United States Environmental Protection Agency

ARSENIC IN DRINKING WATER
COMPLIANCE SUCCESS STORIES

Fallon, NV: Pooling Resources to Construct Arsenic Treatment Facility

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The City of Fallon, Nevada and the nearby Naval Air Station were addressing similar arsenic compliance issues at the same time. By working together they developed a joint solution that was more cost effective.

Lessons Learned

The City of Fallon, NV worked collaboratively with the local Naval Air Station to pool resources and construct an enhanced iron-based coagulation /filtration arsenic treatment plant to serve both the City and the military base. In order to understand the full cost of treatment, they had to consider all factors that contributed to project cost, including the feasibility of blending with other sources of supply or blending untreated and treated water; improvements needed to wells and distribution systems to match the operational efficiency of the new treatment facility; and necessary piping connections from the new treatment plant to the source of supply and the distribution systems.

System Description

The City of Fallon, Nevada is located in Lahontan Valley and provides drinking water services to 8,400 people using ground water as the source of supply. The Lahontan Valley is underlain by three alluvial aquifers and a basalt aquifer located beneath a volcanic feature called Rattlesnake Hill. The basalt aquifer has a very small footprint, measuring approximately 4 miles wide by 15 miles in length. Fallon's water supply originates from this basalt aquifer through four wells (named Well 1, Well 2, Well 3, and Well 4). The basalt aquifer provides water with arsenic levels around 100 ppb. The nearby Naval Air Station and the Fallon Paiute-Shoshone Tribe also draw their water from this basalt aquifer. The City of Fallon has operated a municipal water utility utilizing the same water supply for its customers for over 60 years. The water chemistry has been stable over the years and the water quality, other than arsenic, is considered to be very good. Arsenic is present only in the arsenate form As(V).

Fallon's Road to Compliance

In 1990, the City of Fallon and the Nevada State Health Board, with oversight by the U.S. Environmental Protection Agency (EPA), negotiated and signed a Consent Agreement that required the City to set aside $1,000,000 over a ten-year period to address their arsenic issue. Fallon was required to provide notices to all of its water utility customers on a quarterly basis, as well as new customers, that the water supplied was in violation of the interim 50 ppb arsenic standard. The notice also stated that it was not recommended that customers seek other sources of drinking water. As part of this Agreement, the City agreed to construct a treatment plant to remove arsenic, if necessary to comply, once a final standard was set.

On November 23, 1999, EPA Region 9 issued a Findings and Notice of Violation stating that the City of Fallon was in violation of the Safe Drinking Water Act for exceeding the arsenic maximum contaminant level (MCL) of 50 ppb from 1977 to present. On August 30, 2000, Fallon received an Administrative Order requiring compliance with the arsenic MCL by September 15, 2003. This Administrative Order was replaced by a subsequent Administrative Order on August 28, 2002 that extended the deadline to April 15, 2004.

Selecting Arsenic Treatment Technology

The first step was to identify all available arsenic removal technologies, including the Best Available Technologies listed by the EPA, as well as other promising technologies. The technologies investigated include:

- Adsorption on Activated Alumina
- Strong-Base Anion Exchange
- High-Pressure Membrane Separation
- Enhanced Metal Coagulation
- Adsorption onto Granular Ferric Hydroxide
- Point-of-Use Treatment
- Reverse Osmosis

The various technologies were reviewed to understand the feasibility of being applied in Fallon, and to identify the water characteristics critical to their operation. The City then initiated a very extensive water testing program. Many of the critical constituents identified in the technology review had already been tested; however, to verify past results and to get accurate values of the remaining elements, samples were sent to three different laboratories. The testing did not produce any new information but gave the City the confidence level needed to proceed to the next step.

A thorough review of the technologies was then undertaken using the water quality information developed in the water testing program. The various technologies were evaluated based on the following criteria:

- Effectiveness – Will the treatment process consistently produce water that can meet an arsenic standard of 5 ppb?
- Final water quality – How will the treatment affect the overall water quality (i.e. taste, future standards)?
- Water loss/recovery – How much water will be wasted?
- Raw water composition – Is the process significantly affected by changes in raw water quality?
- Residuals management – What is the impact of handling and disposing the treatment residuals (i.e. is the waste hazardous)?.
- Ease of operation – How difficult will it be to operate? What kind of knowledge, training, and certifications will operators need?
- Cost – What will the impact be to the rate payers (i.e., initial costs and operational costs, chemicals, power, waste by-products, life of the components, testing, reliability of components and processes)?

A scoring matrix was developed and each technology was rated on each of these criteria. At the conclusion of this review, two technologies were identified for bench scale testing: strong-base anion exchange and enhanced metal coagulation.

Bench Testing

Bench scale testing was completed to define the operational conditions and limitations of the selected technologies as they apply to Fallon's water quality. The goal of the bench testing was to define the chemical demands, residual characterization and management issues, process unit requirements, and representative operational criteria.

Bench testing results showed that both strong-base anion exchange and enhanced metal coagulation were able to remove arsenic to the target level of 5 ppb. The enhanced metal coagulation process performed slightly better than was anticipated, while the anion exchange process proved less effective. The enhanced coagulation process proved to be the superior technology in several areas:

- The chemical costs for the enhanced coagulation process were projected to be about 1/3 of the anion exchange chemical costs due to the higher reagent demand and the lower than expected bed volume capacity of the anion exchange resins.
- Enhanced coagulation requires fewer treatment steps and is therefore simpler to operate.
- Residuals management for the enhanced coagulation process involves thickening, dewatering, and disposal. For the anion exchange, at least three additional steps would be required.
- The alkalinity and sulfate concentrations of the water supply made the anion exchange process more sensitive to changes in the influent water quality.
- Water recovery was nearly 100% with the enhanced coagulation while the anion exchange showed 1 to 2% losses.

Pilot Testing

Pilot testing was conducted at one of four City wells, Well 3, to optimize pH adjustment, coagulant dosage, flow rate, and run time between backwashing for the enhanced coagulation process. The pump was pulled from the well and a 2 horsepower submersible pump was installed to supply water for the testing. The test unit consisted of a 16 inch diameter clear column with chemical and coagulant feed systems, a pressure differential gauge, a backwash system, and a composite filter. The composite filter consisted of anthracite, silica, and garnet. The City controlled filter run time using pressure.

Navy Testing

The Naval Air Station at Fallon was also addressing the same compliance issues as the City of Fallon as a result of a Notice of Violation and Administrative Order they received from the EPA. Throughout this process, the City of Fallon and the Navy kept in close contact and shared information at every review phase. Through independent evaluations, both the City of Fallon and the Naval Air Station chose similar treatment technologies. At about this time, because of federal funding arrangements, a decision was made to construct a single treatment plant to remove arsenic from both sources of supply. This decision was also guided by anticipated economies of scale, particularly in the operational costs.

Water Treatment Plant Design

The site selected for the water treatment plant was on City-owned property located between the City and the Naval Air Station. The site is located immediately south of the City's wastewater treatment plant. Approximately 6 miles of pipelines were required to bring raw water from the existing City and Navy wells to the plant site and return treated water back to the respective systems.

In addition to the pipelines, substantial work was completed to retrofit the existing wells. The existing pumps and motors were not sized properly to match the flow and pressure requirements into the treatment plant. Several other system improvements were also needed to maintain the hydraulic integrity of the distribution system.

The new treatment plant was designed to treat 9.7 MGD – enough to meet the needs of both systems. The Navy projected a design use for the year 2023 of 2 MGD. The City calculated its use in 20 years to be 7.7 MGD based on the current peak daily use of 3.9 MGD and a 3% annual growth.

The selected treatment technology was enhanced iron-based coagulation/filtration. Treatment includes pH reduction with hydrochloric acid followed by addition of ferric sulfate and a coagulant. The water is then passed through one of 16 multi-media filters. The pH is raised to about 7.8 using lime. The water is then chlorinated by adding sodium hypochlorite. Because of the modular design and having each filter in either an on or off mode, water is stored in an on-site tank prior to distribution. Variable speed pumps are used to maintain flows and pressures into the two distribution systems. The filters are backwashed on a periodic basis. The sludge is processed through one of two Lamella filter presses. Since the waste passes the toxicity characteristic leaching potential (TCLP) standards and is therefore not classified as hazardous, it is hauled to a City-owned landfill for disposal.

Funding Process

The cost for this project was $19 million including design, construction, and inspection. Of this, approximately $13.5 million was for the treatment plant itself; $4 million for the pipelines connecting the plant to the respective systems; $0.5 million to retrofit the wells; $0.9 million in upgrades to the transmission system; and $80,000 for off-site utilities.

The Navy had estimated a cost of $5.4 million for construction and $0.75 million for the design of a plant to meet their needs only. This total amount of $6.15 million was provided to the City as the Navy's share of the project.

The City secured a number of grants to help fund this project. Several EPA grants provided a total contribution of about $6.8 million. Most of these grants had a 45% non-Federal match requirement. The City received two grants through the Nevada State AB 198 funds for $4.7 million. These State grants were used to meet the non-Federal match requirement. The City of Fallon contributed over $1 million generated through a rate increase. An additional $2 million loan was needed to complete the construction and provide for the start-up of the plant.

Some of the factors that contributed to the project cost, which other utilities should not overlook, include:

1. Since the naturally occurring arsenic level in Fallon's raw water supply is 100 ppb, blending with other water sources or treatment of only a portion of the water was not feasible.
2. The City of Fallon had no existing treatment plant to modify, nor was there a common point in the system through which all the water flows.
3. Nearly 6 miles of pipelines were built just to connect the treatment plant with the two water distribution systems (City of Fallon and the Naval Air Station).
4. Retrofitting the wells was necessary to match the treatment plant requirements and to improve operational efficiency.
5. Changes to the distribution system were necessary to maintain fire flows as well as meet State mandated flow and pressure requirements.

Conclusions

The City of Fallon, Nevada and the nearby Naval Air Station both draw their water supply from an aquifer contaminated with arsenic at levels of 100 ppb. After conducting independent evaluations of arsenic treatment technologies including bench-scale and pilot-scale testing, the City and the Naval Air Station selected similar treatment solutions to reduce arsenic levels below 10 ppb. A decision was made to construct a single treatment plant for both water systems because of federal funding arrangements and the anticipated economies of scale.