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Round 1 Arsenic Removal Technology Demonstration: Evaluation Approach

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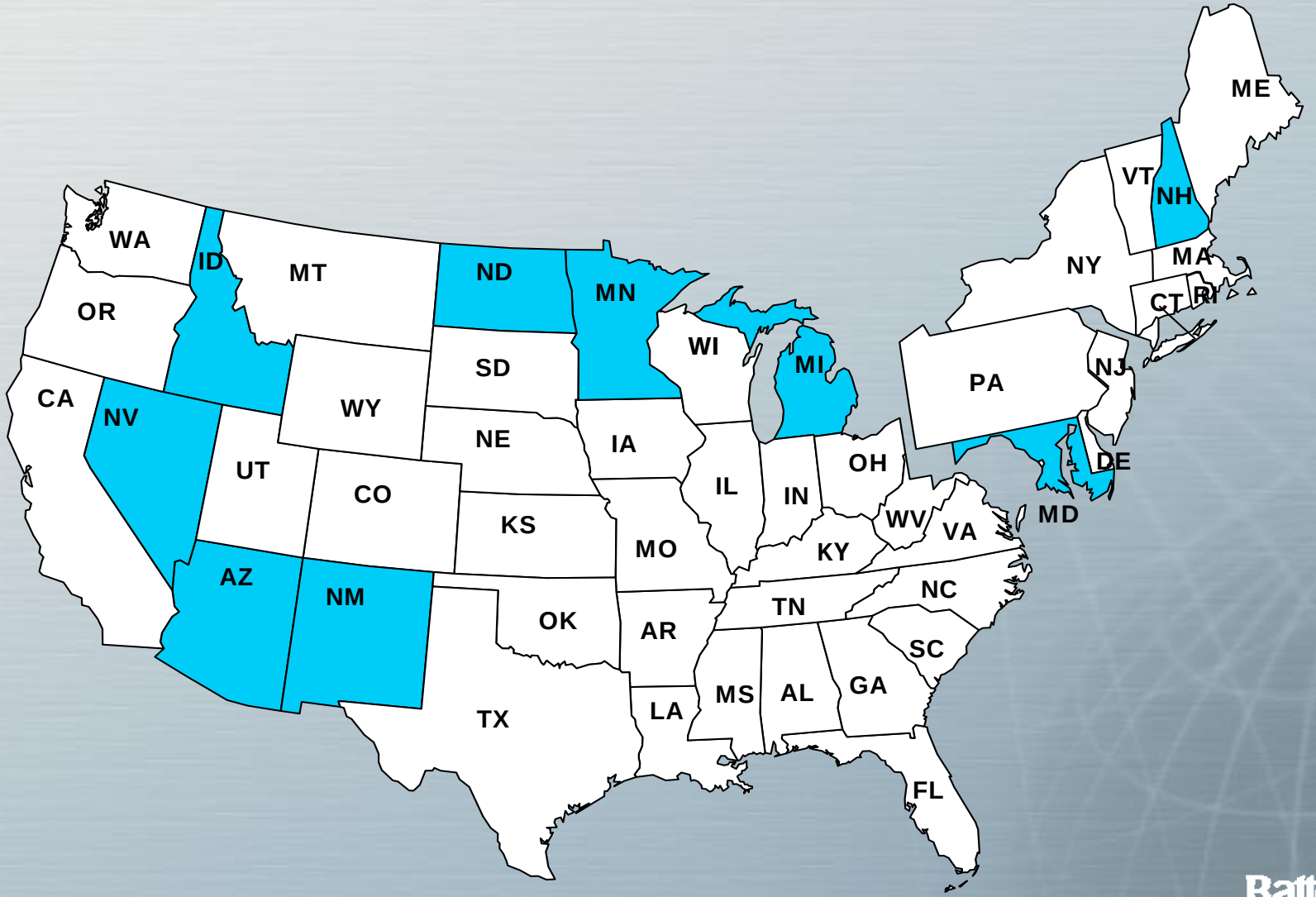
Main Objective

- Conduct full-scale demonstration studies on the removal of arsenic from drinking water supplies at 12 water treatment facilities throughout the United States
- Evaluate the efficiency and effectiveness of the technologies in meeting the new arsenic maximum contaminant level (MCL) of 10 μg/L

Round 1 – 12 Sites in 9 States



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Sites/Technologies Evaluated

State	Facility	Technology	Vendor	System Flowrate (gpm)	Concentration (µg/L)/ pH Unit		
					As	Fe	pH
NH	Bow	AM (G2)	ADI	70	39	<25	7.7
NH	Rollinsford	AM (E33)	AdEdge	100	36	46	8.4
MD	Stevensville	AM (E33)	Severn Trent	300	19	270	7.3
MI	Brown City	AM (E33)	Severn Trent	640	14	127	7.3
MN	Climax	C/F	Kinetico	140	39	546	7.4
ND	Lidgerwood	SM	Kinetico	250	146	1,325	7.2
NM	Anthony	AM (E33)	Severn Trent	320	23	39	7.7
NM	Nambe Pueblo	AM (E33)	AdEdge	145	33	<25	8.5
AZ	Rimrock	AM (E33)	AdEdge	90	50	170	7.2
AZ	Valley Vista	AM (AAFS)	Kinetico	37	41	<25	8.0
ID	Fruitland	IX	Kinetico	250	44	<25	7.4
NV	Reno	AM (GFH)	USFilter	350	39	<25	7.4

Demonstration Objectives

- Determine/document construction and operational costs of the new systems or the modifications of existing systems to achieve compliance
- Evaluate performance of the new processes or process modifications of existing treatment for 1 year in achieving compliance
- Determine the operational and maintenance requirements of treatment systems
- Characterize the residuals produced by the processes, quantity, and chemical characteristics
- Evaluate impact of the treatment processes on the distribution systems

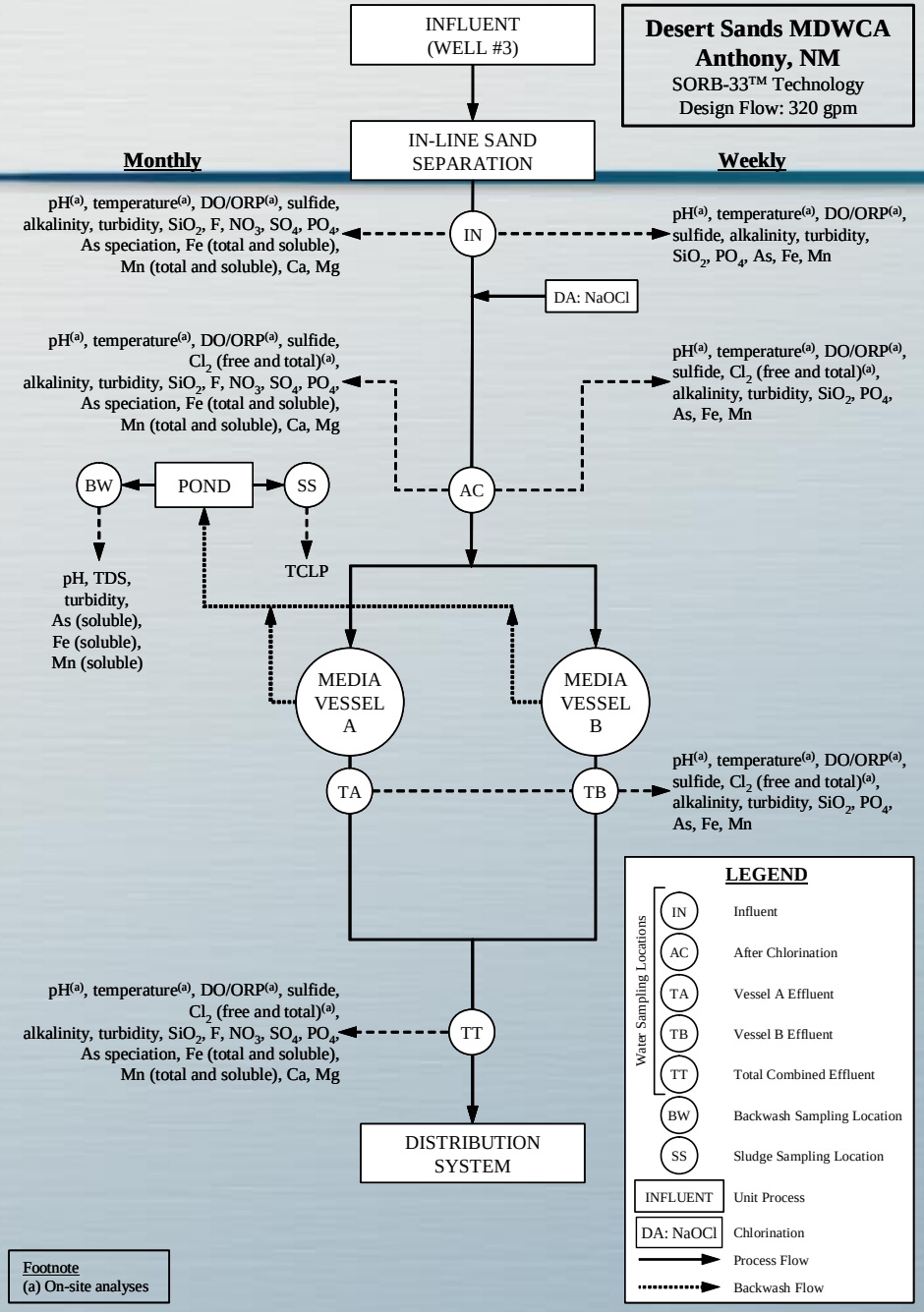
Technology Evaluation Approach

- An approach was developed to collect the data required to facilitate the evaluation of the selected arsenic removal technologies. The types of data collected include:
  - System performance and reliability
  - Simplicity of operation and operator skill requirements
  - Cost-effectiveness
  - Residuals
  - Impact on distribution systems

System Performance

- The key evaluation parameter is the ability of the technology to consistently remove arsenic to less than 10 μg/L
- This parameter is tracked through the collection of weekly water samples and monthly arsenic speciation at the treatment plant
- The weekly and monthly samples are analyzed in the laboratories, and results are provided to Battelle's Project Manager and Study Leads for review within two weeks of the collection of the samples
- Daily, weekly, and monthly operation and maintenance activities are performed and logged by the plant operator at each site
- The exact types of data vary based on the specific site and system, but general tasks performed daily include leak checks, pressure gauge and flow/hour/watt meter readings, and level checks
- Weekly on-site water quality measurements (including pH, temperature, DO, OPR, chlorine residuals, etc.) are performed using field meters

Flow Diagram



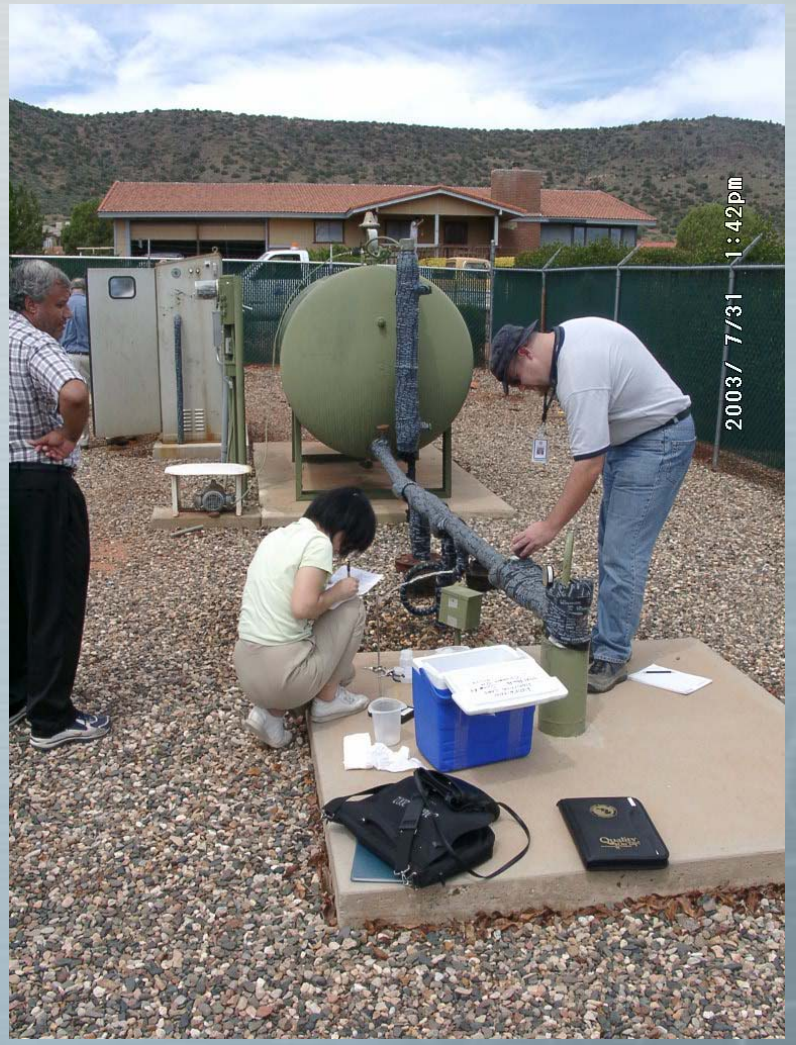
Sampling and Analysis

- Sampling activities include:
  - Source water sampling
  - Treatment plant water sampling
  - Residual sampling
  - Distribution system/fire hydrant sampling
- Analytical activities include:
  - On-site water quality measurements
  - Laboratory analyses for water and solid samples

Arsenic Speciation

Source Water Sampling

- Source water samples were collected during the initial site visit for detailed water quality characterization
- Source water samples were speciated on-site for particulate and soluble arsenic, As(III), and As(V), as well as other metals (i.e., Fe, Mn, and Al)



Treatment Plant Water Sample Collection

- Treatment plant water samples are collected weekly throughout the one-year evaluation
  - Samples are collected at sample ports throughout the process stream, including the inlet, after chlorination, after each vessel, and at the combined effluent, as applicable at each site
  - Each sample port is marked with a color-coded label, corresponding to a color-coded set of bottles allocated to samples from that specific tap
  - Speciation samples are collected at a subset of the total ports for each system, and are collected once every four weeks

Backwash Sample Collection

- Backwash/regeneration water is sampled at each site before being discharged to the sewer, settling pond, or other backwash water disposal area. The water samples are typically collected from sample taps installed on the backwash water discharge line
- Samples are analyzed for arsenic and other water quality parameters

On-Site Measurements

- Field measurements of water quality parameters are performed weekly, in concert with the collection of the samples for laboratory analyses.
- Parameters measured on-site include pH, temperature, dissolved oxygen (DO), and oxidation/reduction potential (ORP), chlorine residuals.

Off-Site Sample Analyses

- Water samples are analyzed by the Battelle ICP-MS Laboratory for arsenic and other metals using EPA Method 200.8
  - Detection limit for As: 0.1 µg/L
- Water quality parameters are analyzed by contract laboratories using standard EPA methods, or equivalent

System Reliability, Simplicity, and Cost Effectiveness

- Reliability is evaluated based upon the unscheduled system downtime and the frequency and extent of any repair/replacement activities, which are recorded on a Repair and Maintenance Log Sheet provided to the operator by Battelle
- The simplicity of system operation and the required level of operator skills are evaluated based on quantitative data and qualitative considerations
  - Time spent operating the system is tracked on a daily Operator's Labor Log Sheet
  - Qualitative considerations include any pre- or post-treatment requirements, the level of system automation, operator skill requirements, an analysis of the preventive maintenance activities, frequency of chemical/media handling, and general operator knowledge required for chemical processes and safety
- The cost-effectiveness of a system is evaluated based on capital costs (equipment, site engineering, and system installation) and operating costs (chemical/media supply, electrical power consumption, and labor hours)

Residuals

- Handling of residuals adds cost and complexity to the operation of the arsenic removal systems
- The quantity of aqueous and solid residuals generated at each site is tracked by the plant operator
  - Aqueous residuals include backwash and regeneration waste water
  - Solid residuals include particulates, sediment, or media fragments produced during backwash, as well as spent media or resin

Key Elements

- Communication
- Operator training
- Sampling logistics
- Data management

Impact on Distribution System

- Distribution system water samples are collected at three LCR residences and/or non-LCR locations at each site both prior to and during the operation of the arsenic removal system
- Results are used to determine the impact of treatment on the water chemistry in the distribution system and the water quality at consumers' taps

Communication

- Frequent communication allows timely input to the performance evaluation from all parties
- The operator provides O&M data to Battelle daily or weekly
- Battelle shares the analytical data with the utility, keeping them up-to-date on the effectiveness of the technology evaluated
- Battelle reviews the operational and analytical data, sharing ideas with the EPA, the utility, and the vendor, to correct problems rapidly

Operator Training

- The facility operator receives training from the technology vendor
- Battelle meets with the facility operator at the introductory meeting and during system start-up, providing training on sample collection, arsenic speciation, and field analytical and operational data collection

Sampling Logistics

- The Battelle Logistics Team coordinates all sampling activities
- Color-coded sample bottles are labeled and packed in coolers along with ice packs, pre-completed air bills, chain-of-custody documents, and sampling instructions, and sent to facility operators
- After coolers are returned to Battelle via overnight courier, the Logistics Team logs in the samples and distributes them to appropriate laboratories

Data Management

- An organized system is critical to maintaining and evaluating data from a multiple-site demonstration
- System operating parameters are saved and updated weekly in spreadsheet format for easy review
- Analytical results are loaded to an Access database
- All results are reviewed weekly by Battelle's Project Manager and Study Leads before forwarding to EPA and the utilities

System Troubleshooting

- The troubleshooting procedure is defined in the Study Plan prepared for each demonstration
- In the event of an operational problem or repair, the operator is to contact the Battelle Study Lead
- The operator and the Study Lead will work together to correct the problem. If necessary, the Study Lead will consult the vendor for troubleshooting or system repair

Reporting

- A Performance Evaluation Study Plan was prepared for each system
- A Six-Month and a Final Performance Evaluation Reports are prepared for each system. The reports
  - Summarize the operational and analytical data collected during the evaluation
  - Document the cost, reliability, ease of operation, and other factors necessary to evaluate the technologies, according to the demonstration objectives
- A Final Summary Report is prepared for all 12 systems
- Battelle maintains real-time communications with EPA regarding the status of each demonstration site
- Battelle provides a formal quarterly verbal progress report to EPA for project status and schedule, problems encountered, and corrective actions taken