United States Environmental Protection Agency

ARSENIC IN DRINKING WATER
COMPLIANCE SUCCESS STORIES

Wisconsin: Geologic Solution for Private Wells in Outagamie and Winnebago Counties

Case Study Contact Information

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The experiences of Wisconsin Department of Natural Resources (DNR) show that stringent construction standards and requirements for private wells (in Outagamie and Winnebago counties) successfully reduced the number of private wells with elevated levels of arsenic.

Background

In northeastern Wisconsin, arsenic in the groundwater is associated with two types of bedrock aquifers - the St. Peter sandstone and the Prairie du Chien Dolomite. Both of these aquifers are tapped by many water wells. The arsenic may be released to well water at high concentrations when it is exposed to air, primarily through the well drilling process and through the lowering of the regional water table.

In 1987, arsenic contamination of groundwater supplies was first discovered in northeast Wisconsin as part of a routine feasibility study for a proposed landfill. Sampling results for private wells adjacent to the landfill showed that several wells had arsenic levels >5 ppb.

Further sampling from 1997 to 2000 revealed that 24% of samples had arsenic levels >10 ppb, and 7% of samples had arsenic levels >50 ppb based on 1,661 samples.

In 2000 and 2001, the county public health departments conducted sampling surveys to further evaluate arsenic levels in private wells constructed in the 1990s. These sampling results showed that of 3,905 wells sampled, 3% had arsenic concentrations >50 ppb and 20% had arsenic levels >10 ppb.

County statistics	Outagamie County	Winnebago County
Total population	155,000	160,177
Population served by public water supply	139,500 (90% total population)	120,133 (75%)
Population served by private wells	15,500 (10%)	40,044 (25%)

Treatment Alternatives

A coagulation/pressure filtration system was considered as an alternative to the coagulation/microfiltration treatment system but was found to be more expensive as shown in Table 1. The pressure filtration alternative has a higher estimated capital cost but lower annual O&M costs. The pressure filtration alternative also has a higher unit cost of water produced based on a present worth analysis of capital and O&M costs ($ per 1,000 gallons produced).

Non-Treatment Alternatives

In 1993, the Wisconsin DNR first established an Arsenic Advisory Area, a 10-mile wide strip through both counties where special well construction methods were recommended to reduce or eliminate arsenic contamination. From 1993 to 2004, few wells were constructed to these standards, however, because the recommended deeper well casings were too expensive and not a requirement.

In response to the high levels of arsenic found in the 2000-2001 sampling survey, the county public health departments issued advisories to well owners on the arsenic testing results and the possible health impacts. The advisory gave well owners two options – they could install an arsenic treatment system on their existing well, or drill a new well according to county standards that specify well casing depths to assure that the well water is not drawn from the arsenic-laden bedrock. Various options for providing alternate water supplies are summarized in Table 1. Note the estimated costs are shown as a range since the cost for developing a well will vary based on the required well casing depth for a particular site.

Table 1
Non-Treatment Options for Individuals and Communities in Outagamie and Winnebago Counties, Wisconsin

Option	Advantages	Disadvantages	Cost
New individual well (deep aquifer)	Homeowner has control of water supply; effective for minimizing arsenic level if specifications followed.	High initial cost due to extra casing and other construction requirements; well owner responsible for water testing.	$7,000-17,000 per home
New individual well (shallow aquifer)	Lower initial costs than deep well; homeowner has control of water supply.	This option is only available in certain areas; water supply is more susceptible to surface contamination; water conservation is required because shallow aquifer may not provide adequate supply; well owner responsible for water testing.	$4,000-7,000 per home
Shared, cluster well for 2-6 homes (deep aquifer)	Lower initial costs per home than an individual well; effective for minimizing arsenic level if specifications followed.	Homeowners need to agree to share well (contract is advised); water use may not be proportional among homeowners; water testing by homeowners; well location may affect subdivision layout; potential legal issues on sharing costs.	$4,000-7,000 per home
Connection to public water supply	Regulated supply of safe drinking water, fluoridation; improved aesthetic water quality (iron, manganese)	High initial costs; homeowner pays annual water bill.	Initial costs vary

Well Construction and Disinfection Standards

In 2004, the DNR created a "Special Well Casing Depth Area" under the provisions of the State Private Well Code (NR 812.12(3)). The special area includes all of Outagamie and Winnebago counties. The DNR decided to apply stringent requirements to all of Outagamie and Winnebago counties because these specifications worked satisfactorily for replacement wells funded by DNR's Well Compensation program (described below under Funding Process).

All new wells drilled within this area are required to meet the following stringent standards for well construction, grouting, and disinfection:

1. Private wells must be constructed with a cement-grouted steel casing that extends at least to the top of the Cambrian sandstone aquifer which lies below the St. Peter sandstone. Township maps show the required casing depth for any particular location.
2. The well cannot be drilled by a rotary-air method because it allows too much air into the subsurface zone and may cause arsenic to be released to the groundwater. The allowed drilling methods include rotary-mud circulation and cable-tool methods.
3. The cement grouting must meet stringent specifications as outlined in the new law.
4. Disinfection standards, designed to minimize oxidation of sulfide minerals, require use of a liquid bleach solution at a low chlorine concentration.

The complete specifications can be viewed at the following website: Special Casing Area Requirements for Arsenic - Well Construction Specifications EXIT Disclaimer

All new private wells drilled in Outagamie and Winnebago counties are required to meet stringent standards for well construction, grouting, and disinfection to prevent arsenic contamination.

In the first year after the new specifications went into effect, 131 wells were constructed according to the more stringent specifications. Only eight of these (6%) produced water with arsenic concentrations exceeding the new drinking water standard of 10 ppb. None of these wells produced water with arsenic concentrations exceeding 50 ppb.

Treatment Alternatives

As an alternative to drilling a new well or connecting to the public water supply, private well owners have the option of installing a treatment system such as a point-of-use reverse osmosis system to remove arsenic from an existing well. For treatment to be effective, regular system maintenance is required. The costs to install a treatment system for a private well range from $4,000 to $7,000 for the equipment plus annual maintenance costs of $400 to $500.

Funding Process

Wisconsin has a Well Compensation Program to assist private well owners in replacing contaminated wells including wells contaminated with arsenic at concentrations higher than 50 ppb. Grant recipients must also meet income eligibility criteria. Grants may be used for the following purposes:

- Develop a new well that meets DNR's specifications;
- Reconstruct an existing well to the new specifications;

- Connect to a nearby well that meets DNR's specifications; or
- Connect to a community water supply.

If none of the alternate water supply options are feasible, grants may be used to install a treatment system to reduce arsenic levels in the existing well.

Conclusion

The Wisconsin Department of Natural Resources has developed a unique solution to reduce arsenic contamination of private wells in Outagamie and Winnebago counties. All new wells must be developed using stringent construction standards including a site-specific well casing depth to ensure that water will not be drawn from the St. Peter sandstone aquifer or the Prairie du Chien Dolomite aquifer which are both sources of arsenic. Sampling results show a reduced number of new private wells have arsenic levels greater than 10 ppb since the new requirements were implemented. Private well owners that need to replace a well due to arsenic contamination may be eligible for a state grant. Alternatives to developing a new well include connection to a public water system, connection to a shared cluster well, and installing treatment for the existing well.

For More Information

Naturally Occurring Arsenic in Well Water in Wisconsin EXIT Disclaimer

Special Casing Area Requirements for Arsenic EXIT Disclaimer