

Project 7

Agency: Oklahoma Department of Environmental Quality

Title: Identification of Potential Well Rehabilitation Options for Arsenic-Rule Compliance in Small Public Water Supply Systems in Oklahoma

Background & Problem

In accordance with requirements of the Safe Drinking Water Act (SDWA) the U.S. Environmental Protection Agency (EPA) lowered the standard for Arsenic in drinking water from 50 micrograms per liter ($\mu\text{g/L}$) to 10 $\mu\text{g/L}$ in January 2001. The new standard became effective January 23, 2006, at which time Public Water Systems (PWSs) had to either begin monitoring for arsenic in their water supplies or submit data for meeting a grandfathering requirement.

In Oklahoma, as many as 25 public water supply systems could lose water supply wells as a result of the new arsenic rule, with the cost of replacing this capacity approaching 50 million dollars. Though larger municipalities have the resources to replace noncompliant wells, smaller communities and rural water suppliers do not.

Most affected water systems in Oklahoma produce water from the Permian-age Garber-Wellington aquifer or the Permian-age Rush Springs aquifer. In terms of sedimentology, these two aquifers are very different. The Garber-Wellington aquifer is a multilayered sandstone and mudstone aquifer which can be as much as 1000 feet thick in central Oklahoma. In contrast, the Rush Springs aquifer is nearly homogeneous sandstone with varying amounts and types of cementation; aquifer thickness is generally less than 300 feet. In the Garber Wellington aquifer of central Oklahoma, concentrations of arsenic (as well as chromium, selenium, and uranium) are sometimes only elevated in one or two zones in a well (Schlottmann and others, 1998).

When considering possible solutions for addressing arsenic there are basically two options; you can look at treatment “engineering” treatment technologies or “geologic” non-treatment techniques.

There are several arsenic removal/reduction technologies “engineering” solutions available but these are typically expensive. These include, but are not limited to precipitative, adsorptive, ion exchange and membrane technologies. While each of these technologies is effective, their uses present the following problems:

- While specific costs may vary, treatment technologies are typically expensive.
- The treatment processes listed above result in the generation of treatment residuals, which must be managed.
- Treatment of drinking water is an activity that exhibits enormous economies of scale, meaning that a system’s ability to pay for treatment is limited by the size of its customer base.

There are multiple, less expensive, “geologic” or well rehabilitation options available as well. These techniques involve the modification of well completion or production operations to reduce or completely exclude arsenic contaminated water from the public water supply. The physical modification of the well would include relocating the pump intake or zonal isolation (sealing off water producing zones with high arsenic concentrations):

- By relocating (raising or lowering) the pump intake farther from the contaminated zone, the well may produce a lesser proportion of water from the contaminated zone. While this method is quick and cheap it potentially will only provide a temporary relief. As water levels change and where conditions exist that allow for a vertical communication of water between different producing zones waters with high arsenic concentrations could eventually make its way into the system once again.
- Zonal isolation could be pursued as a permanent (cementing in a contaminated zone) or temporary (installing a packer on the pump column). This option is advantageous because it ensures that a contaminated zone will no longer contribute any arsenic to the well. This method is best suited for use in open-hole wells and gun-perforated wells with a cement annulus. Zonal isolation also is best suited for use in aquifers where contributing zones are hydraulically separated by relatively impermeable units. The Central Oklahoma Aquifer is ideal for this rehabilitation option because contaminated sandstone zones are naturally separated or compartmentalized by mudstones. Without site specific information, it is unknown if zonal isolation would be effective in the Rush Springs Aquifer, because low permeability units may not be abundant or extensive enough to seal off contaminated zones.

The Oklahoma Department of Environmental Quality (ODEQ) has identified approximately 25 PWS systems that may have compliance issues with the new arsenic standard. As smaller systems have the least resources to address these types of compliance issues ODEQ will attempt to focus efforts under this project towards those smaller systems.

ODEQ is pursuing this project with the understanding that similar efforts were quite successful in a collaborative effort between the Association of Central Oklahoma Governments (ACOG) and three central Oklahoma communities. Under this 2003 effort, conducted to investigate the conditions responsible for the occurrence and distribution of arsenic in the Garber-Wellington Aquifer, a “geologic solution” for mitigating the production of arsenic in municipal water-supply wells was identified and successfully implemented.

By implementing “geologic solutions” arsenic concentrations were lowered in affected wells to non-detect levels (< 0.5 µg/L), which allowed city officials to suspend plans to construct a \$3.0 million arsenic treatment facility and drill replacement wells at a cost savings of more than \$5 million.

Objective

Pursue a collaborative effort between ODEQ, the U.S. Geological Survey and the Ground Water Protection Council to evaluate PWS systems facing compliance issues associated with arsenic and identify possible “geologic solutions.”

- Assess the viability of alternative methods to reduce arsenic levels in public water supply wells
- Determine the feasibility of implementing a “geologic solution” at a minimum of three small PWS systems
- Develop a generalized decision model “Decision Matrix” that can be utilized by all water systems to help them determine if “geologic solutions” might provide a feasible alternative to implementing costly “treatment solutions” for the removal of arsenic, and possibly other constituents, from a system’s water supply.

Methodology

1. Collect and compile available well completion information from a minimum of eight PWS systems
2. From this group of evaluated systems a minimum of three systems will be selected for a more in depth evaluation which will include:
 - The recording of geophysical logs for up to eight system water supply wells, to determine if “favorable” geologic conditions exist for implementation of a “geologic” solution.
 - Select a set wells (minimum of three) which present the greatest likelihood of successful rehabilitation, and using a specialty USGS well profiler tool (Izbicki and other, 1999), perform a velocity profile and collect six depth samples plus one well head sample at each selected well (all tests and samples are performed during normal production using the native pump).
 - All data; geophysical log data, well profiling data, water quality sample analysis, and system production/construction data will compiled into a report format.
3. Based on the results of the investigative portion of this project a “Decision Matrix” will be created outlining the steps a system should follow to evaluate their system to determine if “geologic solutions” might provide a viable alternative to costly treatment to address constituents causing compliance issues.

Environmental Results

The results of this project will provide a method for communities to determine if there is a possible geologic solution to address high arsenic concentrations in PWS wells.

Deliverables:

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| 1. Semi-annual report: | January 15, 2008 to OSE. |
| 2. Final report Year 1: | July 30, 2008 to OSE. |
| 3. USGS Publication: | December 30, 2008. |

Project Duration:

July 1, 2007 to December 31, 2008

Budget

Budget Period:

July 1, 2007 to June 30, 2009

Resource Allocation:

Federal	\$200,000
Total	\$200,000

Budget Funding Breakdown:

Year 1 \$150,000 FY08 Carryover
\$50,000 FY08 Base

Selected References

- Izbicki, J.A., Christensen, A.H., and Hanson, R.T., 1999, U.S. Geological Survey Combined Well-Bore Flow and Depth-Dependent Water Sampler. USGS Fact Sheet 196-99.
<http://ca.water.usgs.gov/archive/reports/fs19699.pdf>
- Ryker, Sarah J., 2003, Arsenic in ground water used for drinking water in the United States, in Welch, A.H., and Stollenwerk, K.G. (eds.), Arsenic in Ground Water – Geochemistry and Occurrence, Kluwer Academic Publishers, Norwell, MA p. 165 – 178.
- Smith, S. Jerrod, 2006, A proposal for the Oklahoma Department of Environmental Quality: *Well Rehabilitation Options for Arsenic-Rule Compliance in Small Public Water Supply Systems in Oklahoma*, U.S. Geological Survey, Oklahoma City, OK, 6pp.
- U.S. Environmental Protection Agency – Office of Water, 2000, Technologies and Costs For Removal of Arsenic From Drinking Water, EPA 815-R-00-028, 284 pp. (includes appendices).
- U.S. Environmental Protection Agency – Office of Water, 2001, Technical Fact Sheet – Final Rule for Arsenic in Drinking Water, EPA 815-F-00-0016, 5 pp.
- U.S. Environmental Protection Agency – Office of Water, 2001, Arsenic and Clarifications to Compliance and New Source Monitoring Rule: A Quick Reference Guide, EPA 816-F-01-004, 2 pp.