

How to Interpret Water Test Results: A Guide for the Public

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Summary

More than 3 million Pennsylvanians use private well water as their main water supply. To date, there are over 1 million private water wells in Pennsylvania (PA), and roughly 20,000 more are drilled each year.¹ While it is more common to find wells in rural areas, private water sources (including wells, springs, cisterns, etc.) are found throughout the state. It is important to keep in mind that these private water sources can be contaminated due to natural processes or industrial activity. Air and soil pollutants as well as elements naturally found in the earth, such as bacteria, iron, chloride, arsenic, and lead can make their way into well water.² Some of these contaminants may make the water smell or taste different while others can cause harm to human or animal health. For this reason, regular well water testing is advised.

In PA, private water wells are not regulated, and it is the responsibility of the property owner to regularly test and treat their water. Yearly well water testing is advised by both the Centers for Disease Control and Prevention (CDC) and the U.S. Environmental Protection Agency (EPA).^{3,4} Testing outside of the routine schedule is also recommended for certain health conditions such as cases of reoccurring gastrointestinal illness, during the first few months of pregnancy, and around 6 months after a baby is born.⁴ Other suggested reasons to test well water quality include, but are not limited to:

- Any change in the taste or appearance of the water
- Agricultural runoff near the well
- Mines or new oil and gas wells drilled in the area^{4,5}
- After any repairs/replacements to well components
- Following flooding events

Oil and gas development have the potential to contaminate groundwater.⁶ The EPA recommends testing well water before and after any nearby oil and gas wells are drilled to create a record of the well's water quality and to ensure there is no contamination after drilling.⁵

To help private well owners understand their water test results, the Pennsylvania Department of Health has created this well water test results interpretation guide. This guide covers the most commonly measured water contaminants, including those associated with oil and natural gas production, with possible health effects related to each contaminant. The health screening level is the level in drinking water below which health symptoms are not expected. When available, the Maximum Contaminant Level (MCL) is used as the health screening level. MCLs, set by the EPA, are the highest level of a contaminant that is allowed in public drinking water to protect public health. This MCL is set by weighing potential human health impacts, feasibility, and cost of purifying the water to that level. Some contaminants also have a Secondary Maximum Contaminant Level (SMCL) from EPA, which is lower than the MCL. At this level the water may look, taste, or smell different but is not based on human health impacts. Information on how well water can be treated to reduce contamination is also discussed.

This document does not list all contaminants that may be present in water nor all associated risks based on exposure to these contaminants. Contaminants that do not have a health screening level may still impact health, but additional research is needed. The guide is not meant to diagnose health conditions or replace the clinical advice of a health care provider. Please contact a health care provider for medical advice. Additionally, a qualified water treatment company is the best source of personalized water treatment recommendations. If you have questions or concerns about

your water test results that are not answered with this guide, please contact the Division of Environmental Health Epidemiology at the PA DOH by calling 717-787-3350 or emailing us at dehe@pa.gov.

How to Interpret Water Test Results

The table below contains many of the water contaminants that may be measured in a water analysis. To use this table, compare the level on the test result with the Health Screening Level to understand if the amount measured in the water sample may cause health concerns for the average individual. Keep in mind that some contaminants may have different potential health effects depending on if the exposure was short-term or long-term. In general, a short-term exposure is anywhere from a couple of days to two weeks. A long-term exposure is typically a year or longer.

Key

| Symbol | Meaning |
|--------|---|
| * | U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) |
| LP | Lowest published health screening value from federal agencies (for both cancer and non-cancer health effects) |
| !! | Exceeding a screening value may pose a risk to your health or safety, follow-up is recommended. |

| Contaminant | Health Screening Level | Potential Health Effects | Possible Symptoms | Secondary Maximum Contaminant Level (SMCL) |
|----------------------|------------------------|--|---|--|
| Aluminum | 7.1 mg/L (LP) | <p>Short-term exposure: Not likely to pose a health risk</p> <p>Long-term exposure: Brain or bone disease possible in people with kidney disease</p> | <p>Individuals with pre-existing kidney disease: Disorientation, memory impairment, dementia</p> | 0.2 mg/L |
| Arsenic !! | 0.010 mg/L* | <p>Short-term exposure: Gastrointestinal issues such as constipation, bloating, nausea, vomiting, diarrhea, abdominal pain and cramping</p> <p>Long-term exposure: May increase the risk of developing certain types of cancer (e.g., skin cancer)</p> | Vomiting, nausea, abdominal pain, numbness/ burning of hands and feet, dark spots on skin, and thickening of the skin on the palms of the hands and soles of the feet | N/A |
| Barium !! | 2 mg/L* | <p>Short-term exposure: Gastrointestinal issues such as constipation, bloating, nausea, vomiting, diarrhea, abdominal pain and cramping, changes in blood pressure, neuromuscular impacts such as muscle weakness, cramps and/or pain</p> <p>Long-term exposure: May decrease kidney function or result in weight loss</p> | Vomiting, abdominal cramps, diarrhea, difficulty breathing, face numbness, muscle weakness | N/A |

| Contaminant | Health Screening Level | Potential Health Effects | Possible Symptoms | Secondary Maximum Contaminant Level (SMCL) |
|------------------------------------|--|---|--|--|
| Calcium | No standard | Consult your physician if you are on a calcium-restricted diet. Otherwise, not likely to pose a health risk. | | N/A |
| Chloride | No standard | Consult your physician if you are on a chloride-restricted diet. Otherwise, not likely to pose a health risk. | | 250 mg/L |
| <i>E. coli</i> !! | Absent * (0 Col/100 mL) | If not treated and the source of <i>E. coli</i> exposure is not removed, severe illness and hemolytic uremic syndrome (HUS) may develop. | Diarrhea, cramps, nausea, vomiting, headaches, fever, fatigue, and in rare cases death | N/A |
| Ethane | No standard | Not likely to pose a direct health risk. Explosion risk if an ignition source is present. | | N/A |
| Iron | No standard | Consult your physician if you are on an iron-restricted diet. Otherwise, not likely to pose a health risk. | | 0.3 mg/L |
| Iron Bacteria | No standard | Not likely to pose a health risk. This may indicate the presence of disease-causing microorganisms. If disease-causing organisms are present, individuals may experience diarrhea, cramps, nausea, vomiting, headaches, fever, and fatigue. | | N/A |
| Lead !! | 0.015 mg/L EPA action level 0.005 mg/L PA DEP standard for bottled, vended, retail and bulk water hauling systems | Short-term exposure: May vary due to sensitivity and age. Long-term exposure: Adults may experience cardiovascular disease, kidney disease, reproductive problems, and issues with the brain, and/or nerves. Children may experience developmental delays, especially those related to the central nervous system. Childhood exposure may contribute to disease development in adults. | May be asymptomatic or symptoms may mimic those of a common cold (fatigue, decreased appetite, joint and muscle pain, headache). Adults: Trouble concentrating, irritability, dizziness, tingling / numbness in extremities, nausea and vomiting, slurred speech, reduced sperm count, stillbirth, miscarriage, hypertension Children: Shortened attention span, delayed processing speed, impairments in visual and verbal memory skills, delayed developmental milestones, underperformance in school, vomiting and nausea | N/A |

| Contaminant | Health Screening Level | Potential Health Effects | Possible Symptoms | Secondary Maximum Contaminant Level (SMCL) |
|------------------------------|------------------------|---|--|--|
| Magnesium | No standard | Consult a physician if you are on a magnesium-restricted diet. Otherwise, not likely to pose a health risk. | | N/A |
| Manganese | 0.3 mg/L (LP) | <p>Short-term exposure: Consult with a physician if you are on a manganese-restricted diet. Otherwise, not likely to pose a health risk.</p> <p>Long-term exposure: Adults may experience damage to the nervous system which includes the brain, spine and nerves. This can also lead to mood changes. Infants and young children are at greater risk for developmental impacts to the central nervous system</p> | <p>Adults: Emotional instability, violent or compulsive behavior, hallucinations, gait disturbance, fixed facial expression, speech impairment</p> <p>Children: Underperformance in school, decreased verbal function and altered motor function, changes in behavior (increased aggression and attention deficit)</p> | 0.05 mg/L |
| Methane | No standard | Not likely to pose a direct health risk. There is the potential for suffocation, due to displacement of oxygen when methane is released into a confined space, or explosion hazards when the gas migrates from the water into the air. | | 7 mg/L (PA action level) 28 mg/L (explosion & suffocation risk) |
| Potassium | No standard | Consult your physician if you are on a potassium-restricted diet. Otherwise, not likely to pose a health risk. | | N/A |
| Propane | No standard | Not likely to pose a direct health risk. There is the potential for suffocation, due to displacement of oxygen when propane is released into a confined space, or explosion hazards when the gas migrates from the water into the air. | | N/A |
| Selenium !! | 0.050 mg/L* | <p>Short-term exposure: Gastrointestinal issues such as constipation, bloating, nausea, vomiting, diarrhea, abdominal pain and cramping</p> <p>Long-term exposure: Very high levels of selenium may lead to a disease called selenosis</p> | Nausea, vomiting, diarrhea, hair loss, deformity to fingernails, and neurological abnormalities such as numbness/odd sensations in fingers or toes | N/A |
| Slime Bacteria | No standard | Not likely to pose a direct health risk. May indicate the presence of disease-causing microorganisms. If disease causing organisms are present, individuals may experience diarrhea, cramps, nausea, vomiting, headaches, fever, and fatigue. | | N/A |

| Contaminant | Health Screening Level | Potential Health Effects | Possible Symptoms | Secondary Maximum Contaminant Level (SMCL) |
|-------------------------------------|------------------------|---|--|--|
| Sodium | No standard | Consult with your physician if you are on a sodium-restricted diet. Otherwise, not likely to pose a health risk. | | N/A |
| Strontium | 4.2 mg/L (LP) | <p>Short-term exposure: Not likely to pose a health risk.</p> <p>Long-term exposure: In infants, children, and adolescents that lack adequate calcium intake, skeletal deformities and/or strontium rickets (bones that are thicker/shorter than normal) may occur.</p> | <p>Infants / Children / Adolescents: Pain in bones and/or muscles</p> | N/A |
| Sulfate | No standard | Not likely to pose a health risk. May induce a laxative effect at levels greater than 500 mg/L upon initial consumption. | | 250 mg/L |
| Sulfur Bacteria | No standard | Not likely to pose a health risk. | | N/A |
| Total Coliform !! | Absent* (0 Col/100 mL) | May indicate the presence of <i>E. coli</i> . Exposure to <i>E. coli</i> may result in diarrhea, cramps, nausea, vomiting, headaches, fever, fatigue, and in rare cases death. | | N/A |
| Total Dissolved Solids (TDS) | No standard | Not likely to pose a health risk. | | 500 mg/L |
| Turbidity | 1 NTU* | Not likely to pose a health risk. May indicate the presence of disease-causing microorganisms. If disease-causing organisms are present, individuals may experience diarrhea, cramps, nausea, vomiting, headaches, fever, and fatigue. | | N/A |

Units Used

| Unit Abbreviation | Meaning |
|-------------------|--|
| mg/L | Milligrams per liter or parts per million (ppm) |
| µg/L | Micrograms per liter or parts per billion (ppb) 1 µg/L = 0.001 mg/L |
| Col/100mL | Colonies per 100 milliliters |
| NTU | Nephelometric Turbidity Units |

Disclaimer: The table above is meant to provide a brief summary of potential health effects associated with the aforementioned contaminants when present in water. This chart does not catalog all risks or adverse health effects associated with consuming or being exposed to the aforementioned contaminants at or above the health-based screening levels. The presence of certain contaminants may lessen or exacerbate the health effects of other contaminants when in a mixture. The health effects mentioned in the chart are specific to ingesting the water (for example, drinking, using the water for food preparation, ingestion during bathing). Additionally, some of the contaminants are listed in the table due to their suffocation hazard if gases accumulate in a confined space while using the water. This includes activities such as showering and washing laundry in poorly ventilated areas.

Individuals with varying health statuses may experience symptoms differently than what is described above. Individuals should consult with a health care provider if they have specific concerns about their health with regard to their water test results. This chart is not meant to diagnose health conditions or replace the clinical advice of a physician.

Overview of Water Treatment Options

Water treatment options are reviewed below with details on how they work and what contaminants they remove. A water quality professional is the best source for determining which water treatment system should be used. Water quality should be monitored regularly to ensure proper system functioning and contaminant removal.

| Water Treatment Type | How Does It Work? | Contaminants Removed and Additional Considerations |
|-----------------------------|---|---|
| Aeration | <p>Aeration systems pass air through water. This results in the release of dissolved gases from the water and into the air, which is then vented outside.</p> <p>Whole house, also known as point of entry (installation along main water line to house) and point of use systems (installation on water line to kitchen faucet) can be installed.</p> | <p>Ethane, Methane, Propane</p> <p>Dissolved iron and manganese will precipitate when treated with aeration and a filtration system will be needed to remove these solids. Efficiency is based upon type of system purchased and regular maintenance. If a proper ventilation system is not installed, exposure to airborne contaminants in the home may occur.</p> |
| Nanofiltration | <p>Nanofiltration uses similar technology as reverse osmosis in that a semi-permeable membrane filter selectively removes molecules of a certain size (0.001 –0.01 microns). As pressurized water passes through the membrane, contaminants remain outside or within the membrane. Water, along with smaller molecules, pass through.</p> <p>Whole house, also known as point of entry (installation along main water line to house) and point of use systems (installation on water line to kitchen faucet) can be installed.</p> | <p>Aluminum, Arsenic, Calcium, <i>E. coli</i>, Lead, Magnesium, Manganese, Iron, Iron Bacteria, Potassium, Sodium, Slime bacteria, Sulfate, Sulfur bacteria, Total coliform, Total Dissolved Solids</p> <p>Filter efficiency is based upon filter composition, age of the filter, and pH of the water. It is not guaranteed that 100% of contaminants will be removed and percent removal will vary by contaminant.</p> |
| Reverse Osmosis (RO) | <p>Reverse osmosis uses a semi-permeable membrane filter to selectively remove molecules of a certain size (0.001 – 0.0001 microns). As pressurized water passes through the membrane, contaminants remain outside or within the membrane. Water, along with smaller molecules, pass through. Reverse osmosis is the most effective treatment system to remove a wide range of contaminants from the water supply.</p> <p>Whole house, also known as point of entry (installation along main water line to house) and point of use systems (installation on water line to kitchen faucet) can be installed.</p> | <p>Aluminum, Arsenic, Barium, Calcium, Chloride, <i>E. coli</i>, Iron, Iron bacteria, Lead, Magnesium, Manganese, Potassium, Selenium, Slime bacteria, Sodium, Strontium, Sulfate, Sulfur bacteria, Total coliform, Total Dissolved Solids, Turbidity</p> <p>Filter efficiency is based on filter composition, age of the filter, and pH of the water. It is not guaranteed that 100% of contaminants will be removed and percent removal will vary by contaminant.</p> |

| Water Treatment Type | How Does It Work? | Contaminants Removed and Additional Considerations |
|--------------------------------------|--|---|
| Ultraviolet (UV) Purification | <p>An ultraviolet purification system exposes living organisms (such as bacteria and viruses) to ultraviolet light. The radiation from the UV light kills the living organisms.</p> <p>Whole house, also known as point of entry (installation along main water line to house) can be installed.</p> | <p><i>E. coli</i>, Slime bacteria, Sulfur bacteria, Total coliform</p> <p>UV purification kills living organisms at the point of installation. If living organisms are present in water lines past the UV light, they may still contaminate the water supply. Efficiency is reduced when water is cloudy.</p> |
| Water Softeners | <p>A water softening system uses ion exchange technology in which water passes through a media containing sodium ions. Calcium and magnesium, which create “hard water”, displace the sodium ions and remain trapped in the media while sodium is released.</p> <p>Whole house, also known as point of entry (installation along main water line to house) can be installed.</p> | <p>Calcium, Magnesium</p> <p>This method is not recommended for individuals on low-sodium diets as the amount of sodium in the water supply will increase. Efficiency is based upon the unit installed and regular maintenance (cleaning or replacing media and restoring brine solution).</p> |

Disclaimer: The water treatment types identified above may not fully eliminate contaminants or prevent contamination. Alternatively, treatment systems may remove contaminants beyond what is listed. Some contaminants are essential nutrients and are necessary for cellular function. If removed from the water supply, it is important to ensure adequate intake from other dietary sources. The Pennsylvania Department of Health does not endorse any specific water treatment system or brand. Water treatment types are listed in alphabetical order for ease of use.

Additional Resources

A

Aluminum

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=190&toxid=34>

Arsenic

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=19&toxid=3>

B

Bacteria (Iron, Slime, and Sulfur Bacteria)

- <https://www.health.state.mn.us/communities/environment/water/wells/waterquality/ironbacteria.html>
- <https://extension.psu.edu/iron-and-sulfur-bacteria-a-slimy-problem>
- <https://www.health.state.mn.us/communities/environment/water/wells/waterquality/hydro sulfide.html>

Barium

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=326&toxid=57>

C

CDC Well Water Testing Recommendations

- <https://www.cdc.gov/healthywater/drinking/private/wells/testing.html>

D

Drinking Water Basics

- <https://extension.psu.edu/a-quick-guide-to-groundwater-in-pennsylvania>
- <https://extension.psu.edu/the-water-we-drink>
- https://www.epa.gov/sites/default/files/2015-11/documents/2005_09_14_faq_fs_homewatertesting.pdf
- <https://extension.psu.edu/testing-your-drinking-water>

E

E. coli

- <https://www.cdc.gov/ecoli/index.html>

EPA Well Water Testing Recommendations

- https://www.epa.gov/sites/default/files/2015-11/documents/2005_09_14_faq_fs_homewatertesting.pdf

I

Iron

- <https://www.health.state.mn.us/communities/environment/water/wells/waterquality/iron.html>

L

Laboratories Accredited by PA DEP

- https://files.dep.state.pa.us/water/bsdw/DrinkingWaterManagement/PrivateWaterWells/zAccredited_Laboratories.pdf

Lead

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=93&toxid=22>

M

Magnesium

- <https://ods.od.nih.gov/factsheets/Magnesium-Consumer/>

Manganese

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=101&toxid=23>

Methane

- https://www.atsdr.cdc.gov/HAC/pha/DimockGroundwaterSite/Methane_in_well_water_5_08.pdf

P

Pennsylvania Department of Environmental Protection Water Quality Standards

- https://files.dep.state.pa.us/water/bsdw/DrinkingWaterManagement/RegsStandardsResources/pa-mcls_06.pdf

S

Selenium

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=152&toxid=28>

Strontium

- <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=655&toxid=120>

T

Total Coliform

- <https://www.maine.gov/dhhs/mecdc/public-health-systems/health-and-environmental-testing/colibact.htm>

W

Water Filtration Systems and Methods

- https://www.epa.gov/sites/default/files/2018-12/documents/consumer_tool_for_identifying_drinking_water_filters_certified_to_reduce_lead.pdf
- https://www.cdc.gov/healthywater/pdf/drinking/Household_Water_Treatment.pdf
- <https://www.health.state.mn.us/communities/environment/water/wells/waterquality/methane.html>
- <https://extension.psu.edu/methane-gas-and-its-removal-from-water-wells>

Common Terms

A

Action Level

If a contaminant is measured at this level or higher, it triggers treatment or other requirements that a public water system must follow.

Analyte

The term used for what a test is measuring in your water. Analytes can also be called contaminants and can include chemicals, compounds, organisms, and more.

C

Certified and Accredited Laboratory

A laboratory accredited by PA Department of the Environment and determined to meet a set of recognized standards.

D

Detection Limit

The lowest level of a contaminant a test is able to measure.

E

Effervescent

When a liquid is bubbling or fizzing due to escaping gas.

H

Health Screening Level

Determines if a contaminant may cause harm. Health impacts are not expected below the Health Screening Levels.

I

Intermediate Exposure

Exposure lasting between 15-364 days.

J

J (abbreviation on test result)

This means the value listed is an estimate. The true value is between the *Reporting Limit* and the *Method Detection Limit*.

L

Long-term Exposure

Exposure lasting for longer than one year.

M

Maximum Contaminant Level (MCL)

The highest level of a contaminant that is allowed in public drinking water. MCLs are set as close to Maximum Contaminant Level Goals (MCLGs) as feasible using the best available treatment technology and taking cost into consideration. These are enforceable standards.

Maximum Contaminant Level Goal (MCLG)

The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Method Detection Limit (MDL)

The minimum concentration that can be measured and reported with 99% confidence that the value is above zero—that is, something is really there. The MDL for a given analysis will vary by laboratory. This number is not as reliable as the *Reporting Limit*.⁶ The *Method Detection Limit* is also known as the *Minimum Detection Limit*.

N**Not Detected (ND)**

Some tests cannot measure contaminants below a certain level, known as the *detection limit*. In this case, the test cannot verify whether a low level of the contaminant is present, and the result shown is the detection limit. For example, some tests cannot measure lead below 1.00 µg/L. If the result shows <1.00 µg/L (U), that means lead was not measured at or above 1 µg/L.

Q**Q (abbreviation on test result)**

The test was conducted many times and the number on the report is the average of multiple tests.

R**Reporting Limit (RL)**

The Reporting Limit is the lowest reliable and accurate number that an analyte can be measured at. This level is typically 2-5 times higher than the *Method Detection Limit*.

S**Secondary Maximum Contaminant Level (SMCL)**

A level used for considering non-health related effects in public drinking water. This includes things like the taste, appearance, or odor of water.

Short-term Exposure

Exposure that occurs once and for up to 14 days.

T**Treatment Technique**

A treatment process required to minimize the level of a contaminant in drinking water.

U**U (abbreviation on test result)**

Stands for *Not Detected*. See *Not Detected* above.

Resources

1. Penn State Extension. (2022, August 26). *A quick guide to groundwater in Pennsylvania*. Penn State Extension. <https://extension.psu.edu/a-quick-guide-to-groundwater-in-pennsylvania>
2. Penn State Extension. (2022a, August 20). *The water we drink*. Penn State Extension. <https://extension.psu.edu/the-water-we-drink>
3. Centers for Disease Control and Prevention. (2023, February 23). *Well testing*. Centers for Disease Control and Prevention. <https://www.cdc.gov/healthywater/drinking/private/wells/testing.html>
4. U.S. Environmental Protection Agency. (2005, May). *EPA Home Water Testing*. U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2015-11/documents/2005_09_14_faq_fs_homewatertesting.pdf
5. Penn State Extension. (2022c, August 26). *Testing your drinking water*. Penn State Extension. <https://extension.psu.edu/testing-your-drinking-water>
6. U.S. Environmental Protection Agency. (2021, February 8). *EPA's Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources*. U.S. Environmental Protection Agency. <https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990>