Case Study - Arsenic Treatment Technologies
Scottsdale, AZ

Background: Water Quality Characteristics

The Scottsdale Municipal Water System serves approximately 180,000 consumers with a combination of surface and ground water. The City has 31 wells, and transports surface water from the Colorado River via an aqueduct, and surface water from the Verde and Salt Rivers through canals. In 1998, average annual water demand was 63 million gallons per day (MGD). 28 MGD comes from the system's ground water sources.

Scottsdale's ground water is generally only treated with chlorination. The system treats the water coming from the Colorado River, but the surface water from the Verde and Salt Rivers is treated by the City of Phoenix and then piped to customers in Scottsdale.

To meet the revised 0.010 mg/L arsenic maximum contaminant level (MCL), the system will need to install new treatment technologies. The City of Scottsdale recently pilot-tested several new treatment technologies.

Typical Raw Water Quality - Scottsdale Test Site[1]

pH	9.0
Arsenic (As(V))	0.039 mg/L
Chloride	156 mg/L
Fluoride	1.3 mg/L
Iron	0.5 mg/L
Nitrate (as N)	2 mg/L
Silica (as SiO_2)	25.3 mg/L
Sulfate	23 mg/L
Total Organic Carbon	<0.2 mg/L

[1] Norton, M; Chang, Y; & Kommineni, S. "Evaluation of Micro-Sand-Based Technologies for Arsenic Removal - Ballasted Sedimentation and Metclean™ Process. AWWARF

Pilot Testing

Scottsdale tested multiple arsenic treatment technologies at various sites around its system. Most recently, the system simultaneously tested a number of emerging arsenic removal technologies at its City's Well No. 4 including:

- Activated alumina (conventional, iron-modified, and high porosity); and,
- Granular ferric hydroxide.

Sponsored by the American Water Works Association Research Foundation (AWWARF), the goal of this pilot project was to test emerging technologies for arsenic removal. This project was one of the first to simultaneously test multiple technologies on a large-scale, year-round basis and was run in conjunction with the pilot testing at the Tucson, AZ water system.

A skid-mounted apparatus holding four separate, identical fixed-bed columns, was installed at the Scottsdale treatment site. Each column, operated in parallel, contained 25 gallons of adsorbent media. The flow rate to the skid was 20 gpm.

Figure 2: Scottsdale Pilot Testing Unit

Four different proprietary adsorption media were tested:

- Conventional activated alumina;
- Iron-modified activated alumina;
- High porosity activated alumina; and,
- Granular ferric hydroxide.

The goals of the tests were to: discover whether the adsorbents would allow Scottsdale to meet the revised 0.010 mg/L arsenic MCL (taking operation and maintenance, labor, and personnel costs into account); test whether there was any seasonal impact on the effectiveness of the technologies; and establish optimum operation protocols for full-scale systems.

Scottsdale collected data from January, 2001 to November, 2001. After chlorination, the raw water pH at Well No. 4 ranged from 8.7 to 9.2. This high average pH as well as high concentrations of silica in the ground water rendered the activated alumina technologies less effective. Despite acid additions to the feed water in February 2001, there was little improvement in the effectiveness of the alumina-based media.

The granular ferric hydroxide proved to be the most effective technology of the four technologies that were pilot-tested even though there were initial problems with the column due to inadequate backwashing.

Ion Exchange Technology
Scottsdale Municipal Water also pilot-tested two emerging ion exchange treatment processes: advanced ion exchange operations (AIXO), and indefinite brine recycling (IBR). Ultimately, it was determined that AIXO was capable of maintaining an effluent arsenic concentration of less than 0.010 mg/L. Initial operational problems with the IBR technology made it difficult to conclude whether the technology was effective in lowering arsenic concentrations. After the operational problems at Scottsdale were resolved, IBR proved to be a promising treatment technology.

Micro-Sand-Based Technology
Through funding from the Arsenic Research Partnership (comprised of AWWARF, EPA, and the Association of California Water Authorities), Scottsdale pilot-tested micro-sand ballasted coagulation-sedimentation (MBCS) technology from June 21, 2001 to July 2, 2001. Here, ground

water from two wells was pumped into and combined in a reservoir. This blended water was fed into the MBCS unit.

Scottsdale added varying doses of ferric chloride upstream of their sedimentation process. Higher ferric chloride doses were required for effective arsenic removal due to the high pH (8.5-8.9) of the raw water. A dose of 15 parts per million (ppm) was determined to be the minimum required for achieving the target arsenic level of 0.010 mg/L. MBCS proved to be a promising arsenic removal technology for the Scottsdale plant and the process generated non-hazardous residuals that can be disposed of in a domestic landfill.

Conclusions

The Scottsdale system is conducting additional studies using granular ferric hydroxide. The first round of tests indicated that granular ferric hydroxide is a promising treatment method, while activated alumina (the cheapest option) is not, due to the high pH and silica levels in the raw water.

The City is considering simplifying the treatment process by treating water at numerous central locations, rather than at each wellhead. The proposal calls for approximately six major clusters of wells (ranging in size from 4-6 MGD) and numerous individual wells, all receiving treatment. In some parts of the City, the water system will blend the ground water with treated surface water from their other sources in order to meet the community's demands.

Cost of the treatment for arsenic has not yet been determined. The City is currently working with two major GFH suppliers to pilot their media and competitively bid for media delivery. The City anticipates that the cost of any new or improved treatment for arsenic will be primarily funded through water rates.

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