# The Benefits & Importance of Pilot Testing

By Chuck Reading & Archie MacDonald

*Pilot tests were performed at three Arizona groundwater locations: Coolidge, Yuma and Buckeye. Questions regarding future treatment processes were analyzed and answered, and a number of treatment questions were addressed in these case studies. These questions included: optimum filter loading rate (gallons per minute [gpm]/sq ft of media), number of bed volumes to exhaustion, effectiveness of backwash water/elution sludge precipitation and future disposition.*

*Three Arizona case studies address important treatment questions*

Fundamental to any pilot testing is a complete water quality analysis. In addition, consideration should be given to use of an independent consultant for pilot testing.

## Coolidge Case Study (Duration: Four Weeks)

The Sandia housing development is located in the city of Coolidge, approximately 40 miles southeast of Phoenix. The Sandia water treatment facility, designed by Tres Rios of Tempe, Ariz., was designed to treat water from a multiple-well system. The wells contain 5.5 mg/L of fluoride and 25 to 26 µg/L of arsenic.

The principle questions were as follows:

- Was oxidation needed to convert As+3 to As+5, or would arsenic adequately adsorb onto the activated alumina media?
- How long would it take for activated alumina to become saturated?
- Would elution fully release the arsenic and fluoride from the activated alumina media?
- What pH value would precipitate the sludge from the elution water and yield the best quality supernatant for discharge into the wastewater treatment plant (WWTP)?
- Will sludge pass the toxicity characteristic leaching procedure (TCLP) test, which determines if sludge can be landfill-applied?

Four weeks of jar testing determined media capacity, effective elution of fluoride, arsenic and sludge and wastewater quality for disposal to the WWTP.

Eight 3-in.-diameter columns were loaded with various depths of activated alumina media. Pilot-test columns were examined for the effects of various pH values, sodium hypochlorite dosage, various media depths and filter loading rates. Blueleaf, Inc., Carlton, Mass.,[1] used a fractional factorial pilot design to gather the most information in the time available. Pilot filter column effluents were monitored for breakthrough, indicating media saturation.

Jar testing was used to determine optimal supernatant quality. Jars containing filter media elution water were prepared at various pH values, and the corresponding sludge settling mass of each jar and supernatant quality was recorded (see Figure 1.)

The four weeks of testing determined media capacity, effective elution of both fluoride and arsenic and sludge and wastewater quality for disposal to the WWTP. This was a comprehensive pilot study and resulted in sufficient data to design the filtration system. The cost of pilot testing was approximately $85,000.

## Yuma Case Study (Duration: One Week)

The city of Yuma installed an iron and manganese filtration plant in 2004 and was operating it at design capacity with no anomalies in treatment. At the design flow rate of 4,200 gpm, concentrations of ±0.53 mg/L manganese and <0.1 µg/L iron were reduced to <0.01 mg/L and ND, respectively. The rapid population growth of the area required additional potable water supplies beyond the capacity of this treatment facility. It was suggested that the current filtration plant might be able to provide additional capacity on an interim basis.

The options were to add another filter—a significant capital expense—or increase the existing filter loading rate—a change with little to no additional cost. To determine the feasibility of increased filter loading rate, a short-term pilot study was commissioned. The goal was to determine if increased flux to 6,000 gpm, or 13.33 gpm/sq ft, could be achieved without sacrificing any loss in treatment quality.

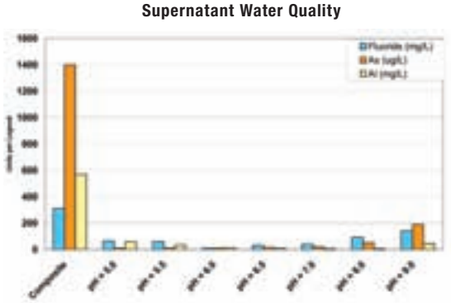
Under the auspices of Carollo Engineers, Phoenix, the pilot involved the use of one 12-in.-diameter test column containing the same media in use at the plant. The flux was set at a test rate of 15 gpm/sq ft. The pilot test revealed that an increase of 4 gpm/sq ft could be achieved. This represented a 42% increase over the current rate of 9.33 gpm/sq ft.

For the city of Yuma, two important filter operation advantages were confirmed by the pilot study; increased filter loading rate and extended duration between backwashes, the latter of which was not an intended part of the protocol but a welcome benefit. The state of Arizona ultimately approved the change in operation, and the plant continues to operate at this rate. By conducting the pilot test at a cost of $28,700, the city of Yuma saved the expense of an additional filter and associated construction and engineering costs.

## Buckeye Case Study (Duration: One Week)

Buckeye is a western suburb of Phoenix. RBF Consulting, Phoenix, designed the Buckeye Sundance water treatment plant to treat 4,200 gpm of raw water from

**Figure 1. Effect of Various pH Values**




**The three left bars are the composite supernatant; the remaining bars are the results from precipitation of the solids at various pH values. Note that pH 6.0 results are best. The Y axis is scaled for both mg/L and µg/L. (Courtesy of Blueleaf, Inc.)**

multiple wells, with provisions for future expansion to treat a total of 6,000 gpm. Across town, North Airport Road Water Campus, a new plant also designed by RBF Consulting, added an additional 3,000 gpm of potable water to meet the city's growing needs.

A complete water quality analysis of the new well revealed, among other things, that 60 to 75 µg/L of arsenic was present. Portions of the well were screened off to reduce the arsenic contamination, but the remaining levels still exceeded the maximum contaminant levels of 10 µg/L.

Blueleaf, Inc. was contracted to conduct a pilot study to determine treatability and confirm the process. The well is approximately three miles from other city wells and, in theory, drawing from the same aquifer. Water quality from the new well produced arsenic at two times the level found at the nearby well. It is never safe to assume that wells will have similar water qualities even though they are in close proximity to one another.

During piloting, it was determined that sulfuric acid would be required to lower the pH for effective arsenic removal. Chlorine was added to oxidize the metals and convert Arsenite+3 to Arsenate+5. Ferric chloride was added to the process as a co-precipitant to adsorb the higher valent form of arsenic. Manganese dioxide, a permanent filter media, will remove all but trace amounts of arsenic in the finished water. The approximate cost of the pilot was $15,000. WWD

*References:*

[1] Erik Grotton, principal, Blueleaf, Inc., Carlton, Mass., specialist in water systems testing and operations.

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