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CD Summary

Contact: 971-673-1111 | cd.summary@state.or.us | www.healthoregon.org/cdsummary

# WELL, WELL, WELL: WHAT'S IN THE WATER?

Case Report: *A 60-year-old female bought a house in the Rogue River Valley in 2000. The house has a well that she used for drinking, cooking, gardening and the swimming pool. After several years she experienced high blood pressure, dizziness, headaches and persistent gastrointestinal issues. She visited several clinicians in subsequent years without receiving a diagnosis. In 2011, her general practitioner asked about her drinking water source and suggested testing her well water. The arsenic result was 127 parts per billion (ppb), much higher than the U.S. Environmental Protection Agency (EPA) 10 ppb maximum contaminant level (MCL) for arsenic in public drinking water. The woman's urine contained 234 micrograms/liter (mcg/L) total arsenic (reference 0–35 mcg/L).*[1]

*Arsenic speciation showed 28 mcg/L of the more toxic (inorganic) arsenic (reference 0–24 mcg/L). The woman reported not consuming seafood, a typical source of arsenic, for at least a week before testing. Subsequently, she installed a reverse-osmosis water treatment system which eliminated the arsenic and her urine arsenic decreased (17 mcg/L total and <15 mcg/L inorganic).*

The EPA sets enforceable standards (MCLs) for drinking water. However, MCLs do not apply to private domestic wells, defined as serving fewer than 3 homes or connections. The 10 ppb MCL for arsenic in public water systems became enforceable in 2006. A comparison of urine arsenic levels in people on public water systems before and after EPA's lowering of the MCL for arsenic from 50 ppb to 10 ppb found a 17% reduction in the surveyed population urine arsenic. However, urine from well water users showed no reduction in arsenic.[2]

## WELL TESTING REQUIREMENTS IN OREGON

Oregon's Domestic Well Testing Act (DWTA) requires testing for arsenic, nitrates and total coliform bacteria, at the time of sale or exchange of real estate, of any well used for domestic purposes.[3] The Domestic Well Safety Program at the Oregon Health Authority provides information on health effects of drinking contaminated water and resources for well treatment and maintenance. It also maintains a database of test results for private domestic well contaminants regulated by the DWTA.[4] Homeowners are not required to test well water for contaminants when it is the source of drinking water for a rental dwelling. Neither is there assistance for renters or rental property owners to test or improve well water quality.

## OREGON DATA

Arsenic, nitrate and coliform bacteria test results from Oregon domestic well testing are summarized below (Table). Nearly 10% of arsenic samples and 1.5% of nitrate samples from private wells in Oregon exceeded the respective EPA MCLs. Total coliform bacteria were detected in 10.5% of domestic well samples collected from 1988 to 2018. *E. coli* was detected in 1.8% of the samples that tested positive for total coliform. There are approximately 350,000 active private domestic wells in Oregon serving nearly 1 million residents.

## SOURCES AND HEALTH EFFECTS OF CONTAMINANTS

**Arsenic**. Arsenic occurs naturally in the earth's crust. Contamination of aquifers and well water with arsenic can occur from erosion of natural deposits, runoff and industrial sources. The Figure (*verso*) shows estimates of Oregon residents potentially exposed to high levels of arsenic in domestic well water The absence of arsenic in a private well is no guarantee that a neighboring well is not contaminated.

Acute arsenic toxicity may cause liver necrosis, cardiomyopathy, acute renal failure and chronic renal insufficiency. Chronic consumption of water containing arsenic can result in impaired cognitive development, cancer, skin lesions, miscarriages, low birth weight, cardiovascular disease, diabetes and peripheral neuropathy.[5,6]

Seafood, meat, dairy products, some wine, some juice (e.g., grape and apple) and cereal (including some rice-based baby food and infant formula) are dietary sources of arsenic, although exposure from these foods is

**Table. Domestic Well Testing Act Data, Oregon (1989 –2018)**

| | | | Coliform Bacteria | |
|---|---|---|---|---|
| | Arsenic | Nitrate | Total Coliform | *E. coli* |
| MCL | 10 ppb | 10 ppm | No detection | No detection |
| % >MCL | 9.9 | 1.5 | 10.5 | 1.8* |
| Range | 0–850 ppb | 0–118 ppm | | |
| Mean | 2.5 ppb | 1.3 ppm | | |

* % of total coliform positive tests. County and census tract level maps and DWTA data for arsenic and nitrates in Oregon are available online

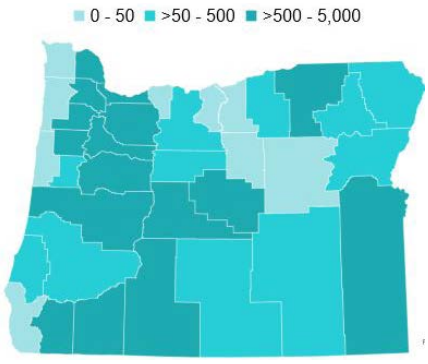
generally much lower compared to exposure through contaminated groundwater. In seafood, arsenic is mainly found in its less toxic organic form, although hijiki seaweed tends to have high concentrations of inorganic arsenic. In addition, some ayurvedic and herbal medicines can be high in arsenic and lead.[7]

Patients should refrain from eating seafood for at least three days before urine testing to minimize confounding test results. In addition, urine arsenic measurements should be done prior to any chelation for helpful comparison to reference values and chelation should be reserved for cases of severe acute arsenic toxicity.[8]

**Nitrates**. Nitrates can occur naturally in surface and groundwater at levels that do not cause health problems. High levels of nitrate in well water often result from improper well construction, well location, septic systems, chemical fertilizers, animal feedlots or industrial and food processing waste. Adverse health effects include reproductive anomalies, cancer and "blue baby syndrome" (methemoglobinemia). N-nitroso compounds have been linked to colorectal cancers, thyroid disease and neural tube defects at water concentrations lower than 10 parts per million (ppm). Vitamin C, alpha-tocopherol, polyphenols and flavonoids have been shown to inhibit endogenous nitrosation.[10]

**Coliforms.** Detection of coliform bacteria in drinking water indicates contamination, possibly by sewage or animal waste that may contain disease-causing bacteria. The presence of *E. coli* in drinking water indicates fecal contamination. Health effects from exposure to coliform bacteria can include nausea, vomiting, diarrhea, jaundice and headache. The EPA MCL for coliform bacteria is zero (no detection). Many households that rely on domestic wells for drinking water also have septic systems, which are a common source of bacterial contamination of well water.

**Figure. Estimated number of residents per county using domestic wells with arsenic concentrations exceeding the EPA MCL of 10 ppb.[9]**




## THE ROLE OF CLINICIANS

Clinicians play a vital role in screening patients who may be at risk of drinking contaminated well water. They should familiarize themselves with the signs and symptoms of arsenic, nitrate and coliform toxicity and encourage patients who drink well water to test the water regularly. Simply adding the question "What is the source of your drinking water?" to an intake form or during a patient interview can provide key information about whether a patient is at risk.

## DOMESTIC WELL TESTING AND TREATMENT

Annual testing is recommended for bacteria and nitrates, although flooding events may require subsequent testing. Test for arsenic at least once. If arsenic is >8 ppb, retesting is recommended. If the second test is <10 ppb, retest in 3 years. If arsenic is >10 ppb, a treatment system and annual testing are recommended.

Treatment for bacteria may include removing the source of contamination, shock chlorinating or continuous treatment, depending on the nature of the problem. Treatment for nitrate includes identifying and removing the source of contamination. Installation of a reverse osmosis treatment system may be recommended. It is important to regularly service a treatment system and ensure proper functioning with a post-treatment sample.

Boiling well water to remove arsenic or nitrate is NOT recommended since that can concentrate the contaminants.

## WATER USE RECOMMENDATIONS

- If arsenic or nitrate exceed the MCL, bottled water is recommended for drinking, cooking and for pet's drinking water until treatment is installed or contaminant source removed.
- If the water concentration of arsenic exceeds 500 ppb, it should not be used for washing hands, bathing or showering and children should be supervised to minimize ingestion while bathing or brushing teeth.
- If coliform bacteria are present, the water should be boiled before drinking, use in food preparation, brushing teeth or washing the face.

## MORE INFORMATION

- Oregon Health Authority Domestic Well Safety Program
- Oregon Department of Environmental Quality: Resources for Private Well Owners
- Oregon Water Resources Department Water Well Owner's Handbook
- Oregon Domestic Well Testing Interactive Maps
- A Screening Tool for Domestic Well Owners: The Water Environmental Literacy Level Scale (WELLS)

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