Impacts of Arsenic Standard on Small Water Systems

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A revised national standard of 10 parts per billion (ppb) for arsenic in drinking water became effective January 23, 2006. So far only a handful of water systems nationwide are in compliance; most are looking for options to come into compliance over the next several years. In 1996, congressional amendments to the Safe Drinking Water Act (SDWA) mandated the U.S. Environmental Protection Agency to develop the "Arsenic Rule" which disproportionately impacts small and rural water systems. In 2001, EPA estimated that the cost of compliance to customers of small water systems (serving less than 3,300 people) will range from $58 to $327 per household per year. But actual costs will be much higher, based on costs of constructed facilities.

The greatest cost will arise from the need for small water systems to install and operate treatment processes for the removal of arsenic. Many providers will have to build and operate a treatment facility for the first time. However, this need will also provide an opportunity for the drinking water industry to employ new and innovative technologies to potentially simplify operations and be cost-effective.

Nontreatment Options

Several nontreatment options may preclude the need to design and construct an arsenic treatment system. Some systems can simply abandon high-arsenic wells and use other wells in the system. Others can meet the new standard by diluting the high-arsenic water with low-arsenic water. Or a new well may be drilled that does not supply high-arsenic water.

Another approach is to modify a well to seal off the hydrogeologic strata that contain elevated levels of arsenic. To assess the feasibility of this alternative, a zonal sampling and spinner log study must be performed first to determine the extent of sealing needed. Then the option must be considered in light of the reduction in flow that would accompany such well modification.

Treatment Methods and Considerations

Wellhead treatment options usually use either coagulation-filtration, ion exchange, or adsorption methods. Reverse osmosis can also be used, but resulting brine disposal problems almost always make this impractical. For systems of less than 100 connections, point-of-use technologies installed at homeowners' taps may also be cost-effective.

Coagulation-filtration involves a pressurized granular media filtration process preceded by the addition of a coagulant and a mixing step that allows the arsenic to bond with filterable iron hydroxide particles. The process is very cost-effective for arsenic levels greater than 25 ppb, but requires handling of chemical and spent backwash wastes.

Ion exchange utilizes a presaturant ion (such as chloride) on a solid, synthetic resin that is exchanged for the arsenic ion. The process is similar to household water softener technology, and creates waste brines and rinse streams that must be properly managed and disposed of. Caution must be taken with ion exchange systems to not generate hazardous wastes (defined as arsenic levels greater than 5 milligrams per liter).

Adsorption involves the separation of a substance from a liquid and its accumulation or concentration at the surface of a solid media. Water is passed through a vessel with a bed of iron oxide, zirconium, titanium, alumina, or composite media that removes the arsenic. Adsorption is most effective and simple to operate when pH levels are below 8, and interferences from silica, vanadium, phosphorus, iron, and manganese are not present. Higher

Water system	Treatment type	Size	Capital cost
Phoenix	iron media adsorption	several (0.5 - 3 MGD)	$0.6 - $1.7 M
Litchfield Park Service Company	iron media adsorption	5 MGD	$3.1 M
Gilbert	iron media adsorption	1.2 - 1.8 MGD	$1.6 M
Avondale	coagulation/filtration	6 MGD	$4.5 M
Arizona Water Company	coagulation/filtration	3 - 5 MGD	$1.9 - 2.2 M
Triple G Dairy	adsorption (titanium media)	30 gpm	$40,000
Camp Verde	adsorption (regenerable media)	30 gpm	$40,000

Costs for arsenic treatment at selected Arizona systems. (MGD = million gallons per day, gpm = gallons per minute.)

pH waters require additional treatment to depress the pH. Many different adsorption package systems are available.

Adsorption processes use treatment media that will ultimately become exhausted. The media can either be regenerated (on- or off-site) or simply replaced with new media and placed in a sanitary landfill. Frequency of replacement can range from a few months to several years, depending on arsenic level, pH, and how often the well runs. By contrast, ion exchange systems are frequently regenerated in place and the media is not replaced. Many systems have opted for adsorption media disposal and replacement with new media. However, media regeneration and reuse recently have become more economical, especially with the introduction of innovative titanium, zirconium, and composite media that can be regenerated relative efficiently by the vendor.

Waste Disposal

All presently approved treatment processes remove arsenic from water but also tend to increase concentrations in the liquid and solid residual streams and generate waste disposal problems. Most solid residuals may be placed in a sanitary landfill for disposal. All solid residuals must comply with toxicity characteristic leaching procedure (TCLP) criteria in addition to remaining stable within the disposal environment. Stabilization of solid wastes to prevent migration into the groundwater must also be considered.

For very small water utilities in outlying areas, disposal of liquid residuals is problematic, as nearby sewer connections are generally not available. Liquid residuals must comply with groundwater protection permit requirements if evaporation ponds are used, or be trucked off site for acceptable disposal processing. These issues are concerns for very small water systems that lack funds or expertise for treatment system operation or proper disposal of residuals.

Implementation Costs

State and federally funded technical assistance for small systems to address planning, technology evaluation, and

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New Study to Benchmark Home Water Usage

How much water do residents of new homes consume? No one knows for sure, so EPA and six water districts in the West and three in the South plan to find out. The 10 agencies have announced a 33-month study to collect detailed information about how much water is consumed in "standard" new homes versus "high-efficiency" ones.

The $530,000 study will be performed by collecting data from billing records, surveys, and meter measurement of usage signifying faucet, clothes washer, toilet, and other household uses. EPA will invest $350,000, with the other agencies contributing $20,000 each.

The study will help establish voluntary targets for builders who want to provide buyers with alternate water-efficiency options; develop criteria for water-efficient homes based on water-using products and building design or on average gallons used per resident per day; and create special certification marks to help consumers identify water-efficient new homes. The study results will aid states and water utilities in making local decisions on establishing water-use criteria for new homes, planning water-efficiency programs, and projecting future needs.

The project will demonstrate how advanced technologies, such as water-efficient landscape designs, weather-based irrigation controllers, and high-efficiency toilets and faucets can reduce water use below current levels. Relationships between household indoor-water use and variables such as the number of residents, home size, and types of fixtures and appliances present will be studied. Outdoor water use will be quantified from total annual use, rates of application, local plant water requirements, lot size, landscape design, and type of irrigation system controller.

The water systems involved in the study are in eight states: Arizona, California, Colorado, Florida, Nevada, North Carolina, Oregon, and Utah. The Salt Lake City Water Department will cooordinate the effort among the participating state agencies. Forty standard and 20 higher efficiency homes will be selected in each city.

Visit www.epa.gov/owm/water-efficiency/.

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operation and maintenance impacts are vitally important to ensure the continued successful operation of treatment facilities. Estimated annual combined capital and operation and maintenance (O&M) costs nationwide to comply with the new standard range from $22.2 billion (EPA estimate) to $65.5 billion (AWWA estimate). These estimates were based on similar unit-cost curves from credible industry sources, but assumptions regarding the treatment technologies utilized and the support facilities necessary varied significantly.

The Arizona Department of Environmental Quality (ADEQ) commissioned a study in 2003 which culminated in the Arizona Arsenic Master Plan. The report focused on developing costs for funding mitigation projects for arsenic-impacted systems serving fewer than 10,000 persons, which are generally simple groundwater systems with wells, storage tanks, and hydropneumatic control systems. Of the 287 small systems estimated to be required to reduce the arsenic content in their water, 174 (61 percent) serve less than 500 people. An additional 84 systems (29 percent) serve between 500 and 3,300 people. The remaining 29 systems (10 percent) serve fewer than 10,000. The statewide estimate for arsenic treatment for systems serving less than 10,000 persons was $109 million with an annual O&M cost of $14 million.

Several Arizona water systems recently implemented arsenic treatment; their capital costs are shown in the table on page 24.

In May 2006, a request for proposals was issued by Arsenic Remediation Coalition (ARC), a group of small Arizona utilities, for providing arsenic treatment systems for 46 separate small water systems. As reflected by the proposals, design and construction costs vary according to the size of the system. Estimated annualized costs ranged from $0.30 to $1.30 per 1,000 gallons of water treated.

A point-of-use (POU) removal system was proposed for seven of the small ARC systems (with 7 to 92 connections) and yearly O&M costs were $100 per connection, with capital costs of $443 per connection. POU treatment is significantly more expensive than central treatment on a unit cost basis, however they treat only the water used for cooking and drinking—less than 1 percent of the total water system flow— and are therefore more economical.

Compliance Extensions

The SDWA allows water systems that can prove inability to comply to request a time extension, or "exemption." Exemptions may provide up to nine extra years for compliance as long as the arsenic level "will not result in an unreasonable risk to health." A specific strategy for compliance, including a time frame, must be presented, along with documentation of the factors that make it impossible to immediately comply with the arsenic rule.

Requests for exemptions are not limited to small systems. Many large systems have requested exemptions for specific water sources that are only operated during times of peak demand and thus have a lower priority. The larger systems have constructed treatment systems for the sources that supply the average and maximum day requirements.

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