

Having Confidence in the Quality of Your Drinking Water

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Having Confidence in the Quality of Your Drinking Water

It is easy to assume that if your water is clear and odor-free that it is safe to drink. However, many compounds and microorganisms can be in your water that do not affect taste or clarity. Having your drinking water tested is the best way to ensure that your water is safe for your family to consume. Recently, there have been many reports in the local and national media about the detection of lead and other compounds in drinking water. These reports make people wonder what might be in their drinking water, and many people have reached out to University of Tennessee Extension to inquire about getting their water tested. While UT Extension does not provide water testing services to the public, there are several state-certified commercial laboratories in Tennessee that provide water quality analyses. The purpose of this bulletin is to provide Tennessee residents with the information they need to make good decisions about whether they need to have their water tested, which constituents they should have evaluated and where to send their water samples for testing.

Also included in this document are the basic drinking water regulations followed by public water suppliers. The U.S. Environmental Protection Agency (EPA) has developed national primary and secondary drinking water regulations that are used by public water systems to determine and ensure the quality of the water supplied to their customers. These same standards can also be used by homeowners that use wells or springs for their water supply to evaluate the quality of their drinking water.

Where does my water come from?

Knowing where your water comes from can help you make an informed decision about having your water tested. Most Tennesseans receive their drinking water from a public water system. These systems are regulated by the Tennessee Department of Environment and Conservation Division of Water Resources (TDEC-DWR) under the authority of the Tennessee Safe Drinking Water Act of 1983 and the Federal Safe Drinking Water Act of 1974. These laws and regulations set standards for drinking water quality and ensure that public water systems in Tennessee provide drinking water that meets these standards. If you have your own drinking water well or use a spring or stream as your drinking water source, then you have a private water system. The owner of a private water system is solely responsible for monitoring the quality of their drinking water.

Public Water Systems

TDEC-DWR estimates that 92 percent of Tennessee residences are served by public water systems, often known as water utilities. This number is so high because of the difficulty of finding high quality groundwater in large areas of Middle and East Tennessee. In these areas, the thick layer of bedrock greatly increases the cost of boring a well and there is no assurance of finding good quality water. Rural communities have taken advantage of federal grants and Tennessee's revolving loan program to install public water systems in areas where residences cannot establish a private water supply. If you are on a public water system, your water is monitored for many compounds per state and federal regulations, especially if a surface water source is used as the source of raw water. A list of these compounds is included in the [appendix](#).

Private Water Systems

It is estimated that 8 percent of Tennessee residences use private wells or springs as their drinking water source. Residents that use springs or streams as a drinking water source have the highest potential risk, and these people need to be diligent about protecting their water source from contaminated stormwater runoff.

Surface Water

Surface water is exposed to more potential contaminants than groundwater and therefore has the greatest potential risk. Tennessee is rich in streams, rivers and lakes. The origin of many of our cities was based on water availability, both for drinking and for commerce. While plentiful surface waters require treatment before being suitable for human consumption, sediment is the primary constituent that is removed during the water treatment process. Sediment comes from eroded soil. As part of the erosion process, soil particles are carried into waterbodies by stormwater. The larger soil particles tend to settle while the very fine particles are held in suspension. This suspension of particles is the cause of turbidity, or murky water. Suspended sediment in drinking water is both an aesthetic problem and a health concern. Pesticides, bacteria and other contaminants can be adsorbed to the sediment particles. Surface waters are the raw water source for drinking water for most of the communities in East and Middle Tennessee.

Public Water Systems

By law, a public water system is an entity that provides water for human consumption and has 15 or more connections or serves 25 or more individuals daily for more than 60 days per year. These systems could be owned as either a public utility, private company or individual. Public water systems are further divided by size:

- a small system serves 3,300 or fewer people.
- a medium-sized water system serves more than 3,300 and no greater than 50,000 people.
- and a large system serves greater than 50,000 people.

Public water systems can also be non-community systems. Examples of non-community systems are water systems that serve a transient population, such as rest stops, hotels, restaurants, churches and service stations. (Rules of the Tennessee Department of Environment and Conservation, Chapter 0400-45-01 Public Water Systems, <https://publications.tnsosfiles.com/rules/0400/0400-45/0400-45-01.20190217.pdf>, accessed January 3, 2020).

Groundwater

The western portion of Tennessee benefits from outstanding groundwater resources. Most of the communities in this area can depend on the groundwater to serve as a plentiful supply of clean drinking water. Very little treatment is needed before this water is considered safe for human consumption. Large areas of Middle and East Tennessee are underlain by karst geology — land characterized by limestone and dolomite bedrock formations. Finding groundwater in these areas is less certain — well drillers must bore through rock formations to find groundwater. Minerals from the rock formation will dissolve into groundwater and these minerals can impart undesirable characteristics to the water.

Groundwater has less potential for contamination but may contain dissolved minerals and other constituents that may make it undesirable for consumption. A water provider may use surface or groundwater as a raw water source, but before they can call it drinking water the provider must demonstrate that it is safe for consumption. In contrast, if you provide your own water using a well or a spring, you must make your own determination as to the safety of the water.

Who is at risk?

From Pathogens

Historically the primary concern with drinking water has been the removal of pathogens. Pathogens are disease-causing microorganisms, and the act of removing pathogens is called disinfection. More than any other factor, the disinfection of drinking water has extended our life expectancy and has allowed for population growth. Most healthy individuals can tolerate low level exposure to pathogens without becoming ill. However, vulnerable populations must be more cautious with their exposure. If your household includes infants, the elderly, expectant mothers or immunocompromised individuals, then having your water tested for pathogens is warranted.

Living In An Older Home

In recent times, lead contamination has become a national concern. Lead in water originates from the plumbing. Lead pipes have been used since antiquity because lead is malleable and inexpensive. Lead poisoning from pipes was recognized in the late 1800s, but it was not until the 1920s that an effort was made to ban lead pipes. Many communities still have lead pipes as part of the distribution system. Engineers and scientists have developed methods to coat the inside of lead-based pipes to reduce the lead concentration in the drinking water to an acceptable level. Another lead source was the solder used to join copper pipes. In the 1980s lead-based solder was banned. However, most older homes have leaded solder joints in their household waterlines. It should be noted that the lead

contribution by leaded solder is very low, and that the concern about lead concentrations at this level is out of an abundance of caution. The dissolution of lead from the solder into water is a slow process so most of the dissolved lead is removed from your water pipes while running the water to bathe, wash clothes or other high water use activities. If you are concerned about the possibility of lead in your drinking water, having your water tested for lead is a good way to determine your risk.

Are There Sinkholes And Exposed Bedrock

Large areas of Middle and East Tennessee have carbonate rock (i.e., limestone) that is close to the soil surface. Infiltrating rainwater slowly dissolves this rock and leaves open voids, such as caves and sinkholes. These fractures in the rock structure can serve as direct conduits between the surface and the groundwater, allowing contaminants to be rapidly transported into potential drinking water sources. From a regulatory perspective, this is defined as *groundwater under the direct influence of surface water*. This water has a higher risk of pathogen contamination. A water supplier would need to treat and test this water the same as if it were withdrawn from a lake or river. If you have a private water supply and the water becomes cloudy or turbid with rainfall events, it is very likely that your water is under the direct influence of surface water. This water should not be consumed until the water has cleared and the turbidity has been flushed through your plumbing. If a better water supply cannot be found, then a household water disinfection system is strongly recommended for your home.

Are There Nearby Industries

An additional reason to consider having your drinking water tested is if you live near a source of potential water contaminants. If your home is near an old industrial facility, then there may be harmful chemicals in the groundwater under that site. Examples of potential sources of surface or groundwater pollution include landfills, factories that produce or use chemicals, gasoline stations and electrical generation plants. Testing for industrial chemicals can be expensive, so it is important to let the water-testing laboratory know what type of facility may have contributed contaminants to your water source so that the appropriate compounds can be evaluated.

What is potable water?

Simply stated, potable water is water that is considered safe to use for drinking and cooking. Potable water does not mean that other compounds are not dissolved in the water, only that those other compounds do not pose an immediate threat to human health. It is not realistic to test water for every potential pathogen and toxic chemical. Instead, water is tested for a wide range of probable contaminants. If the results of these tests show that the level of contamination is below prescribed thresholds, then the water is considered potable.

It should be noted that water could be potable and at the same time not desirable to drink. Water can adsorb compounds that affect taste (such as low concentrations of sulfur) but are not harmful to consume. Further, potable water may contain dissolved calcium, iron and manganese that can form a hard scale in the pipes and water heaters or create red stains on fixtures and laundered clothes. In regard to water testing, determining the suitability of the water for domestic uses (often called aesthetic effects) can be just as important as determining whether the water is safe to consume.

Risk versus Safe: Risk is a probability of loss or injury. There is risk in everything we do, from the food we eat to our daily commute to work. Safe is not an assurance against loss or injury, but rather, it is an acceptable risk. The presence of *E. coli* in drinking water is an unacceptable risk, and that water must be disinfected before consumption. In contrast, recreational water can have an *E. coli* presence with a geometric mean of 126 colony-forming units (cfu) per 100 mL of water before the risk is unacceptable. At this level of contamination, it is estimated that 8 out of 1000 people who come in contact with this water could potentially develop a gastrointestinal illness. While you do not want to be one of the eight who got sick, this is considered an acceptable risk.

Risk is also associated with toxicity. Because water is the universal solvent, many compounds can be dissolved in water but at concentrations too low to cause bodily damage. The old adage 'the dose makes the poison' applies here, as there are concentration thresholds for dissolved compounds that must be reached before the toxicity becomes too risky. The appendix provides the threshold values for the compounds regulated by the [Safe Drinking Water Act](#).

What is in my water?

From chemistry, we know that water is H₂O. This arrangement of hydrogen and oxygen atoms allows water to absorb many other compounds. As such, drinking water is not just H₂O. In fact, ultrapure water, such as distilled water, is not desirable to drink — it has a flat taste. High quality drinking water has low concentrations of naturally occurring dissolved minerals such as calcium, manganese and/or potassium. These minerals give water a desirable taste and provide our bodies with important trace nutrients. The primary goal of water treatment is to remove harmful compounds and pathogens but not to create pure H₂O.

When to have your water tested.

This table provides a quick reference to when you should consider having your water tested. If you experience any of the listed conditions or if any of the land-uses or industrial activities take place in your watershed, then it is recommended that you test your drinking water for the listed contaminant (Adapted from U.S. EPA (2005), Home Water Testing, EPA 816-F-05-013, May 2005, <https://www.epa.gov/privatewells/protect-your-homes-water>. Accessed January 3, 2020).

Observation	Recommended Water Analysis
Frequent gastrointestinal illnesses	Coliform bacteria
House built before 1980s	pH, lead, copper
Location is known for radon ^{1,2}	Radon
Soaps do not lather	Hardness
Red slime in toilet tank	Manganese, iron
Rotting egg smell	Hydrogen sulfide, metals
Cloudy water	Color units, turbidity
Clogged or leaking metal pipes	Corrosion potential, pH
Local use of pesticides, fertilizers and livestock production	Nitrate, pesticides, coliform bacteria
Surface mineral mining	Metals, pH, corrosion potential
Drilling for natural gas or oil	Chloride, sodium, barium, strontium
Gasoline odors or buried tanks	Volatile organic compounds
Landfill, automobile junkyard	Volatile organic compounds, metals, pH

¹ <https://www.tn.gov/health/cedep/environmental/data/environmentaldata/radon/radon-data.html>

² <https://www.epa.gov/sites/production/files/2014-08/documents/tennessee.pdf>

Primary Drinking Water Standards

As part of the federal Safe Drinking Water Act, the U.S. EPA developed a list of chemicals, minerals and radionuclides that can be found in water supplies and are known to be harmful. Called the [National Primary Drinking Water Regulations](#), this list sets limits on the level of contaminants that are allowed in drinking water. Public water systems must ensure safety by testing that the water they provide meets these standards. This list includes pathogens, disinfection by-products, disinfectants, inorganic chemicals, organic chemicals and radionuclides.

Pathogens

Historically, pathogens have been the primary contaminant of concern in drinking water. By rule, public water systems must take water samples from their distribution network to test for the presence of pathogens and to determine if there is sufficient residual disinfectant concentration remaining in the distribution system to prevent re-growth. When there has been a water system emergency, such as a natural disaster or pipeline rupture, the water service provider will issue a boil water advisory. This advisory is issued when contaminated water has entered the distribution

system and the drinking water is not considered to be disinfected. With these safeguards in place, the risk of pathogen contamination is very low when using a water service provider. This is not the case when you provide your own water. Regarding pathogens, the highest risk water source is a spring or stream. This water can be directly influenced by stormwater runoff. If the stormwater comes into contact with livestock manure, human wastes or even wildlife feces, then the stormwater can serve as a source of pathogens to your drinking water source. If you are using a spring or stream as your drinking water source, consider the use of a disinfection system. A common household disinfection system utilizes ultraviolet (UV) light to inactivate microorganisms. As water passes through these devices, it is irradiated by an UV lamp. This high-energy light damages the microorganism's DNA, rendering it unable to replicate. Household disinfection systems should be installed near where the water enters the house and at a location where the system can be serviced.

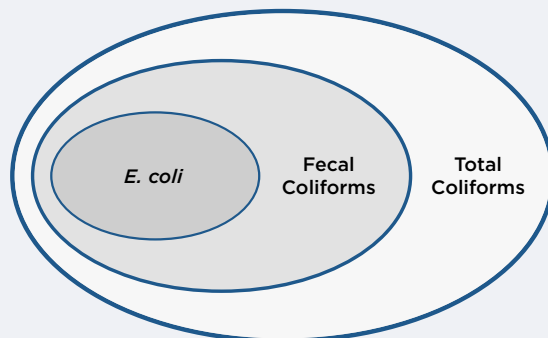
Privately owned drinking water wells tend to produce pathogen-free water due to the treatment of rainwater as it infiltrates through the soil. When wells are contaminated, the pathogen source is usually associated with the well rather than the groundwater. The wellhead is the location where the well casing protrudes from the soil surface and is susceptible to stormwater intrusion. If there are poultry in the yard or livestock in a nearby pasture, then stormwater can carry pathogens to the well casing that could serve as a direct conduit to the groundwater. Likewise, a surfacing septic system could be mixing with the stormwater. Fundamental management practices for well owners include diverting stormwater away from the wellhead, keeping livestock and poultry more than 150 feet from the well and ensuring that the septic system is operating properly.

Many rural homes in Tennessee have a drinking water well that is no longer being used — a water supplier was established sometime after the house was built and the well is now abandoned. Abandoned wells need to be properly closed to prevent surface water influence to the groundwater. [TDEC-DWR provides well closing guidelines.](#)

If you are concerned about pathogens in your well water, then have it tested for the presence of pathogens. Table 1 in the Appendix provides a list of the regulated microorganisms and their limits in drinking water.

***E. coli* as an indicator:** Having clean drinking water is the single most significant factor enabling increased human life expectancy and population growth. Drinking water disinfection prevents the historic waterborne diseases that plagued our ancestors. During the disease process, the body sheds the disease-causing pathogens in the stool and other bodily fluids. If these fluids enter drinking water sources, the water becomes a vehicle of the disease.

Many waterborne diseases are caused by bacterial species, including *Vibrio cholerae*, *Salmonella enterica*, *Shigella dysenteriae* and *Escherichia coli* (*E. coli*) to name a few. Within each of these species, there can be many sub-varieties (or serovarieties) that may have differing abilities to cause human illness (or pathogenicity). It is too expensive to test for every potential pathogen in drinking water. As a balance of risk and cost, the presence of just a few species and bacterial families are evaluated as indicators of the potential for true pathogens. During an illness, and especially during diarrheal diseases, the body sheds pathogenic and non-pathogenic bacteria from the gut microflora. Rather than test water for a specific pathogen, scientists and technicians test the water for a common species of gut bacteria, *E. coli*, and for the larger group of coliform bacteria. It is assumed that if the water contains *E. coli* and/or total coliforms, it has come in contact with fecal wastes and the risk is unacceptable that the water might contain pathogenic microorganisms. Likewise, if *E. coli* and/or total coliforms are not detected, there is an acceptable risk that no pathogens are present in the water.



Drinking water is tested for *E. coli* because it is found in the gut of nearly all animals. Thus, the presence of *E. coli* in water is an indication of the strong potential for the water to have been contaminated with human or animal fecal waste.

E. coli is a subset of a larger group of coliform bacteria that is measured as total coliform. If total coliforms are not detected in your drinking water, then the risk is very low that your water contains human pathogens.

Disinfectants

The disinfection of drinking water is a delicate balance. Sufficient disinfectant must be added to ensure pathogen destruction but not so much that the water becomes undesirable or harmful to consume. The majority of public water systems use some type of chlorine as a disinfectant. Chlorine is a strong oxidizer, and it reacts with many dissolved organic compounds (in this case, microorganisms are dissolved organic compounds) and with some of the dissolved minerals. These oxidation reactions consume chlorine — thus creating a chlorine demand. The consumed chlorine is no longer available for disinfection. Many public water systems add enough chlorine to meet the demand and then additional chlorine is added to provide a residual. This residual will provide protection against pathogens while the water is moving through the distribution network. Typically, the goal for the chlorine residual is about 2 mg/L. As shown in Table 2 in the Appendix, there are upper limits on the residual chlorine concentration.

Disinfection By-Products

Disinfection by-products are undesirable and potentially carcinogenic compounds that are inadvertently created during the disinfection process, especially when chlorine products are used as disinfectants. When chlorine is added to water, it reacts with naturally occurring dissolved organic compounds. Depending on the composition of the organic compounds, the reaction can result in chemicals that can also affect the drinking water quality. Table 3 in the Appendix lists the regulated disinfection by-products and their limits.

Private water systems can also use chlorine for disinfection. Home water treatment systems are available that inject sodium hypochlorite (non-perfumed bleach) into the waterline. If you are concerned about chlorine-based disinfection by-products, then it is recommended that you change to an UV light system.

Inorganic Compounds

Many metals, salts and other minerals will dissolve in water. Stormwater carries eroded minerals into streams, and as groundwater moves through porous rock formations minerals in the rocks will dissolve into the water. In low concentrations, most of these minerals are not a threat to human health. In fact, our bodies require trace minerals, such as calcium, potassium and magnesium for good health. Low concentrations of these minerals in drinking water will satisfy our dietary requirement. However, if our water flows through rock formations that contain arsenic, fluoride, sulfur, iron and other potentially toxic minerals, then the water must be tested to determine whether it is safe for consumption. Table 4 in the Appendix is a listing of the federally regulated inorganic chemicals and their limits.

PFAS: In recent years, many news outlets began reporting that perfluoroalkyl (or PFAS) compounds have been found throughout the world's drinking water supply. This is a group of synthetic organic chemicals, many of which have been in production since the 1940s. Two of these compounds, PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid) are the most commonly found PFAS contaminants. PFOS is an ingredient in fire-fighting foam and is often found near airports and military bases where it has been used to extinguish fires. PFAS is found in many consumer products used to repel stains on upholstery fabric, on cookware and other non-stick food packaging. Because these compounds are not metabolized and are only minimally degraded by natural processes, they are very persistent in the environment. These compounds are not regulated by the Safe Drinking Water Act, but because they can bioaccumulate, the U.S. EPA established lifetime health advisories in 2016 for PFOS and PFOA levels of 70 parts per trillion in drinking water to provide people with a margin of protection from a lifetime of exposure. A health advisory is not an enforceable or regulated standard but does provide technical guidance for water providers. Some of the potential links between human health and PFAS compounds include low infant birth weight, effects on the immune system, cancer and thyroid hormone disruption. PFOS has been phased out of production in the U.S. and eight major global suppliers began phasing PFOA and PFOA-related chemicals out of production in 2006.

Organic Compounds

The Safe Drinking Water Act requires public water systems test for many organic compounds. Most of these compounds were released into the environment through industrial activities, pesticide spraying or pharmaceuticals. Some are even consumer products. There are potentially tens of thousands of organic compounds that have been developed and it is not realistic to test for all of them. Before an organic compound can be in your drinking water, there must be a source of that compound. Therefore, laboratory water testing tends to focus on the compounds that could be found in your area. Table 5 in the Appendix is a listing of the federally regulated organic compounds and their limit in drinking water.

Radionuclides

A radionuclide is an atom that has an unstable nucleus. As these atoms seek stability, they emit (or radiate) subatomic particles, such as alpha and beta particles and photons. These high-energy particles can damage tissue and cause cancer. Radionuclides are a concern in drinking water because radionuclides occur naturally in the environment and can be dissolved in water. According to the United States Geological Survey (USGS), radionuclides, such as uranium and thorium, are part of the natural geology, and as water passes through rock formations that contain uranium or thorium minerals, these minerals can dissolve in the water (DeSimone et al., 2014). In drinking water, radionuclides are regulated by the radiation intensity produced by a water sample rather than the concentration of radioactive compounds. Table 6 in the Appendix is a list of the federally regulated radionuclides and their limits in drinking water.

Measures of Concentration

Water quality standards are mostly given in units of concentration – the mass of a constituent in a volume of water. The most common units of concentration are milligrams per liter (mg/L). Considering that 1 mL of water has 1 gram of mass and recalling that there are 1000 mL per liter and 1000 milligrams per gram, we can say that is 1,000,000 milligrams per liter of water. Thus, we can equate a concentration (mg/L) to parts per million parts or ppm. As such, if we have 5 mg/L of nitrate in our drinking water, then we often say that we have 5 ppm of nitrate. For very low concentrations, the common units of concentration are microgram per liter (µg/L) and nanogram per liter (ng/L). A microgram per liter is equivalent to parts per billion (ppb) and a nanogram per liter is equivalent to one part per trillion (ppt).

If we assume that 1 mL of water is composed of 20 drops, then 1 ppm is equivalent to four drops of ink in a 55-gallon barrel full of water. Likewise, 1 ppb is equivalent to one drop of ink in 132,000 gallons, and 1 ppt is one drop of ink in 200 Olympic-sized swimming pools.

Secondary Drinking Water Standards

The secondary drinking water standards represent waterborne constituents that are a nuisance rather than harmful. These constituents are divided into three categories: aesthetic effects, cosmetic effects and technical effects.

Aesthetic Effects

Aesthetic effects are taste, odor and color. Taste and odor are mostly influenced by the minerals that are dissolved in the water. Once people become accustomed to their water supply, they tend to think the water is tasteless – it tastes neither good nor bad. Generally speaking, only when they receive water from a different source do they notice the water has a different taste. Much of Middle and East Tennessee are underlain by carbonate rock, and as water flows through these formations, calcium and magnesium will dissolve into the water. West Tennessee has sand and gravel aquifers, which contain minerals that do not readily dissolve in water, and thus the water has a different taste. Again, the taste is neither good nor bad – it is just different. Table 8 in the Appendix provides examples of the many types of minerals that can be found in groundwater.

In Tennessee, water taste and odor become more problematic when the geology contains sulfur, iron, copper, zinc and chloride. At low concentrations, these elements are not harmful to consume but can impart strong, undesirable tastes and odor to drinking water. Household water treatment systems are available that can remove most taste and odor compounds. Many of these devices work by changing the pH of the water and forces undesirable compounds to

precipitate out of solution. Other devices use resins that have the opposite charge as the malodorous compounds, the compounds bind with the resin and are occasionally backflushed out of the treatment system.

Cosmetic Effects

Most public water systems add fluoride to water to help prevent tooth decay. However, too much fluoride can lead to tooth discoloration. Water that is sourced from fluoride-rich aquifers could have an undesirable cosmetic effect on the consumers, but it not considered to be harmful. On the contrary, private water supplies have no additional fluoride. Pediatricians, doctors and dentists recommend these people supplement with dietary fluoride.

Technical Effects

Technical effects relate to the damage water can do to water processing equipment, the distribution system and household plumbing. The most common technical effect Tennesseans contend with is mineral precipitation or scaling. As mentioned above, much of Tennessee has water with dissolved calcium and magnesium. These minerals can precipitate out of solution and form hard mineral deposits within pipes, water heaters, dishwashers and bathtubs. The infamous bathtub ring is formed when soap reacts with calcium and forms the ring around the tub. Nearly all detergents contain compounds that trap dissolved minerals and prevent them from precipitating out on clothing, dishes, sinks and bathtubs. A second common technical effect is dissolved iron. Under anaerobic conditions (without dissolved oxygen), iron can dissolve in groundwater. When the water is exposed to oxygen, the iron will form an insoluble precipitate and leave a red stain on plumbing fixtures and clothes.

As listed in Table 7 in the Appendix, the limits on these 15 constituents are guidelines rather than enforceable standards. Because these limits are guidelines, public water systems can distribute water that has constituents in excess of the U.S. EPA standards. Aesthetic and technical effects are the most common reason that people will have their water tested. If your household experiences problems with secondary contaminants, there are home-based water treatment systems that can effectively remove most of these constituents. A simple activated carbon filter attached to your water supply line can remove many of the taste and odor constituents. When choosing a water treatment device, it is a good practice to look for devices that are certified by NSF International. The U.S. EPA provides [more information about secondary contaminants](#).

Hard versus Soft Water: While the primary focus of this bulletin has been on testing your drinking water for safe consumption, many people have their water tested for aesthetic reasons. In Tennessee, the most common reason for water testing is hardness. Hard water is a colloquial term meaning that it is “hard” to get soap to lather. This effect is due to the excessive concentration of dissolved minerals, mostly calcium and magnesium. Hard water is also responsible for the mineral deposits in pipes and water heaters. Water softeners remove these dissolved minerals by exchanging the calcium and magnesium ions for sodium, which is the reason salt is added to water softeners.

How can I get my water tested?

Public water systems must test their water for many chemicals. By rule, the laboratories performing these analyses must have a state certification for each of the tests they perform for public water systems. As a consumer, you do not have to use a state certified laboratory to test your water; however, having this certification ensures that the analysis will be conducted by knowledgeable personnel using up-to-date instruments.

The current list of Tennessee certified laboratories is available from the [TDEC-DWR Laboratory Certification Program webpage](#).

For convenience, a list is provided in the Appendix. This list (Table 9) only includes laboratories located in Tennessee and are not located at Department of Defense and Department of Energy facilities. This list is current as of August 27, 2021.

Appendix

Tables 1-6 list the constituents that must be monitored by public water systems. These constituents and their limits are taken from the [U.S. EPA National Primary Drinking Water Regulations](#).

Table 1. List of microorganisms that are enumerated by public water suppliers as required by the National Primary Drinking Water Regulations.

Contaminant	Max. Contaminant Level (mg/L)	Sources of Contaminant in Drinking Water
<i>Cryptosporidium</i>	zero	Human and animal fecal waste
<i>Giardia lamblia</i>	zero	Human and animal fecal waste
Heterotrophic plate count (HPC)	N/A ¹	HPC measures a range of bacteria that are naturally present in the environment
Legionella	N/A ²	Found naturally in water; multiplies in heating systems
Total Coliforms (including fecal coliform and <i>E. Coli</i>)	zero	Coliforms are naturally present in the environment; as well as feces; fecal coliforms and <i>E. coli</i> only come from human and animal fecal waste
Turbidity	Greater than 0.3 NTU in 95 percent of samples ³	Soil runoff
Viruses (enteric)	99.99 percent removal	Human and animal fecal waste

¹Not a direct measure of pathogens – must be less than 500 colonies per mL.
²No numeric limit – if Giardia and virus are inactivated, legionella should be inactivated.
³NTU – nephelometric turbidity units – measure of water cloudiness. Turbidity can harbor microorganisms.

Table 2. List of disinfectants that are measured by public water suppliers as required by the National Primary Drinking Water Regulations.

Contaminant	Max. Contaminant Level (mg/L)	Sources of Contaminant in Drinking Water
Chloramines (as Cl ₂)	MRDL=4.0 ¹	Water additive used to control microbes
Chlorine (as Cl ₂)	MRDL=4.0 ¹	Water additive used to control microbes
Chlorine dioxide (as ClO ₂)	MRDL=0.8 ¹	Water additive used to control microbes

¹Maximum residual disinfectant level (MRDL)

Table 3. List of disinfection by-products that are measured by public water suppliers as required by the National Primary Drinking Water Regulations.

Contaminant	Max. Contaminant Level (mg/L)	Sources of Contaminant in Drinking Water
Bromate	0.010	Byproduct of drinking water disinfection
Chlorite	1.0	Byproduct of drinking water disinfection
Haloacetic acids (HAA5)	0.060	Byproduct of drinking water disinfection
Total Trihalomethanes (TTHMs)	0.080	Byproduct of drinking water disinfection

Table 4. List of inorganic chemicals that are measured by public water suppliers as required by the National Primary Drinking Water Regulations.

Contaminant	Max. Contaminant Level (mg/L)	Sources of Contaminant in Drinking Water
Antimony	0.006	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder
Arsenic	0.010	Erosion of natural deposits; runoff from orchards; runoff from glass and electronics production wastes
Asbestos (fiber greater than 10 micrometers)	7 million fibers per L	Decay of asbestos cement in water mains; erosion of natural deposits
Barium	2	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Beryllium	0.004	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace and defense industries
Cadmium	0.005	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints
Chromium (total)	0.1	Discharge from steel and pulp mills; erosion of natural deposits
Copper	1.3	Corrosion of household plumbing systems; erosion of natural deposits
Cyanide (as free cyanide)	0.2	Discharge from steel/metal factories; discharge from plastic and fertilizer factories
Fluoride	4.0	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories
Lead	0.015	Corrosion of household plumbing systems; erosion of natural deposits
Mercury (inorganic)	0.002	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands
Nitrate (measured as Nitrogen)	10	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits
Nitrite (measured as Nitrogen)	1	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits
Selenium	0.05	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines
Thallium	0.002	Leaching from ore-processing sites; discharge from electronics, glass and drug factories

Table 5. List of organic compounds that are measured by public water suppliers as required by the National Primary Drinking Water Regulations.

Contaminant	Max. Contaminant Level (mg/L)	Sources of Contaminant in Drinking Water
Acrylamide	*1	Added to water during sewage/wastewater treatment
Alachlor	0.002	Runoff from herbicide used on row crops
Atrazine	0.003	Runoff from herbicide used on row crops
Benzene	0.005	Discharge from factories; leaching from gas storage tanks and landfills
Benzo(a)pyrene (PAHs)	0.0002	Leaching from linings of water storage tanks and distribution lines
Carbofuran	0.04	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	0.005	Discharge from chemical plants and other industrial activities
Chlordane	0.002	Residue of banned termiticide
Chlorobenzene	0.1	Discharge from chemical and agricultural chemical factories
2,4-D	0.07	Runoff from herbicide used on row crops
Dalapon	0.2	Runoff from herbicide used on rights of way
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples and orchards
o-Dichlorobenzene	0.6	Discharge from industrial chemical factories
p-Dichlorobenzene	0.075	Discharge from industrial chemical factories
1,2-Dichloroethane	0.005	Discharge from industrial chemical factories
1,1-Dichloroethylene	0.007	Discharge from industrial chemical factories
cis-1,2-Dichloroethylene	0.07	Discharge from industrial chemical factories
trans-1,2-Dichloroethylene	0.1	Discharge from industrial chemical factories
Dichloromethane	0.005	Discharge from drug and chemical factories
1,2-Dichloropropane	0.005	Discharge from industrial chemical factories
Di(2-ethylhexyl) adipate	0.4	Discharge from chemical factories
Di(2-ethylhexyl) phthalate	0.006	Discharge from rubber and chemical factories
Dinoseb	0.007	Runoff from herbicide used on soybeans and vegetables
Dioxin (2,3,7,8-TCDD)	0.00000003	Emissions from waste incineration and other combustion; discharge from chemical factories
Diquat	0.02	Runoff from herbicide use
Endothall	0.1	Runoff from herbicide use
Endrin	0.002	Residue of banned insecticide
Epichlorohydrin	*1	Discharge from industrial chemical factories; an impurity of some water treatment chemicals
Ethylbenzene	0.7	Discharge from petroleum refineries

Ethylene dibromide	0.00005	Discharge from petroleum refineries
Glyphosate	0.7	Runoff from herbicide use
Heptachlor	0.0004	Residue of banned termiticide
Heptachlor epoxide	0.0002	Breakdown of heptachlor
Hexachlorobenzene	0.001	Discharge from metal refineries and agricultural chemical factories
Hexachlorocyclopentadiene	0.05	Discharge from chemical factories
Lindane	0.0002	Runoff/leaching from insecticide used on cattle, lumber, gardens
Methoxychlor	0.04	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock
Oxamyl (Vydate)	0.2	Runoff/leaching from insecticide used on apples, potatoes and tomatoes
Polychlorinated biphenyls (PCBs)	0.0005	Runoff from landfills; discharge of waste chemicals
Pentachlorophenol	0.001	Discharge from wood preserving factories
Picloram	0.5	Herbicide runoff
Simazine	0.004	Herbicide runoff
Styrene	0.1	Discharge from rubber and plastic factories; leaching from landfills
Tetrachloroethylene	0.005	Discharge from factories and dry cleaners
Toluene	1	Discharge from petroleum factories
Toxaphene	0.003	Runoff/leaching from insecticide used on cotton and cattle
2,4,5-TP (Silvex)	0.05	Residue of banned herbicide
1,2,4-Trichlorobenzene	0.07	Discharge from textile finishing factories
1,1,1-Trichloroethane	0.2	Discharge from metal degreasing sites and other factories
1,1,2-Trichloroethane	0.005	Discharge from industrial chemical factories
Trichloroethylene	0.005	Discharge from metal degreasing sites and other factories
Vinyl chloride	0.002	Leaching from PVC pipes; discharge from plastic factories
Xylenes (total)	10	Discharge from petroleum factories; discharge from chemical factories
¹ This compound is monitored only if used as part of the water treatment process.		

Table 6. List of radionuclides that are measured by public water suppliers as required by the National Primary Drinking Water Regulations.

Contaminant	Max. Contaminant Level	Sources of Contaminant in Drinking Water
Alpha particles	15 picocuries per Liter (pCi/L)	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation
Beta particles and photon emitters	4 millirems per year	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation
Radium 226 and Radium 228 (combined)	5 pCi/L	Erosion of natural deposits
Uranium	30 ug/L	Erosion of natural deposits

[Table of Secondary Standards](#)

Table 7. Measures of water quality and compounds that are included on the U.S. EPA list of secondary drinking water standards.

Contaminant	Secondary MCL	Noticeable Effects Above the Secondary MCL
Aluminum	0.05 to 0.2 mg/L	colored water
Chloride	250 mg/L	salty taste
Color	15 color units	visible tint
Copper	1.0 mg/L	metallic taste; blue-green staining
Corrosivity	Non-corrosive	metallic taste; corroded pipes/fixtures staining
Fluoride	2.0 mg/L	tooth discoloration
Foaming agents	0.5 mg/L	frothy, cloudy; bitter taste; odor
Iron	0.3 mg/L	rusty color; sediment; metallic taste; reddish or orange staining
Manganese	0.05 mg/L	black to brown color; black staining; bitter metallic taste
Odor	3 threshold odor number	rotten egg, musty or chemical smell
pH	6.5 - 8.5	low pH: bitter metallic taste; corrosion high pH: slippery feel; soda taste; deposits
Silver	0.1 mg/L	skin discoloration; graying of the white part of the eye
Sulfate	250 mg/L	salty taste
Total Dissolved Solids (TDS)	500 mg/L	hardness; deposits; colored water; staining; salty taste
Zinc	5 mg/L	metallic taste

Table 8. List of Dissolved Inorganic Constituents in Groundwater – from Freeze and Cherry 1976.

Major constituents (greater than 5 mg/L)			
Bicarbonate	Calcium	Chloride	Magnesium
Silicon	Sodium	Sulfate	Carbonic Acid
Minor Constituents (0.01 to 10 mg/L)			
Boron	Carbonate	Fluoride	Iron
Nitrate	Potassium	Strontium	
Trace Constituents (less than 0.1 mg/L)			
Aluminum	Antimony	Arsenic	Barium
Beryllium	Bismuth	Bromide	Cadmium
Cerium	Cesium	Chromium	Cobalt
Copper	Gallium	Germanium	Gold
Indium	Iodide	Lanthanum	Lead
Lithium	Manganese	Molybdenum	Nickel
Niobium	Phosphate	Platinum	Radium
Rubidium	Ruthenium	Scandium	Selenium
Silver	Thallium	Thorium	Tin
Titanium	Tungsten	Uranium	Vanadium
Ytterbium	Yttrium	Zinc	Zirconium

Table 9. Laboratories approved for drinking water analyses located within the state of Tennessee¹.

Laboratory ²	Tennessee Certification held for these Parameters
AIRL, Inc. 550 37th Street NE Cleveland, TN 37312 423-476-7766	turbidity, corrosivity, pH, sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, bromate, total coliform, fecal coliform, and <i>E. coli</i> .
Assured Bio Labs. 228 Midway Lane, Suite B, Oak Ridge, TN 37830 865-813-1700	Total coliform and <i>E.coli</i> .
Industrial Microbiological Labs., Inc. 451 First Street NW Cleveland, TN 37311 423-476-7717	Total coliform, fecal coliform and <i>E. coli</i> .
Microbac - Knoxville Division 505 East Broadway Avenue Maryville, TN 37804 865-977-1200	Disinfection byproducts, total coliform, <i>E. coli</i> , turbidity, corrosivity, pH, sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, and bromate
Microbac Laboratories, Inc - Nashville 640 Spence LN, Suite 121 Nashville, TN 37217 615-242-1480	Total Coliform, <i>E.coli</i> , turbidity, corrosivity, pH

Microbac Laboratories, Inc. - Tri Cities 2109 West Market Street Johnson City, TN 37604 423-926-6385	Total Coliform and <i>E. coli</i> .
NSA KJS Joint Venture MidSouth - Millington P. O. Box 54291 Millington, TN 38054 901-874-5792	Total Coliform and <i>E. coli</i> .
Pace Analytical National Center for Testing & Evaluation (ESC) 12065 Lebanon Road Mount Juliet, TN 37122-2605 615-758-5858	Disinfection byproducts, total coliform, <i>E. coli</i> ., turbidity, corrosivity, pH, sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, bromate, and organics
Premium Waters 1614 Industrial Road Greeneville, TN 37745 423-787-0457	Total coliform and <i>E.coli</i> .
Teledyne Brown Engineering, Inc. 2508 Quality Lane Knoxville, TN 37931-3133 865-934-0393	Radiochemistry
Tennessee Tech. University Water Center PO Box 5033 Cookeville, TN 38505 931-372-3061	Disinfection byproducts, total coliform, <i>E. coli</i> ., turbidity, corrosivity, pH, sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, and bromate
TestAmerica Knoxville 5815 Middlebrook Pike Knoxville, TN 37921 865-291-3000	Sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, bromate, and organics
Waypoint Analytical, LLC 2790 Whitten Road Memphis, TN 38133 901-213-2400	Disinfection byproducts, total coliform, <i>E. coli</i> ., turbidity, corrosivity, pH, sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, bromate and organics
Waypoint Analytical, LLC (prev TEC Environmental) 2269 Dr. F. E. Wright Drive Jackson, TN 38305 731-423-5315	Total coliform, <i>E. coli</i> ., sodium, nitrite, nitrate, fluoride, sulfate, cyanide, asbestos, chlorite, and bromate
¹ This list does not include certified laboratories that are located at Department of Defense and Department of Energy facilities or are located out of state.	
² This list is adapted from the State of Tennessee Laboratories Approved for Drinking Water Analyses, found at https://www.tn.gov/content/dam/tn/environment/water/drinking-water-unit/wr_wq_dw_approved-commercial-labs.pdf (accessed January 3, 2020). Questions about Tennessee's certified laboratory program should be directed TDEC Water Supply Branch at 615-532-0191.	

References and Other Useful Links

DeSimone, L.A., McMahon, P.B., and Rosen, M.R., 2014, The quality of our Nation's waters—Water quality in Principal Aquifers of the United States, 1991–2010: U.S. Geological Survey Circular 1360, 151 p., <http://dx.doi.org/10.3133/cir1360>.

Freeze, R. A. and J. A. Cherry. (1979) Groundwater. Prentice Hall, Inc., Englewood Cliffs, New Jersey, USA.



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