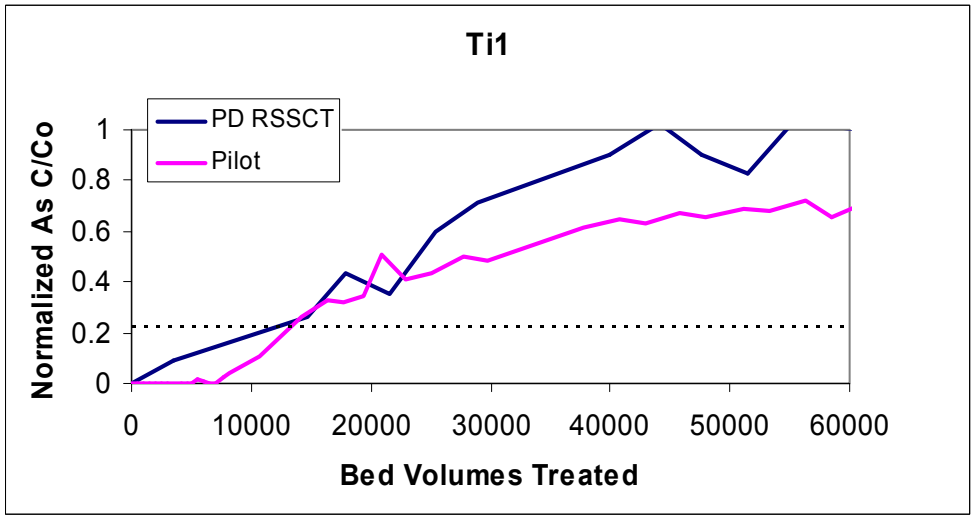
First Community Pilot: Socorro, NM







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First Community Pilot: Socorro, NM

- **Results: Arsenic Removal Capacity**

Parameter	IBS1	Ti1	Resin1	Ti1	IBS2 (4 min EBCT)
BV to 10 ppb	8,600	13,000	27,000	32,000	43,000
Capacity at 10 ppb, mg/g	0.60	0.70	1.38	1.67	3.56
Capacity at 35K BV, mg/g	1.17	1.39	1.75	1.67	3.01
C/Co at 35K BV	0.88	0.60	0.35	0.38	0.15
BV at C/Co = 0.8	33,000	87,000	53,000	63,000	>270,000
Capacity at C/Co = 0.8	1.15	2.26	2.10	2.23	> 4.62

First Community Pilot: Socorro, NM

- **Results: Arsenic Removal Capacity**

Parameter	IBS2		
	2 min	4 min	5 min
BV to 10 ppb	24,000	43,000	42,000
Capacity at 10 ppb, mg/g	1.95	3.56	3.47
Capacity at 35K BV, mg/g	2.59	3.01	2.92
C/Co at 35K BV	0.50	0.15	0.12
BV at C/Co = 0.8	84,000	>270,000	>235,000
Capacity at C/Co = 0.8	4.03	> 4.62	>3.47

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First Community Pilot: Socorro, NM

Results: Physical Observations

- **Sieve Analysis: 0.8-29% media loss**
- **Particle Size Uniformity: All media had C_u < 5, most <2.5 (fairly uniform)**
- **Surface Area: Doesn't seem to affect As removal – the media with the smallest surface area had the highest capacity**
- **Each column reacted differently to operating conditions**
  - **Media was lost due to backwashing**
  - **Media compacted throughout pilot experiment**

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Second Community Pilot: Anthony, NM

- 100% groundwater source for drinking water
- Warm springs (~85°F) provide 240-270 gpm, 20 ppb As (mainly As III).
- High sulfates, TDS
- Phase 1: August 2005 Start
  - Tested 3 IBS, 1 ZrO_2, 2 TiO_2, 2 resins, 1 La-coated DE, 3 new/experimental sorbents
  - Intermittent Flow Operation

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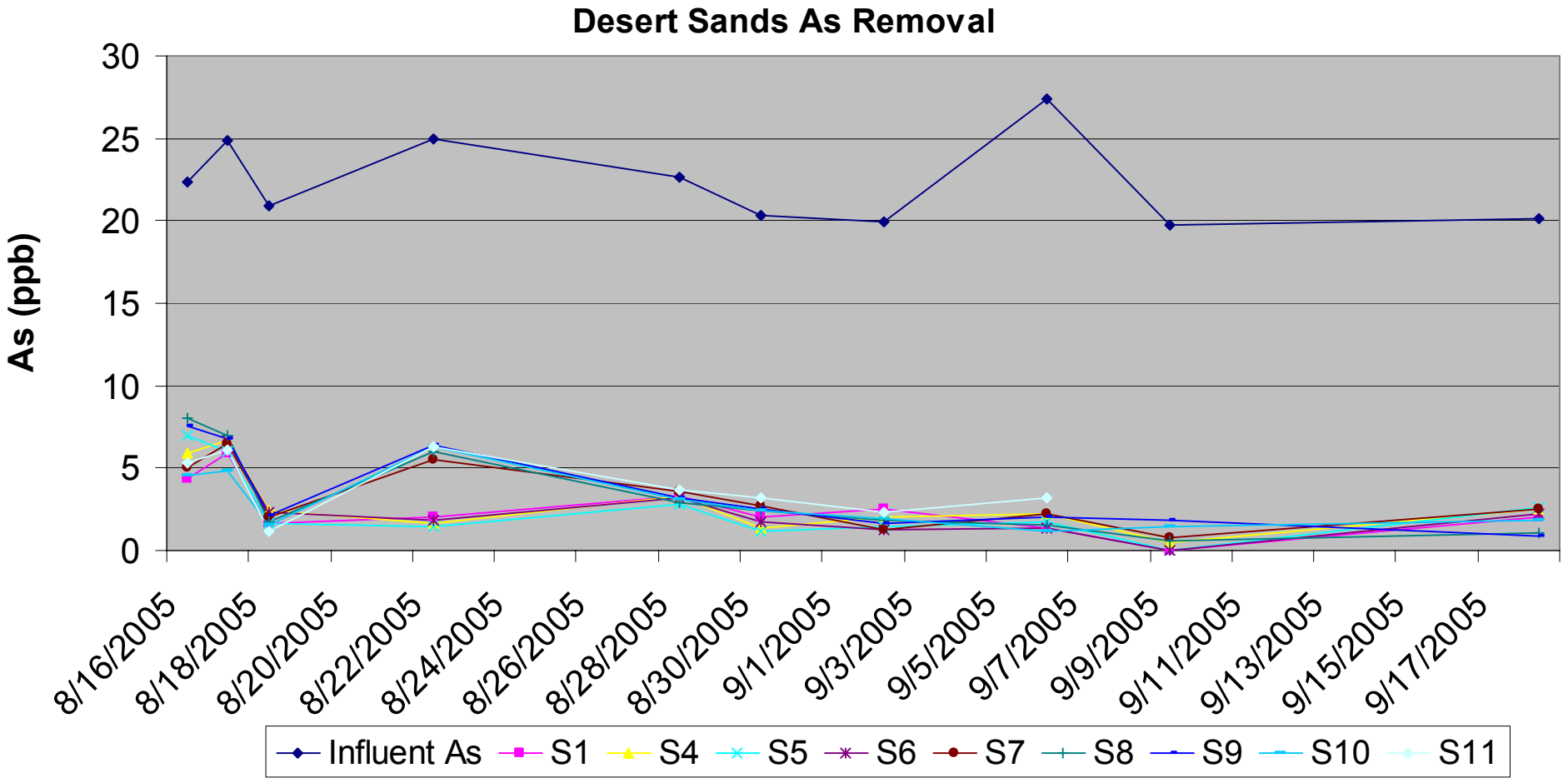
Second Community Pilot: Anthony, NM



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Second Community Pilot: Anthony, NM

Results: Physical Observations

- Sieve Analysis: 0.8-29% media loss
- Many of the media required extensive preparation (overnight soaking, 1-2 hour initial backwash)
- Several of the media have required frequent backwashing (some weekly)
- Not all of the As (III) is being oxidized to As (V), will increase HOCl detention time soon
  - None of the columns' effluent are at non-detectable levels

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Third Community Pilot: Rio Rancho, NM

- 100% groundwater source for drinking water
- Deep well (800 ft) provides 2000 gpm, 20 ppb As (mainly As V).
- High sulfates, Vanadium, TDS
- Phase 1: September 2005 Start
  - Tested 2 IBS, 1 ZrO_2, 1 TiO_2, 2 resins, 2 under-the sink RO units
- Continuous Flow Operation
- Pre-sieved media prior to loading & initial backwash (> 60 mesh)

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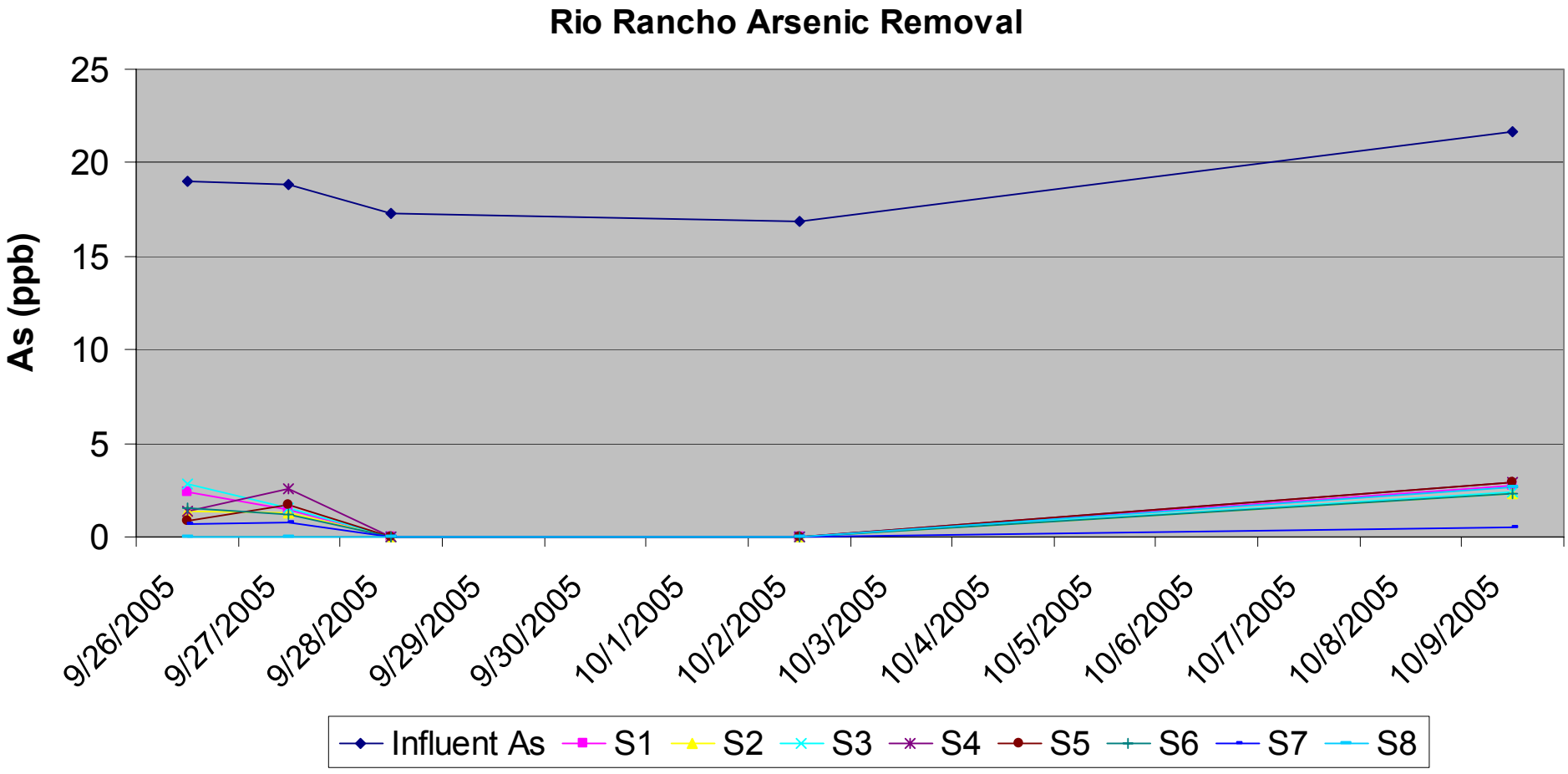
Third Community Pilot: Rio Rancho, NM



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Third Community Pilot: Rio Rancho, NM

Results: Physical Observations

- **Sieve Analysis: 0.8-29% media loss**
- **Pre-sieving cut down initial backwash time to 15 minutes per column**
- **Only two media have required a backwash**

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Next New Mexico Pilot: Jemez Pueblo

- As levels : 20-30 ppb ; optimal F level
- Treatment plant under construction (mid-November 2005 completion?)
- Opportunities for training and outreach will be important aspects of pilot test program
  - Will work with local high school students (science projects, etc.)
- Will study oxidation methods, coagulation/direct filtration

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Hydrothermal Waters in Jemez Silicic Volcanic Field

- Thermal springs plume extends along Jemez fault zone (San Diego Canyon).
- Composition similar to deep thermal waters.

- Soda Dam
  - Na-HCO_3-Cl water
  - pH = 6.7
  - Na = 960 ppm
  - HCO_3 = 1500 ppm
  - Cl = 1500 ppm
  - As = 1500 ppb

- Jemez Springs
  - As = 700 ppb
- Jemez River
  - As = 28 - 66 ppb
- Jemez Pueblo
  - 20 ppb As(III)
  - New standard = 10 ppb

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Summary

- **Pilot Test Demonstration Objectives**
  - Generate cost/performance data for innovative technologies for small communities
- **Technology Selection**
  - Initial technologies chosen from participants in Vendors Forum
  - Later stages include technologies vetted by university and government labs with State and Federal funding
- **Site Selection**
  - Initial sites in New Mexico
  - Subsequent sites chosen through State and Tribal contacts and Web site applications
- **Initial Pilot Studies**
  - Socorro, NM – February 2005 start
  - Desert Sands, NM – Fall 2005 start
  - Rio Rancho, NM – Fall 2005 start
  - Jemez Pueblo – Spring 2006 start

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