



Arsenic Water Treatment for Individual Wells in Maryland

Arsenic is a naturally occurring element present in food, soil, rocks, air and water. The presence of arsenic in groundwater is largely the result of minerals dissolving naturally from weathered rocks and soils over time. Water that is pumped from wells in that aquifer may contain detectable amounts of this element.

Arsenic has been detected in some well water of the Coastal Plain Province of Maryland at levels exceeding the drinking water standard. (See Figure 1.) Research conducted by the Maryland Geological Survey (MGS) confirmed the presence of detectable arsenic in drinking water wells located in Anne Arundel, Calvert, Caroline, Dorchester, Kent, Queen Anne's, St. Mary's, Talbot and Worcester counties. The aquifers primarily affected are the Piney Point and Aquia.

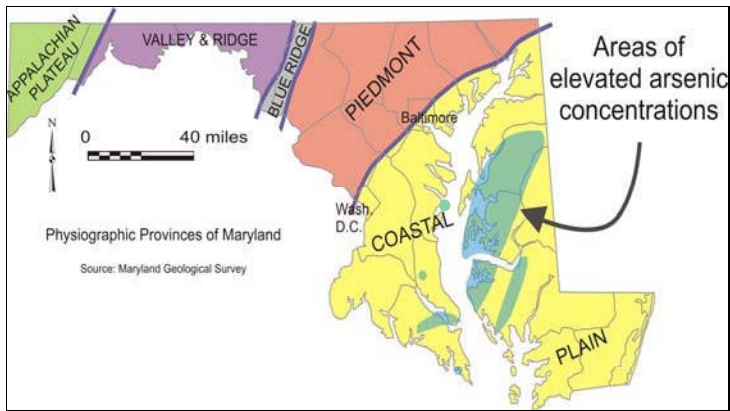


Figure 1.

Arsenic is a toxic element. Ingesting inorganic arsenic over many years (chronic exposure) increases the risk of skin cancer and tumors of the bladder, kidney, liver and lung. It has also been found to have possible links to blood vessel damage, heart problems, diabetes and skin changes. Based on its review in 2002, the Environmental Protection Agency (EPA) lowered the drinking water standard from 0.050 to 0.010 milligrams per liter (mg/L or parts per million, ppm) in order to protect human health. For more information please see the MDE website.

Arsenic does not generally impart color, taste or smell to water, therefore, testing for arsenic by water sampling is the only way to determine its presence. Check with your local Health Department about the need to have your drinking water tested for arsenic. A list of certified labs is available at <http://www.dhmd.state.md.us/labs/html/WtrCrt/watcert.html>. Approved test methods for inorganic arsenic are found on Environmental Protection Agency's (EPA) web site at http://www.epa.gov/safewater/methods/inch_tbl.html. EPA estimates that the costs per analysis range from \$15 to \$50 per sample.

The results of your water sample will indicate the level of arsenic in the water. EPA has set the Maximum Contaminant Level (MCL) at 0.010 mg/L. Maryland has changed its MCL to reflect the new EPA standard. You may also see results expressed in

micrograms per liter ($\mu\text{g/L}$ or parts per billion, ppb).

Arsenic in groundwater generally occurs in two forms, pentavalent arsenic (also known as Arsenic V, As +5, or arsenate) and trivalent arsenic, (also known as Arsenic +3, Arsenic III, or arsenite). Trivalent arsenic is generally more difficult to remove from drinking water than pentavalent arsenic. To date, research conducted by the MGS has indicated both Arsenic III and Arsenic V exist in groundwater samples evaluated. Furthermore, preliminary MGS research has found Arsenic III occurring at higher concentrations than Arsenic V. In general, laboratories will test and report total arsenic unless you specify a particular method of arsenic speciation analysis. It may be helpful to request analysis for the form of arsenic present in your water supply as this information may be necessary to select the appropriate treatment technology.

A Certificate of Potability (COP) is required before a newly constructed well can be put into service. In order to obtain a COP, the water quality produced from the well must be free of contaminants. If arsenic is found to be above 0.010 mg/L then the water must be treated for arsenic as part of the requirements for obtaining a COP. Currently data are being collected and analyzed to determine if specific drilling depths can be designated to avoid arsenic concentrations above the MCL. It may be advisable to have your well re-sampled prior to making water treatment decisions.

Options Available To Homeowners

- Check with the Local Health Department or MDE to determine if an aquifer with low arsenic concentrations exists.
- Treat all water that enters the house with a Point of Entry (POE) treatment unit (also called "whole house"), or,
- Treat the water at a specific tap with a Point of Use (POU) treatment unit.

Selection of the most appropriate method of treatment may vary depending on the homeowner's choice and water chemical characteristics. When selecting a water treatment unit, the effectiveness, cost efficiency, and maintenance requirements of the unit should also be considered. Homeowners are advised to seek the services of a qualified water treatment professional before selecting a treatment unit. The current situation involving arsenic treatment is rapidly evolving to meet current and future demand due to the lower arsenic standard. For instance, the National Sanitation Foundation (NSF), an independent third-party accreditation association in conjunction with the EPA's Environmental Technology Verification Program (ETV), is in the process of verifying several arsenic reduction technologies. MDE has reviewed available literature pertaining to treatment units and offers the following summary.

Water Treatment Technology Options

Special Iron Oxide Adsorptive Media – Iron based adsorption is a relatively new technology, which uses an iron oxide based, non-regenerative media. Variations of this type of media are emerging as viable arsenic removal alternatives. An arsenic water treatment

evaluation program initiated by New Jersey compared POE ferric oxide media adsorption technology and anion exchange technology. The study found that the ferric adsorption technology: effectively removed both species of arsenic from the source water; was easy to operate and maintain; and, did not return captured arsenic to the environment through regeneration (backwash). Once the media has depleted its adsorption capacity, it is removed from the canister and fresh media is added. Typical media life may be 2 – 3 years, depending on household water use. Small point of use (single tap) iron oxide adsorption systems are becoming available for use.

Activated Alumina adsorption removes arsenic by exchanging the arsenic with the hydroxide ions on the alumina surface. A pre-oxidation step is required to convert Arsenic III to Arsenic V, since activated alumina does not effectively reduce Arsenic III. Pre-oxidation technology includes chlorination, potassium permanganate, ozone and solid phase media. Activated alumina may require pH adjustment since removal efficiency is reduced at higher pH values. Media replacement depends on household water usage. If chlorination is used as a pre-oxidation method, post treatment by passing water through a granular carbon filter to remove the chlorine is generally desired. More frequent operation and maintenance may be required given the complexity of additional treatment steps. Iron activated alumina (Fe-AA) is an iron-based variation. In addition, Point of Use activated alumina treatment with pre-oxidation may also be a feasible option.

Anion Exchange can be effective in removing arsenic V. A pre-oxidation step is required to effectively convert arsenic III to arsenic V prior to treatment. If chlorination is used as a pre-oxidation method, post treatment by passing water through a granular carbon filter to remove the residual chlorine is generally desired. If sulfate is present in the drinking water above 50 ppm, efficiency is reduced. Anion exchange units require proper operation and maintenance. If the units are not regenerated on a timely basis, the anion resin can leach the adsorbed arsenic at much greater concentrations. The waste brine can contain high concentrations of arsenic and should be disposed properly.

Reverse Osmosis is typically a point of use (POU) (single tap) treatment option. Reverse osmosis is effective in reducing arsenic V. A pre-oxidation step is required to convert the arsenic III to arsenic V. If chlorination is used as a pre-oxidation method, post treatment by passing water through a granular carbon filter to remove the chlorine is generally desired. Pre-softening of the water is recommended when the raw water hardness is greater than 10 grains (170 mg/L). Reverse osmosis consists of a membrane filter, which will need to be replaced after 2 to 3 years depending on water use. Pre and post membrane cartridges may need to be replaced more frequently.

Table 1. provides a comparison of arsenic reduction technologies.

Comparison of Arsenic Treatment Technologies ^{1,4,8}

Technology	Type of Arsenic Removed	Waste Generated	Regeneration Required	Pre-oxidation Required	Process & Maintenance
Special Iron Oxide Adsorptive Materials	As III, As V	Low	No	No	Simple
Other Adsorptive Media – Activated Alumina (AA), Fe-AA	As V, (variable As III removal)	Low (Disposable type only)	No (Disposable type Only)	Yes	Simple-Moderate
Anion Exchange	As V	High	Yes	Yes	Complex
Reverse Osmosis	As V (variable As III removal)	Low	No	Yes	Moderate

Sources of Information

- Giles, Greg. "POE Arsenic Reduction: New Adsorption Alternative for Whole House Treatment". Water Conditioning and Purification. March 2003, vol.45/3, pps 50-54.
- Kommineni, Sunil., Narahimhan, Ramesh., Durbin, Herb. "Point-of-Use/Point-of-Entry Treatment for Arsenic Removal: Operational Issues and Costs", presented at Orlando, Florida. Proceedings of Public Water System Compliance Using Point-of-Use and Point-of-Entry Treatment Technologies. NSF Center for Public Health Education. February 13-14, 2003.
- Maryland Department of the Environment, Water Supply Program. "Arsenic Rule Implementation Guidance". September 2004
- Moretti, Dr. Charles. (Principal Investigator). "Demonstration Project Summary, Point of Use Reverse Osmosis Treatment for Removal of Arsenic from Drinking Water". Drinking Water Assistance Program for Small Systems (DWAP) a program of the Montana University System Water Center. March 2002.
- National Sanitation Foundation, Arsenic Fact Sheet Reference: NSF/ANSI Standards 53 and 58 - 2002
- On Tap, "All About Arsenic," Summer 2002, Vol. 2, Issue 2.
- On Tap, "New Methods for Removing Arsenic", Winter 2003.
- Spayd, Steve. "Draft Information Circular, Arsenic Water Treatment for Residential Wells in New Jersey". New Jersey Geological Survey & Bureau of Safe Drinking Water. March 2004.
- Welch, Alan., Ryker, Sarah., Helsel, Dennis., Hamilton, Pixie. "Arsenic in Ground Water of the United States: An Overview". Water Well Journal. February 2001.

The following Web Sites may be referenced for more information about arsenic:

- US E.P.A. at www.epa.gov/safewater/arsenic.htm
- Maryland Geological Survey at www.mgs.md.gov/
- National Drinking Water Clearinghouse at www.nesc.wvu.edu/ndwc
- National Sanitation Foundation at www.nsf.org

Comments or requests for information are welcome.

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