

Arsenic Research

Naturally-occurring arsenic was discovered in Wisconsin's groundwater in 1989 during a routine investigation conducted by the DNR. Approximately 4% of the private wells located in Winnebago and Outagamie Counties had arsenic levels that exceeded the federal drinking water standard at that time (50 µg/L). Over the years the department has continued to work with drillers to improve well drilling and construction techniques to minimize arsenic levels in potable wells.

Arsenic is released from aquifer materials by several mechanisms. The primary mechanism in NE Wisconsin is oxidation of sulfide minerals when groundwater is drawn down and the rock is exposed to air, or air is introduced to the rock formations during well drilling. Other metals (such as nickel, cobalt, cadmium, chromium, lead and iron) associated with the sulfide minerals can also be released to groundwater and may increase health risks. The primary mechanism in SE Wisconsin, and in some glaciated areas of Northern Wisconsin, is the release of arsenic bound to iron oxide minerals in the aquifer sediments. In these settings, lack of oxygen in the groundwater system makes the iron oxides soluble which also frees the arsenic.

Between 2002 and 2004 the DNR required more stringent specifications within four small areas where arsenic contamination problems were severe. To avoid creating a 'hodge-podge' of small special well casing depth areas (SWCDAs) scattered over a two-county region, DNR expanded the SWCDAs to include all of Winnebago County and Outagamie County. Information on the specifics of the SWCDAs requirements can be found at: <https://dnr.wisconsin.gov/topic/Groundwater/arsenic/casingRequirements.html>.

Understanding the occurrence of arsenic in Wisconsin's groundwater has been a good example of interagency cooperation. Initial work with DHS and local health departments and town boards effectively defined the problem and raised awareness. Research supported by the joint solicitation helped define the extent and mechanisms of release. DNR and Commerce (now DSPS) worked jointly with water treatment companies on developing treatment systems for arsenic removal. Well drillers assisted in identifying drilling methods that reduce arsenic.

Sixteen studies through the joint solicitation (as of 2015) have explored arsenic related topics from detection to geologic controls to well construction and treatment (See <https://dnr.wisconsin.gov/topic/Groundwater/Arsenic>). Completed research focused on release mechanisms, triggers and reaction kinetics that affect well construction, disinfection, and rehabilitation. A second focus of work is identifying other areas of the state with impacted groundwater.

A DHS Health Consultation study on arsenic in private wells in the Wind Lake, Racine County area showed arsenic is present in both the deep glacial and Silurian bedrock aquifers (<https://www.atsdr.cdc.gov/HAC/pha/WindLakePrivateWells/WindLakeHC04-28-2009.pdf>). Of 25 wells tested, 12 contained arsenic levels above the Enforcement Standard (ES) of 10 µg/L. Free test kits were made available to any interested resident in the area and resulted in 92 samples from 70 different private wells. The results showed 22 of 70 (31%) wells with arsenic levels at or above the ES. Test results ranged from 10 to 27 µg/L. In addition to arsenic, water from 10 wells had lead at levels above the ES of 15 µg/L.

The DNR, DHS, DSPS and others continue to work on arsenic problems around the state. Arsenic has been found at levels above the ES in every county. DHS has conducted two separate studies on the health effects of arsenic on Wisconsin citizens. DHS researchers

have observed higher rates of skin cancer, heart disease and depression among consumers of water that contains traces of arsenic (Knobeloch et al, 2002; Zierold et al, 2004).

A 2007 study funded through the joint solicitation examined the relationship between arsenic contamination and common well disinfection practices such as shock chlorination. Results indicate a complex cycling of iron and arsenic in well bores and aquifers. Microbiological activity in the aquifer and the amount of pumping from a well affect arsenic release related to shock chlorination (Gotkowitz et al, 2008; West et al. 2012). Results suggest that managing the quality of water in domestic wells in arsenic-impacted areas of Wisconsin may be beyond the ability of individual homeowners.

Effective well construction requirements implemented in SWCDAs in Winnebago and Outagamie Counties are being applied in other areas of the state. In addition, extending public water supplies or promoting use of household treatment systems are alternatives for providing a reliable source of potable water.

Efforts to address arsenic in groundwater include:

- Ongoing testing of private wells for arsenic through the fee-exempt testing offered to low-income families by local health departments.
- Refinement of the geology in the Outagamie and Winnebago county area and updating casing requirements.
- DHS and DNR sampling of transient non-community wells.
- DSPS and DNR evaluating and pilot testing arsenic treatment systems for public and private systems that do not have an alternative aquifer option. One point-of-use treatment system was approved.
- DNR efforts to improve well construction for school and community wells.
- DHS, DNR and the WGNHS worked together to gather information from drillers and pump installers on areas with high iron and corrosive water, which may be indications of an arsenic problem. Sampling of these areas is led by DHS.
- DHS and DNR targeting of wells for sampling in the southern and SW portions of the state.
- Requiring arsenic sampling for all new and reconstructed wells in Florence County.
- Educational outreach to the well drillers continues.

More information related to arsenic can be found on the DNR Arsenic Web Page: <https://dnr.wisconsin.gov/topic/Groundwater/Arsenic>.

References:

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Gotkowitz, M., K. Ellickson, A. Clary, G. Bowman, J. Standridge and W. Sonzogni, 2008. Effect of well disinfection on arsenic in ground water, Ground Water Monitoring and Remediation, 28: 60-67.

West, N., M. Schreiber and M. Gotkowitz, 2012. Arsenic release from chlorine-promoted alteration of a sulfide cement horizon: Evidence from batch studies on the St. Peter Sandstone, Wisconsin, USA, Applied Geochemistry, doi: 10.1016/j.apgeochem.2012.01.019

Zierold K, Knobeloch L, and H Anderson. 2004. Prevalence of chronic disease in adults exposed to arsenic-contaminated drinking water, Amer J Public Health, 94(11):1936-1937.