A Guide to the National Drinking Water Standards and Private Water Systems

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Introduction

Is your water safe to drink? Does it smell funny or is it cloudy or off-color? Local news stories about chemical spills, leaking oil tanks, toxic waste sites, and pesticide use may make you wonder about what is in your water. Whether you get your water from a public or a privately-owned public water system, or your own well or spring, having a safe source of drinking water is vital to the health of you and your family.

Throughout this document, references will be made to public water systems and private water systems. For definition purposes, public water systems (suppliers) serve more than 25 people and have 15 or more service connections. Private water systems include domestic wells and springs, and publicly-owned private water systems with less than 15 service connections and serve less than 25 people, such as a small housing development. People who get their water from a public water system have more protection from potential contamination because federal and state regulations require monitoring and remediation by public water suppliers to ensure a clean supply of water. But, private water system users are solely responsible for the quality of their drinking water and must act on their own to correct any problems that occur with their water supply.

The purpose of this document is to provide general information about drinking water contaminants, the National Drinking Water Standards, and home water treatment systems. Private water system users can use this information to determine what steps should be taken if they suspect a problem with their drinking water.

Learning About Water

In science class we learned that water is made up of two hydrogen atoms and one oxygen atom. That sounds fairly simple. However, the water from public and private water systems rarely contains only hydrogen and oxygen.

Because water is a universal solvent, many materials dissolve in it. Water found in nature generally contains a variety of contaminants such as minerals, salts, heavy metals, organic chemicals (contains carbon and can occur naturally or be man-made), radioactive residues, and living materials such as parasites, fungi, and bacteria. These materials enter water through natural processes, such as contact with rocks, soil, decaying plant and animal matter, and other materials. Industrial and agricultural sources can introduce chemical and pesticide residues into water. The primary contributors to microbiological contamination of water are human and animal wastes.

Sources of Water

According to the Environmental Protection Agency's (EPA) 1992 report to Congress on The Quality of our Nations's Waters1, 95 percent of all the fresh water available (excluding icecaps) comes from ground water. Surface water (streams, lakes, rivers, and reservoirs) make up the balance of available water. In the U.S., 53 percent of the population relies to some extent on ground water as a source of drinking water. About 8 of every 10 Virginians use ground water for at least part of their daily water supply, whether from public water systems or private water systems.

Contaminated Water May Not Be Bad Water

When most people see or hear the word contaminated, it signals danger or disease. However, the official federal definition defines a contaminant as "any physical, chemical, biological, or radiological substance or matter in water."2 Whether water is safe to drink depends on the specific contaminants it contains, how much of each contaminant is present, and how these contaminants affect human health.

Sometimes, water that is cloudy or slightly off-color may not be dangerous to drink, while water that is perfectly clear may contain tasteless, odorless, and colorless contaminants with serious health effects. Some substances in small concentrations, such as iron, are good for human health. Others, such as fluoride, may be beneficial at low levels and cause potential health problems at higher levels.

A contaminant's threat to human health depends on a variety of factors:

- the toxicity of the contaminant (toxic means poisonous)
- the concentration level poses a health risk
- the amount of water a person drinks
- the sensitivity of different people to specific contaminants (for example, children, elderly people, individuals with weakened immune systems, and pregnant women may be at greater risk)
- the ways different contaminants in the water combine to become more or less toxic
  the nature of the contaminant (chemical or living)

Biological contaminants are the most common type of health-threatening contaminants. Federal and state regulation requirements and improved water treatment systems have reduced, but not eliminated, the threat of bacterial outbreaks for people on public water systems. However, people using private water systems usually have no disinfection treatment system and the possibility of bacterial contamination presents the greatest threat to their water supply.

Sources of Bacterial Contaminants

Septic systems, sewage treatment plants, and runoff from wood-lands, pastures, and animal feedlots are potential sources of biological contamination. Bacteria is usually not found in ground water unless the water is contaminated by waste materials and filtered through an improperly constructed well. This can be a problem, especially when wells are constructed in coarse textured soil and fractured bedrock or limestone. Private water systems can be contaminated if septic systems or sewage lines are close to the water source or are not working properly. Leachate from livestock operations and illegal landfills and dumps may also contaminate drinking water sources with bacteria.

While almost all surface waters contain some bacteria, most coliform bacteria enter streams through runoff from areas with high concentrations of animal and human activities. Coliform bacteria live in human and animal intestines, decaying plant materials, and in the soil. While not a health hazard themselves, coliform bacteria found in your drinking water are a good indicator that your water may be contaminated with other, more harmful, bacteria such as giardia or cryptosporidium, that can cause serious illness.

Other contaminant sources

Other drinking water contaminants and sources include pesticides, de-icing salts, synthetic chemicals, heavy metals, petroleum products, chemical fertilizers, leaking chemical storage tanks, wastewater from factories, and runoff from highways, parking lots, and suburban lawns.

Does Your Water Come From A Public or Private Water System?

If your water comes from a public water system, federal and state regulations require the supplier to test regularly for a variety of contaminants to ensure that the water is safe to drink. The test results are public information and are available for review by the customer. Call your water utility to see these reports.

A sample of a public water system report

Water that comes from a private water system is not regulated by state and federal laws. You are responsible for the water quality. However, the National Primary Drinking Water Standards can be used by private water system users to decide if there is a potential problem with their drinking water. The next section explains how the regulations were developed and how they can be applied to a private water system.

Setting Safe Drinking Water Standards For Public Water Systems

The Safe Drinking Water Act

P.L. 93-523, the Safe Drinking Water Act (SDWA) enacted on December 16, 1974, was designed to protect public drinking water supplies from harmful contaminants. The goal was to provide safe drinking water to citizens served by public water systems (serving 25 or more persons regularly or a system with 15 or more service connections). Congress gave the U.S. Environmental Protection Agency (EPA) the authority to establish acceptable or "safe" levels for known or suspected drinking water contaminants and to design a national drinking water protection program.

Between 1974 and 1986, the EPA had developed standards for 22 contaminants and the SDWA was amended four times: (1) in November 1977 by P.L. 95-190; (2) in September 1979 by P.L. 96-63; (3) in December 1980 by P.L. 96-502; and (4) in June 1986 by P.L. 99-339. The 1986 amendments increased EPA's enforcement authority and included provisions requiring EPA to develop regulations for 83 specific contaminants by June 1989.

In addition, the law required the EPA to regulate 25 additional contaminants every three years. Since 1986, the EPA has issued seven major regulations that establish standards for either a specific contaminant or groups of contaminants. Under these guidelines, the EPA set standards called **maximum contaminant levels (MCLs)** for each contaminant. In 1988, the 100th Congress added the Lead Contamination Control Act, P.L. 100-572, to the SDWA. This legislation was intended to reduce the exposure to lead in drinking water.

The standards are enforced through regulations requiring public water systems to test for contaminants and install new types of filters or adopt other appropriate treatment methods if the test results indicate contaminants have entered the drinking water system. These standards only apply to public water systems, but they can serve as a guide to water quality for private water systems. A list of the National Primary Drinking Water Regulations (NPDWR) is included in Appendix A.

Secondary Drinking Water standards, or **Secondary Maximum Contaminant Levels (SMCLs)**, are concentration limits for nuisance contaminants and physical problems, such as offensive taste, color, odor, corrosivity, foaming, and staining. The Secondary Standards are not enforced, and public water systems are not required to test for and remove secondary contaminants. However, these standards are useful guidelines for private water system users who want to ensure that their water will be suitable for all household uses. The Secondary Maximum Contaminant Levels are included in Appendix B.

A laboratory analysis will identify the concentration of certain contaminants in your water. A good way to determine if there is a problem with your water supply is to compare your test results with the federal standards in Appendix A and B. For more information on water testing, see page 13.

Establishing the Maximum Contaminant Level Goal and Maximum Contaminant Level

The **Maximum Contaminant Level Goal (MCLG)**, is a health-based standard that serves as a goal in setting the legally enforceable standards. Scientists evaluate the potential human health threat of each contaminant. They use data from experiments on laboratory animals, such as rats and mice, to answer some basic questions about the contaminant's effects on mammals. Also, the scientists find out whether workers exposed to the contaminant in factories or other workplaces have ever suffered any health problems. Surveys of the contaminant's occurrence in food, air, and water are used to determine how likely people are to be exposed to it.

From these animal studies and surveys, a figure called the Acceptable Daily Intake (ADI) is calculated for chemicals that cause adverse health effects other than cancer. The ADI is used to establish the MCLG. However, the MCLG is not a legally enforceable standard.

All this information is used to set the **Maximum Contaminant Level (MCL)**, the amount of the contaminant in drinking water that the EPA has decided will not endanger human health over a lifetime of exposure. People drinking a typical amount of water (two liters per day for adults, one liter for children) during their average lifetime (70 years) with a contaminant at or below the MCL should not be endangered by the contaminant.

The enforceable standard is the Maximum Contaminant Level (MCL) and it is set as close as possible to the MCLG. In setting the MCL, factors other than health effects are considered, i.e., testing feasibility, and the combined cost of analyzing and treating the water to remove a contaminant. Often, the MCL is less stringent than the MCLG.

The Maximum Contaminant Level Goal and Maximum Contaminant Level are expressed in the scientific units of concentration listed in Table 1. These units of measurement are used in the National Primary Drinking Water Standards in Appendix A, and the Secondary Drinking Water Standards in Appendix B.

Table 1. Units of Measurement

Concentration
parts per million (ppm) = (approximately) milligrams per liter (mg/l)
parts per billion (ppb) = (approximately) micrograms per liter (µg/l)
grains per gallon (gpg) = 17.1 milligrams/liter
Numbers
million = 1,000,000
billion = 1,000,000,000
trillion = 1,000,000,000,000
quadrillion = 1,000,000,000,000,000
Radioactivity
curie = 3.7 x 1010 disintegrations per second
picocurie (pCi) = 0.000000000001 curie = 1.0 x 10-12 curie (3.7 x 10-2 disintegrations per second)

half-life = the time required for half the atoms of a radioactive substance to disintegrate
rem = the dosage of radiation that will cause the same biological effect as one roentgen of X-ray or gamma-ray dosage (Roentgen Equivalent Man)
millirem (mrem) = 0.001 rem = 1.0 x 10-3 rem
roentgen = an international standard unit of X-ray or gamma-ray radiation

Water Testing

Because you'll have to pay a laboratory to test your water, you want to be able to tell them what tests you want done. The cost would be enormous to test for every possible harmful contaminant " petroleum products, pesticides, heavy metals, bacteria, nitrate, volatile organic compounds, and/or radioactive substances. You need to decide what specific contaminants you are concerned about and why you want your water tested for them. Homeowners with private water systems should test for bacteria at least once a year and for selected chemicals (see table 2) every three years. However, other situations may require additional testing. Your water quality may be affected by where you live or what is located near your water supply. Also, Table 2 provides some guidelines on conditions that may prompt you to have your water tested more frequently.

If your water changes taste, odor, or color suddenly, you may want to contact the local health department or the Department of Environmental Quality (DEQ) regional office closest to you for advice before you begin paying for any tests. A list of DEQ's regional offices can be found on page 50.

Testing for Bacteria

The Virginia Department of Heath recommends that private water systems be tested for bacterial contamination at least once a year or with reoccurring gastrointestinal illnesses. A total coliform test is the test most often done. If the total coliform test shows a "total coliform positive", then a fecal coliform test should be performed. Coliform bacteria is present in the intestine of humans and animals and is transmitted through waste materials. The presence of fecal coliform bacteria in a sample indicates that the water has been polluted with the feces of humans or other animals. Some illnesses attributed to bacteria and other microbiological organisms include gastroenteritis, dysentery, hepatitis, and typhoid fever.

Table 2. When to Test Your Water

Conditions or nearby activities	Recommended test
recurrent gastrointestinal illness	coliform bacteria
household plumbing contains lead	pH, alkalinity, hardness, lead, copper
radon in indoor air or region	radon
scaly residues, soaps don't lather	hardness
water softener to treat hardness	manganese, iron (before purchase)
stained plumbing fixtures, laundry	iron, copper, manganese

objectionable taste or smell	hydrogen sulfide, corrosion, ph, alkalinity, hardness, metals
water is cloudy, frothy, or colored	color, detergents
corrosion of pipes, plumbing	corrosion, pH, lead, copper, alkalinity
rapid wear of water treatment equipment	pH, corrosion, alkalinity, hardness
nearby areas of intensive agriculture	nitrate, pesticides, coliform bacteria
nearby coal, other mining operation	metals, pH, corrosion
gas drilling operation nearby	chloride, sodium, barium, strontium
gasoline or fuel oil odor	volatile organic compounds (VOCs)
dump, landfill, factory or dry-cleaning operation nearby	VOCs, pH, sulfate, chloride, metals
salty taste and seawater, or a heavily salted roadway nearby	chloride, TDS, sodium

Other diseases more recently associated with waterborne micro-organisms are giardiasis and crypotosporidiosis. Symptoms characterizing waterborne illnesses are nausea, abdominal pains, dehydration, and diarrhea. While usually non fatal, these illnesses can cause mild to severe discomfort, and result in economic loss from medical expenses and loss of employment time. Giardia is the most frequently identified organism associated with a waterborne illness. Cryptosporidium, a protozoan similar to the one that causes giardiasis, produces symptoms like giardiasis but they are more severe. The incubation period varies from 2 to 12 days, and symptoms can last for 10 to 14 days or longer. For more information about these waterborne illnesses, contact your local health department or the Virginia Department of Health state office.

If you suspect that any physical problem you are experiencing may be caused by your drinking water, consult your physician. If the water sample is accompanied by letters from a physician and a local health director, the state's Division of Consolidated Laboratory Services (DCLS) will test (free of charge) private water system samples for bacteriological contamination.

Testing for Chemicals

Inorganic chemicals are metals, salts, and other chemical compounds that do not contain carbon. Some of the inorganic chemicals for which EPA has set federal standards include asbestos, fluoride, barium, cadmium, chromium, mercury, nitrate, nitrite, selenium, antimony, beryllium, cyanide, nickel, thallium, lead, and copper.

Not all of these inorganic chemicals indicate human-caused contamination. For example, in some areas of Virginia, naturally occurring concentrations of fluoride in ground water exceed the proposed federal standard. Excess amounts of sodium fluoride can damage the immune system.

Copper, a common and essential element used by humans and animals, is found in rocks, soil, water, and air. It is mined extensively in the U.S. and is used in the manufacture of wire, sheet metal, pipe (sometimes used in private water systems), and other metal products. Also, copper is used in the treatment of plant diseases, water treatment, and as a preservative for wood, leather, and fabrics. High intakes of copper can cause liver damage and gastrointestinal irritation.

One of the most common inorganic contaminants found in rural water supplies is nitrate. Its presence in your private water system may indicate contamination from a failing septic system, farm animal feedlots, or fertilizers used on gardens, lawns, and farm fields (Figure 3). Analyses of inorganic chemicals can cost between $150 and $300 or more, depending on the laboratory and the number of tests done. If tests show a nitrate level of 10 ppm or higher (this is the enforceable standard for water from a public water supply), pregnant women and infants under six months should use an alternative water supply.

Inorganic chemicals, such as lead and copper, can also be introduced by your plumbing system. Leaching from lead pipe and lead-based solder pipe joints used in your home's plumbing may allow lead to enter your water supply. Toxic levels of lead can cause kidney and nerve damage, low birth weights, and mental impairment in fetuses, infants, and children. Sources of copper in private water systems are often found in conjunction with copper plumbing and a low pH.

If your private water system is in an area of intensive agricultural use, test for the pesticides commonly used in that region. You also may want to test for inorganic chemicals that can cause taste, odor, staining, or color problems. These include iron, manganese, and sulfate. These chemicals may not make your water unsafe to drink, but may be a nuisance. Some common water problems that can be identified by odor, taste, or color are listed in Table 3.

Organic Chemicals are compounds that contain carbon and occur naturally or be manufactured for a variety of uses. These chemicals are divided into four categories: synthetic organic chemicals, volatile organic chemicals, polychlorinated biphenyls (PCBs), and disinfection by-products. Synthetic organic chemicals are used in industrial and agricultural products such as pesticides. If ingested, these contaminants can cause liver, kidney, and nervous system damage, and may be carcinogenic. Degreasing agents, varnishes, paint thinners, some pesticides, and petroleum products are included in the volatile organic chemical (VOCs) classification. Health problems associated with VOCs include liver, kidney, and nerve disorders. PCBs are found in electrical transformers and capacitors, and as fluid in vacuum pumps and compressors. The use of PCBs has been banned in new products. However, residues of old products still remain in the environment. Disinfectants used in water treatment systems may form organic by-products. For example, chloroform is a by-product of chlorination and in high levels, may be carcinogenic. If organic chemicals are stored, manufactured, or used near your water supply or you suspect your water is contaminated, you should have your water tested. However, the tests are expensive. Ask the water-testing lab about the cost before you send a water sample.

Table 3. Common Water Problems

Symptoms	Probable Cause
Color	
yellowish water; yellow stains on china, bathroom fixtures, laundry	tannins (harmless acids) from nature

brownish water; brownish slime in toilet tanks	iron bacteria
blue-green water; green stains on sink and and porcelain fixtures	copper dissolved from pipes and connections
green or blue ice cubes	acid water dissolving copper from line to ice maker
black stains on laundry and fixtures	manganese
yellow, black stains on bathroom fixtures; tarnished silverware	hydrogen sulfide
reddish-brown material that settles out (rusty water from faucet)	precipitated iron from rusty pipes, wells, or ores
reddish-brown stains on fixtures, laundry, dishes (water from faucet appears clear)	dissolved iron
Odor	
rotten egg	hydrogen sulfide
septic or sewage	septic system discharge into groundwater
chlorine	excessive chlorination
gasoline or oil	leak in fuel oil or gas tank
Taste	
salty	high sodium, magnesium
metallic	acid water or high iron
chemical	insecticides or herbicides

Radiological Contaminants, radon, radium, and uranium, occur naturally and are produced through a radioactive decay process. In Virginia, natural levels of radon are mostly found in certain counties of the Piedmont. The inhalation and ingestion of excessive levels of radiological contaminants can cause cancer.

Corrosive or aggressive water can dissolve copper, lead, zinc, and chromium from pipes and pipe connections into drinking water. Corrosivity can be determined by measuring the acidic condition of the water, or the pH value. If your water is corrosive, you also may want to have it tested for metal contaminants including copper, lead, zinc, and chromium. They could be present in your tap water as a result of the corrosion of your plumbing.

Hardness in water, or hard water, generally has calcium and magnesium at levels high enough to interfere with the sudsing and lathering of soaps and detergents. Build up of deposits on the insides of pipes, water-heater elements, and plumbing fixtures can result in higher maintenance costs with increased replacement of water heater elements and pipes. Hard water is rarely a health problem, but can be a nuisance. A white crusty deposit in your tea kettle may be your first indication of hard water. Water treatment may be needed for water with a total hardness of 7.0 grains per gallon (gpg) or greater.

Table 4. Hardness Classification

Concentration of Hardness		
In Grains per gallon (gpg)	**In Milligrams per Liter (mg/L)**	**Relative Hardness Level**
Below 3.5	Below 60	Soft
3.5 to 7.0	60 to120	Moderately Hard
7.0 to 10.5	120 to180	Hard
10.5 and above	180 and above	Very Hard

Source: Interpreting Your Water Test Report, Virginia Cooperative Extension, Extension publication 356-489, Virginia Tech, Blacksburg, VA. Reprinted 1995.

Choose A Certified Laboratory to Test Your Water

Approach water testing laboratories as a smart shopper. Approximately 108 public and private laboratories in Virginia are certified by the Division of Consolidated Laboratory Services (DCLS) to test drinking water quality. More than 100 out-of-state water laboratories are also approved by the DCLS to test water. Contact your local extension or health department office to obtain the names of water testing laboratories closest to you. Each laboratory sets its own prices for water testing. Check with individual laboratories to get prices and the kinds of tests they are certified to perform. For a complete up-to-date list of all state-approved laboratories and the specific tests they are certified to perform, write or call the:

Division of Consolidated Laboratory Services
State Laboratory
1 North 14th St.
Richmond, VA 23219
(804) 786-3411

Most labs test private water system samples as a very small part of their overall workload, so ask about turnaround time (you should be able to get results in two weeks) and about the information that will be provided with the test results. A good lab should help you interpret the results and make sense of the scientific data. Also, contact your local extension or health department office if you need help interpreting your test report. Compare your test results with the EPA's National Primary Drinking Water Standards listed in Appendix A, and the Secondary Drinking Water Standards in Appendix B. While these standards were designed to protect public water system users, they can be used as a guide to determine if you have a problem with your private water system.

How you take the water sample may affect the result. The laboratory you choose to test your water should provide you with specific sampling instructions and clean bottles or small plastic bags in which to collect the sample. Depending on the contaminants you want to test for, the sample may have to be refrigerated or treated with special chemicals. You may need to take a sample from the tap with the first flush of water in the morning or after the tap has been allowed to run for a period of time. If you suspect a problem somewhere in your home plumbing, you may need to take samples from several points " before and after water enters the hot water tank, for example, or at the inlet and outlet of a filtering device.

Follow the instructions carefully for taking samples. Sampling is the most important part of testing. A carelessly collected sample can give you inaccurate results. Also, be careful about when you deliver the sample to the lab. If your sample arrives at the laboratory on a Friday, it may have to sit over the weekend.

Test Results: Learning A New Language

A good laboratory will provide some explanation of your test results, but often that explanation includes only a description of the units used to express results. The **report of analysis**, as some laboratories call test results, can take a variety of forms. It may be a computer printout of results for the specific tests you requested, or a preprinted form with your results typed or written into blocks or spaces. It may include some general information about the laboratory that performs the test and the types of tests that were done, or it may provide only your results.

The amount of a specific contaminant in your water sample will be expressed as a concentration " a specific weight of the substance in a specific volume of water. The most commonly used concentration units for drinking water analyses are provided in Table 1.

The test results also may use other symbols and abbreviations. Laboratory methods have detection limits, or levels below which contaminants cannot be reliably detected. That does not necessarily mean that the chemical is not present. There could be so little present that it cannot be reliably detected with the laboratory equipment or testing procedures being used. This can show up on a laboratory test report in a number of ways. Some laboratories will report the finding as *b.d.l.* (below detection limit) or *n.d.* (not detected). Others will print it as a numerical result using the symbol for "less than" (<). For example, if your report lists a result of *<0.02 mg/l* for chromium, this means that 0.02 mg/l (milligrams per liter) is the detection limit of the test for chromium, and the water had less than 0.02 mg/l chromium in it, if any.

The important question is whether the contaminant poses a health threat at that particular concentration. Compare your water test results to the federal standards and to other guidance numbers, such as health advisories, to assess the potential for health problems.

Health advisories specify levels of contaminants that are acceptable for drinking water over various lengths of time: one-day, ten-day, longer-term (approximately seven years), and lifetime exposures (essentially the same as MCLGs). These standards are not legally enforceable, and may change in the future as new information becomes available.

If you have any questions about what the laboratory report means, call the laboratory and ask. You've paid for the test, and a good laboratory should explain clearly what the results mean. Also, contact the Virginia Department of Health state office, your local health department, or extension office if you have questions about the test results.

If Your Water Doesn't Meet Federal Standards....

Probably the most important thing to keep in mind is that drinking water standards are designed to protect human health over a whole lifetime of drinking water. Call your local health department or extension office for advice if you're concerned about contaminants in your drinking water. Some contamination problems should be solved as quickly as possible. Others may not threaten the health of everyone in the household but may pose a danger to specific members. For example, nitrate may not be of concern to adults or older children, but could threaten the health of infants. Also, many cancer-causing chemicals are a threat only if taken in over many years.

Toxic doses of contaminants can cause either acute or chronic health effects. An acute effect usually follows the ingestion or inhalation of a contaminant and occurs almost immediately. Acute health effects include: nausea, lung irritation, skin rash, vomiting, dizziness, and even death. Chronic health effects include: cancer, birth defects, organ damage, and nervous and immune system disorders.

Giardia, cryptosporidium, and other biological contaminants can cause immediate illnesses such as diarrhea or other more acute symptoms, especially in infants and individuals with compromised immune systems. Unfortunately, testing for biological contaminants is expensive. However, a laboratory test for coliform bacteria is simple and costs around $15. This test is a good indicator of bacteria contamination and could mean that there are other harmful bacteria present in your drinking water.

Your response to a contamination problem also may depend on how much the contaminant concentration exceeds the drinking water Maximum Contaminant Level. You may want to request health advisory documents from the EPA's Safe Drinking Water hotline, (800) 426-4791, Monday through Friday, 8:30 am to 4:30 pm, Eastern Standard Time (EST). Health advisories contain a certain margin of safety and provide a reference guide for decision-making about contaminated water. Unfortunately, health advisories are not always available for every contaminant, for each exposure, and for children and adults. Health advisory documents give the levels and background information about how those levels were determined and what sorts of health effects may be expected.

If your water has contaminants that exceed EPA standards, there are several steps you need to take. First, you need to try to find the source of contamination and eliminate it, if possible. If this action fails to satisfactorily correct the problem, the next step is to decontaminate your water supply using some type of water treatment method or system.

Find the source of the problem. This is the most important step. Unfortunately, it is usually not easy to pin-point the source of contamination, and some contaminants are naturally present. Listed below are some possibilities you may want to consider:

If your water is contaminated by coliform bacteria or nitrate, is it possible that surface runoff from a barnyard or farm animal feedlot has polluted your water supply? Is the well properly sealed, preventing runoff from getting into it? Could your septic system be malfunctioning and allowing contaminants to enter your water supply? Are fertilizers applied to fields or lawns close to the well?

If petroleum contamination is the problem, have you had a spill of gasoline from a gas tank or diesel from a fuel tank? Do you have home heating oil with an underground storage tank or lines that could be leaking? Do you live near a gasoline station or industry with underground or aboveground storage tanks and lines? Have you (or your neighbor) spilled a petroleum product near a water source?

If herbicides or insecticides are detected in your water, do you use such chemicals yourself? Could surface runoff into an improperly sealed well be contributing to the problem? Do you live near a large orchard, in an agricultural area, or next door to a farm chemical manufacturer or distributor? Have you recently had your home treated for termites or other household pests?

If the contaminant is an industrial chemical of some type, you may want to find out if your local newspapers have carried any stories about ground water contamination problems, improper waste disposal, or local hazardous waste sites.

If a toxic or hazardous substance is contaminating your water supply, have these substances been poured or flushed into your household plumbing? These chemicals can pass through your septic system without being treated and contaminate your water supply. In addition, they can destroy the beneficial bacterial action in your septic tank. Such chemicals include paints, varnishes, photographic solutions, paint thinners, waste oils, pesticides, antifreeze, wood preservatives, and household cleaners that contain lye or petroleum distillates. These substances should never be introduced into your septic system.

In karst areas, limestone and dolomite are dissolved by the action of water and form sinkholes, caves, underground drainage systems, and springs. If sinkholes and caves have been used for waste disposal, this can contaminate private water systems.

If you have a well that is no longer usable or has been abandoned, has it been properly sealed to prevent contamination of water supply systems? Has the abandoned well been used to dispose of wastes of any kind?

If you suspect that your private water system is contaminated as a result of a ground water contamination incident, report the problem to the DEQ regional office nearest you. Local health department and extension offices also may be able to help you find the source of your water problem.

If you have found the contamination source, you need to take corrective action to eliminate the contamination before you install a treatment device. Having your well resealed, your spring properly enclosed, or your septic tank pumped out are some actions that you may help to solve the problem.

Options for water cleanup

Water treatment devices can be expensive. Finding a new drinking water source is also costly. Table 5 gives the estimated costs for some options available to the homeowner.

Drill a new well or connect to a public water system. If you are unable to do anything about the source of contamination, you should consider drilling a new well or connecting to a public water system. However, if the contamination is a regional ground water problem, drilling a new well may not be a viable solution.

Table 5. Household Water Cleanup Options and Estimated Costs

Option	Estimated Costs
Water treatment system:	
Activated carbon filtration	Faucet-mounted $25-50
	Under the sink $50-300
	Whole house $500-800
Distillation	Countertop $300-350
	Automatic $600-800
Anion exchange	Whole house $500-800
Reverse osmosis	Single tap $400-600
Bottled water	$7 to $15 weekly for a family of four
New well	$3.50 to $4.50 per inch diameter per foot of depth, plus casing and pump costs
Public system	$12,000+ per household hookup depending on distance to water main, plus monthly water payments

Buy bottled water. In 1992, the average American drank nearly ten gallons of bottled water, three times more than a decade before. Purchasing bottled water is an expensive alternative, and drinking such water does not necessarily solve your problem. Some contaminants can cause health problems whether they are consumed with drinking water or inhaled from the atmosphere. Activities such as showering and doing laundry can cause volatile chemicals to evaporate from water more quickly and contaminate air. Other contaminants may be absorbed through the skin, making showering or bathing in contaminated water a potential health risk.

Even though the EPA regulates public water systems, bottled water is not covered under these regulations. Bottled water is regulated by the U.S. Food and Drug Administration (FDA) under the FDA's Good Manufacturing Practice Regulations (21 C.F.R., Parts 110 and 129). However, on December 1, 1994, the FDA published regulations (21 C.F.R., Parts 129 and 184) requiring all bottled water suppliers to meet the same water quality standards required of public water systems. These regulations became effective May 30, 1995. Because FDA classifies bottled water as food, the Federal Food, Drug, and Cosmetic Act and the Fair Packaging and Labeling Act requirements must also be met. Check the label for the National Sanitation Foundation (NSF) mark. The National Sanitation Foundation (NSF) is a non-profit organization that sets standards to protect public health and certifies various products to ensure that these standards are met.

Standard definitions of the types of bottled water were established to help eliminate confusion over terms used in labeling. In addition, the regulations require that water bottled from a public water system be labeled as such, unless the water is processed properly and can be labeled as distilled or purified water. Water labeled as sterile must meet the FDA's requirements for sterility, particularly bottled water marketed for infants.

Under the regulations, some bottled carbonated water is not regulated because it is considered a soft drink or similar beverage, such as seltzer water, soda water, or tonic water. The bottlers of these products are required to label the product accurately and it must be safe for consumption. These beverages have carbon dioxide added during the bottling process and may have added flavorings and sugar. But, **carbonated water** or sparkling water that is naturally carbonated is regulated under the water quality standards for bottled water. "Naturally carbonated" means the carbon dioxide gas was present in the underground water source. The types of bottled water which have been defined by the FDA are listed below:

> **Artesian water** comes from a well that taps a confined aquifer (a water-bearing rock, rock formation, or group of rocks) in which the water pressure pushes the water level above the top of the aquifer when the aquifer is penetrated by a well. The overlying confining unit is not as susceptible to above-the-ground activities and the possibility of contamination is reduced.
>
> **Distilled water** is produced by a process of distillation (vaporizing water, then condensing it) that removes impurities and natural minerals.
>
> **Mineral water**, which was previously exempt from bottled water quality standards, must come from a water source tapped at one or more boreholes or natural springs in a protected underground source and must contain at least 250 parts per million (ppm) in total dissolved solids. Solids in mineral water must be listed on the label.
>
> **Purified water** is processed by distillation, deionization (passing water through resins that remove most of the dissolved minerals), reverse osmosis (using membrane filters to remove dissolved solids), or other purification processes. Because purified water is

commonly used in laboratories and for medical purposes, purified water must meet the definition for "purified" water in the most recent edition of the United States Pharmacopeia (published standards for medicines and other health care technologies).

Spring water comes from an underground source from which water flows naturally to the earth's surface. There must be a natural force causing the water to flow to the surface through a natural outlet. If a bore hole is used to collect the water underground, it must be placed where the spring would have emerged.

Bottled water produced by members of the International Bottled Water Association (IBWA), which includes about 85 percent of water bottlers worldwide, is screened regularly for 200 contaminants. Members of the IBWA agree to unannounced inspections by the National Sanitation Foundation (NSF), an independent testing group. The NSF also certifies home water treatment devices. Membership in the IBWA is noted on the bottle label or the NSF mark is displayed on the label. For more information about bottled water regulations, call the IBWA at 1-800-928-3711, Monday-Friday, 9 a.m. to 5 pm, EST.

Install filters or other home treatment units. A wide variety of drinking water filters and treatment devices for home use are on the market. The next section discusses the different types of water treatment devices available for the homeowner with a private water system.

Choose the Treatment Device That Will Solve Your Problem

Drinking water filters and treatment units are referred to as *point-of-use* or *point-of-entry* devices. Point-of-use units (POU) treat water from a specific tap, while point-of-entry (POE) devices treat all the water that enters your home. For example, a POE device might be desirable if showering and bathing are possible routes of exposure to the contaminant. A POU unit would attach to the faucet, or fit under the sink and treat the water you use for drinking and cooking. Also, stand-alone models can be used on your kitchen counter to treat just the amount of water you want to use at any one time. Water treatment devices need to be chosen for the specific contaminants you want to eliminate. Some water treatment systems get rid of pesticides and industrial cleaners, while others are most effective at removing heavy metals.

There are several ways to tell if your water treatment unit is working properly: (1) test the water on a regular basis and confirm that the contaminants have been removed; (2) watch to see if your problem is solved (i.e., staining, odor, or taste has been eliminated). One important caution: follow the manufacturer's recommendation for maintaining the devices by changing filters or membranes regularly. Filters that are not maintained properly can cause more serious problems than unfiltered water. For example, certain kinds of filters may get saturated with a contaminant, and release it into drinking water at higher concentrations than in the untreated water.

If you find that your private water system contains unacceptable levels of contaminants, and you are considering the purchase of a water treatment unit, be an informed consumer. While most sellers of water treatment units are reputable, some take advantage of the public's fears about drinking water and are selling expensive devices that may be overdesigned or may not solve the specific water problem you want to treat.

Before you buy a home water treatment unit, contact your local health department or extension office to get water quality information and learn about health "risk" factors. In addition, call the Federal Trade Commission's Bureau of Consumer Protection at (202)326-3650 for factsheets concerning home water treatment units; contact the local Better Business Bureau to find out if they have received any complaints against water treatment dealers; and talk to your friends and neighbors about their experiences with water treatment systems and dealers.

When you are ready to purchase your water treatment unit, look for evidence that the treatment device has been tested and approved by an independent group. For example, the National Sanitation Foundation (NSF) tests water treatment units. The NSF is a voluntary certification program for water treatment devices and bottled water. While the NSF can not recommend a particular brand of water treatment unit, they can provide you with useful information about the various water treatment units and technologies.

Also, the Water Quality Association (WQA), a trade association of manufacturers and distributors, offers voluntary validation standards and advertising guidelines to their members. The WQA can provide specific information on water treatment units. Another source of information on health effects of particular contaminants, or home water treatment units and processes, is The Environmental Health Clearinghouse at 1-800-643-4794.

National Sanitation Foundation
3475 Plymouth Road
Ann Arbor, MI 48106
(800)NSF-MARK

Water Quality Association
4151 Naperville Road
Lisle, IL 60532
(708)505-0160

Be aware that the EPA does not test and approve specific treatment devices. An EPA registration number is assigned if the manufacturer claims that the device inhibits or reduces bacterial growth. It merely indicates that the company has registered their product with the EPA.

Do Comparison Shopping

After you have gathered all your information about water treatment units, you need to take time to do some comparison shopping for costs, cancellation and refund policies, installation methods, maintenance requirements, and warranties. Answering the following questions will help you make decisions when choosing your water treatment unit:

1. How long has the company been in business? Have complaints been filed against the company? Check with the Better Business Bureau, the state Attorney General's office, and other customers to find out if they are satisfied with the service and products.
2. Are the products and manufacturer rated by the NSF or WQA? If the products has been tested by one of these independent agencies, it will have a seal indicating that the product has met industry standards.
3. Was the product tested for the specific contaminant you want to treat? Ask to review the test results to see if the manufacturer's claims are reliable.
4. If an in-home test was performed on your water, what did the test results show? Contact your local health department or extension office to help you evaluate your test results. An in-home test will be able to determine only the basic water quality parameters (i.e., pH, hardness, iron, and sulfur).
5. Does the specific water problem require whole-house treatment (point-of-entry) or a single-tap device (point-of-use)? Contaminants that are dangerous if inhaled, absorbed through the skin, or ingested may require that all water be treated when it enters the house. For other contaminants, treatment may only be necessary for water used in cooking and for drinking purposes.
6. Will the manufacturer retest the water after several months to check if the device is working? Is there an indicator light or alarm mechanism to let you know if there is a malfunction in the system and does it shut off automatically? Ask for a written guarantee that the device will correct the specific problem, or you will be refunded your money.
7. What is the total cost of installation and maintenance? Also, ask if you can perform the maintenance and when is maintenance necessary? Watch for hidden costs such as installation fees, regular maintenance fees, equipment rental fees, costs for disposal of spent cartridges, and increased electrical usage charges.
8. What kind of warranty is provided with the water treatment unit and what is the expected lifetime of the device? Read your warranty information carefully and find out what parts and costs are covered and for how long the warranty lasts. Find out what you should do if you have problems. Get the name, address, and telephone number of the company that manufactures the water treatment unit and the name of a service representative that can help if repairs are needed.

Types of Water Treatment Units

Brief descriptions of the major types of water treatment devices are provided below. This information should not be used in place of the complete instructions for installation, use, maintenance, and replacement that you should receive when you purchase a water treatment device. The dealer or sales person should explain to you how the device works and what you need to do to make sure it continues to work properly. Also, Table 6 provides an overview of the most common water problems and the appropriate water treatment unit.

ACTIVATED CARBON OR CHARCOAL FILTERS: Granular activated carbon (GAC) is the method of choice for removing many organic compounds. Because activated carbon filters do not absorb every contaminant in the same amount, the kinds of organic contaminant determine the efficiency of the GAC filtering unit. Activated carbon filters also can be used to solve taste and odor problems, to remove radon, and is the most common treatment used by private water system users.

Table 6. Water Contaminants and Treatment Methods

Water Treatment Method								
Water Quality Problem	**UV Rad**	**Act. Carbon**	**Chlorination**	**Ion Exchange**	**Reverse Osmosis**	**Distillation**	**Aeration/air stripping**	**Mechanical Filtration**
Chlorine		X						
Coliform bacteria, other micro-organisms	X		X		X	X		
Color (black sediment, reddish-brown)		X	X	X	X			
Inorganics, minerals, and heavy metals (lead, mercury, arsenic, cadmium, barium)		X1		X2	X	X		
Iron/manganese (dissolved)			X4	X5		X	X3	
Iron/manganese (insoluble)								X _
Water Quality Problem	**UV Rad**	**Act. Carbon**	**Chlorination**	**Ion Exchange**	**Reverse Osmosis**	**Distillation**	**Aeration/air stripping**	**Mechanical Filtration**
Nitrates				X6	X	X		
Odor and off-taste		X	X	X	X		X	
Some pesticides7		X			X			
Radium				X	X			
Radon gas		X					X	
Salt					X	X		
Sand, silt, clay (turbidity)								X
Volatile organic chemicals		X			X	X8	X	
Water hardness				X				

The contaminants are actually retained in the filter, so replacement of the filter is **important**. Check with the manufacturer to determine when the filter should be changed. A build-up of contaminants on the filter can result in a high concentration of contaminant being flushed through the filter and into the water you drink. You may need to have your water tested regularly to be sure that the filter is still effectively removing contaminants. Activated carbon filters do *not* remove nitrate, metals, bacteria, or the organic chemical vinyl chloride.

AERATION: Aeration is a process that allows volatile contam-inants to be broken down into small droplets (spray) in the air. Fresh air is then drawn through the spray and collected in a storage tank, repressurized, and is passed through a filter. The contaminants are carried to a storage tank. Water that looks bubbly as it leaves the tap is being aerated by the faucet. However, con-taminants that are removed from water by aeration are trans-ferred to the air, where they also may be capable of posing a health threat. Be sure that any aeration device you purchase vents the air to the outdoors or collects the contaminant in a filter. Follow the manufacturer's guidelines for the proper disposal of these filters.

AIR STRIPPING: This is another method that transfers contam-inants from water to air. Air is forced through a column of water (typically the water flows down through the unit as air is forced up from the bottom). This method effectively removes radon and volatile organic chemicals, including vinyl chloride, but the same caution as for aeration applies.

ANION EXCHANGE: Anion exchange resins are materials that at-tract negatively charged particles (anions), and removes them from the water. This method effectively removes nitrate from drinking water.

CATION EXCHANGE: Cation exchange is a process similar to an-ion exchange, but the particles removed are positively charged (cations). Water softeners, which remove calcium, magnesium, and iron from water, but add sodium are cation exchange units. Filters become saturated with the removed contaminants, and must be flushed with sodium periodically. People with hypertension or high blood pressure should consult with their physician about possible health risks associated with drinking softened water because of the added sodium level. Water softeners have some filtering ability, but if the water contains a high level of particulate matter or heavy turbidity, then it should be filtered before entering the softening system.

DISINFECTION: Disinfection methods reduce the numbers of bacteria in water to levels thought to be safe for human consumption. One such method, chlorination, also causes dissolved iron to fall out of solution as a solid, which then can be filtered out through a sand filter. Household chlorination units often use common household chlorine bleach. Other disinfection methods include distillation and treating with ultraviolet light or ozone.

PURIFICATION: Purification differs from disinfection in that purification methods kill all organisms in the water. Boiling water for at least two minutes is one recommended purification method. However, boiling increases the concentration of contaminants such as metals and nitrate, so it may not be the best method for all situations.

ULTRAVIOLET IRRADIATION: Ultraviolet light systems are relatively effective at controlling *Giardia* cysts as well as bacteria, and generally require less maintenance than a chlorination system. This system works in much the same way that sunlight does in killing bacteria in surface water. Ultraviolet lamps, similar to fluorescent lamps, are enclosed in a protective quartz sleeve. Water flows in a thin layer around these lamps and the lamp temperature provides the germicidal action. Lamps must be kept clean to prevent plaque from forming and decreasing the ultraviolet light rays. A lower lamp temperature, contact time with water, turbidity, and tiny traces of iron compounds can influence the effectiveness of the system. In order for ultraviolet disinfection systems to work properly, dissolved and suspended solids must be removed from the water periodically to ensure that the water is exposed to the light sufficiently.

MECHANICAL FILTERS: Mechanical filters generally use sand or spun cellulose to strain out dirt, sand, clay, and silt from drinking water. Filters that can strain out particles of 2 microns and meet the specified NSF standards are needed to remove *Giardia* cysts. The drawback to using filters fine enough to remove cysts is that they may clog frequently with sand or clay and require considerable maintenance.

DISTILLATION UNITS: Distillation is a process in which water is boiled, the steam is trapped and cooled to liquid water, and contaminants are left behind. Distillation is especially useful for removing inorganic contaminants including sodium, sulfate, and nitrate, and for nonvolatile organic contaminants. This process does not work for volatile organic contaminants, which turn to vapor even more quickly than water and are carried along with water vapor through the cooling process. Microbiological organisms, such as cryptosporidium and giardia, can be removed using distillation. However, distillation will not remove all chemical pollutants (especially volatile contaminants) and some bacteria may still pass through the system. Using a distillation system will increase your energy use because of the additional cost of heating the water.

POLYPHOSPHATE FEEDERS: These devices remove iron from water. They are effective only with cold water. Hot water releases the iron and the iron accumulates in the water heater which results in rusty water.

IRON FILTERS: Green-sand filters can remove ferrous iron (the form of iron that is dissolved in water) and manganese. The filter bed has to be backwashed frequently to remove accumulated iron, and the filter medium has to be recharged with potassium permanganate.

NEUTRALIZERS: Neutralizing systems are used to treat corrosive and acidic water. The most common home treatment is to run water through granular calcite (including materials such as marble, lime, or calcium carbonate). Some systems use soda ash, sodium carbonate, or caustic soda (sodium hydroxide) if the water is very acidic. Disadvantages to using neutralizers are increased water hardness because of added calcium, or added sodium which may cause health problems.

REVERSE OSMOSIS: Reverse osmosis units force water across a membrane that has tiny holes in it large enough for water molecules to pass through but too small for most contaminants.

Large amounts of water must be used to flush contaminants off the membrane, so your water use will increase if you install a reverse osmosis unit. It is estimated that it takes about four gallons of tap water to get one gallon of treated water using a reverse osmosis unit.

Do Your Part To Prevent Drinking Water Contamination

As the number of synthetic compounds with the potential for contaminating drinking water sources increases, so will the concern about the safety of our drinking water. At the same time, decisions about acceptable drinking water will become more and more difficult. The costs of treating contaminated water may begin to shape our water treatment policies.

Even ground water, long thought to be protected by its location beneath the earth's surface, can be threatened by human activities. An obvious solution to our increasing water quality problems is to prevent contamination from occurring. Although most of us think of factories and chemical industries as being responsible for water pollution, everyone must accept some of the responsibility. All of the products we use, the homes we live in, the food we eat, and the way we design our towns, cities, and rural areas affect water quality.

The following list describes some water pollution sources and brief suggestions for preventing drinking water contamination:

SEPTIC SYSTEMS: The proper siting, installation, and maintenance of home septic systems can prevent the surface ponding of raw wastes, and the contamination of ground water by nitrate, bacteria, and other wastes.

HOUSEHOLD HAZARDOUS WASTES: Toxic and hazardous substances poured or flushed into household plumbing can pass through your septic system without being treated and contaminate ground water. Such chemicals include paints, varnishes, photographic solutions, paint thinners, waste oils, pesticides, antifreeze, wood preservatives, and household cleaners that contain lye or petroleum distillates. Proper disposal of these substances is essential. Consult the fire department, health department, or the Department of Environmental Quality's Waste Division, Office of Technical Assistance for acceptable methods of disposal. Disposing of these substances through a septic system can destroy the beneficial bacterial action in the septic tank.

PESTICIDES AND FERTILIZERS: Reducing the amounts of fertilizer and pesticides applied, using less toxic chemicals, and applying pesticides that are readily degradable are the most effective methods to reduce the threat to water resources. If you use pesticides or fertilizers, follow directions carefully and use them as efficiently and safely as possible.

LEAKING UNDERGROUND STORAGE TANKS: If your private water system is contaminated by petroleum products, your underground fuel oil tank may be leaking. If your underground tank is steel and more than 20 years old, it may be leaking even if your water has not yet shown any signs of contamination. An unexplained loss of oil from your tank or the appearance of water in the tank are indications of a potential leak. Above ground tanks also can leak, and uncontained spills can result in con-tamination of ponds, streams, and ground water. If you suspect an oil spill or leak, contact the DEQ regional office nearest you. If you own an underground or above ground heating-oil storage tank that is 5,000 gallons or less, the Virginia Petroleum Storage Tank Fund can assist you with reimbursements for reasonable and necessary clean-up costs over $500. For more information about that program, contact the DEQ regional office nearest you.

WASTE DISPOSAL: Limiting the amount of waste you generate by recycling, re-using, and repairing instead of discarding can significantly reduce the total amount of waste added to landfills or incinerated. The less waste disposed of, the less danger there is of contaminating ground water or surface water with landfill leachate. Preventing the illegal dumping of wastes, especially in sinkholes and abandoned wells, protects ground water. **ABANDONED WELLS:** Wells that are no longer usable or are abandoned must be properly sealed to prevent possible contamination of ground water and to preserve the yield and pressure of the aquifer. Wells temporarily abandoned should be sealed with a water-tight cap or well head seal. If the well is permanently abandoned, procedures outlined in Virginia's Private Wells Regulations, VR 355-34-100, Section 3.11 Well Abandonment should be followed. An abandoned well should never be used for disposal of wastes of any kind. **WATER OVERUSE:** Using water wastefully can result in water contamination. In some areas of the state, particularly along the coast, over-withdrawal of ground water can result in saltwater intrusion into freshwater wells. Adopting water conservation measures can help prevent that problem. **URBAN AND RURAL EROSION:** Construction, agriculture, and urban and suburban development all affect water resources. Disturbance of the soil surface often results in flooding and erosion, loading streams and reservoirs with silt and sediment, and preventing water from seeping into the earth to replenish ground water supplies.

This is a brief summary of some of the ways that you can get involved in protecting water resources. Safe, drinking water is something we all want and need " and it is our responsibility.

Others May Be Able To Help You

A variety of resources are available to Virginia residents who have drinking water problems:

Division of Consolidated Laboratory Services......................(804) 786-7617
to request a list of state-certified testing laboratories (Note: This list also can be requested from your local or regional health department.)

Virginia Bureau of Radiological Health Radon Hotline......................(800) 468-0138
for information and advice on testing for radon

Virginia Cooperative Extension Service
for information on protecting your water supply, local ground water conditions, water testing, interpreting test results, treating contaminated water, and information about agricultural practices in your area. Extension offices are listed in the telephone book under the local county or city offices.

Virginia Department of Environmental Quality Regional Offices:
(see map of regional offices on inside back cover) Contact your regional office to report suspected ground water contamination incidents.

Southwest Regional Office	**West Central Office**
355 Deadmore St.	3015 Peters Creek Rd.
P. O. Box 1688	P. O. Box 7017
Abingdon, VA 24212	Roanoke, VA 24019
(540)676-4800	(540)562-3666
FAX: (540)676-5584	FAX: (540)562-3680
Northern Regional Office	**Piedmont Regional Office**
1549 Old Bridge Road	4949-A Cox Road
Woodbridge, VA 22192	Glen Allen, VA 23058
(703)490-8922	(804)527-5020
FAX (703)490-6773	FAX: (804)527-5247
Tidewater Regional Office	**Valley Regional Office**
287 Pembrook Office Pk.	116 N. Main St.
Pembroke II, Suite 310	P. O. Box 268
VA Beach, VA 23462	Bridgewater, VA 22812
(804)552-1840	(540) 828-2595
FAX: (804)552-1849	FAX: (540) 828-4016

Virginia Department of Health......................(804)786-6278
VDH is the primary state agency to help residents with health-related drinking water problems. Your local health department can provide help with problems concerning wells, quality of well water, and septic systems. Telephone numbers for local health departments are listed in the phone book under the county or city offices. The Virginia Department of Health field offices (see the map on page 70 for the planning districts and field office locations) for the Office of Water Programs are:

Field 1	Field 2
Abingdgon Field Office	**Lexington Field Office**
454 East Main Street	131 Walker St.
Abingdon, VA 24210	Lexington, VA 24450
Planning Districts: 1,2,3,4	Planning Districts: 5,6,7,10
(540) 628-5161	(540) 463-7136
Fax: (540) 628-1634	Fax: (540) 463-3892
Field 3	Field 4
Southeast Virginia Field Office	**East Central Field Office**
5700 Thurston Ave.	300 Turner Road
Virginia Beach, VA 23455	Richmond, VA 23225
Planning Districts: 19,20,21,22	Planning Districts: 15,17,18
(804) 363-3876	(804) 674-2880
Fax: (804) 363-3955	Fax: (804) 674-2815
Field 5	Field 6
Danville Field Office	**Culpeper Field Office**

1347 Piney Forest Road	400 South Main St.
Danville, VA 24540	Culpeper, VA 22701-3318
Planning Districts: 11,12, 13,14	Planning Districts: 8,9,16
(804) 836-8416	(540) 829-7340
Fax: (804) 836-8424	Fax: (540) 829-7337

Virginia Water Project......................(540) 345-1184
for community technical assistance with public and private water systems

Virginia Water Resources Research Center......................(540) 231-5624

National Sanitation Foundation......................(800) NSF-MARK
for information on NSF's testing and approval of water treatment devices.

Safe Drinking Water Act Hotline......................(800) 426-4791
for information about drinking water contaminants and their standards.

National Drinking Water Clearinghouse......................(800) 624-8301
for drinking water information and news for America's small communities.

Water Quality Association......................(708)505-0160

The following is a short list of some of the many books, brochures, and documents available for additional information about drinking water problems.

Drinking Water. . . An Endangered Resource. 1988. S.U. Lester and B. Lipsett, Citizen's Clearinghouse for Hazardous Wastes, Inc., P.O. Box 6806, Falls Church, VA 22040; telephone (703) 237-2249; $7.50 (includes 4th class postage/handling). 48 pages.

Drinking Water Filters: What You Need to Know. 1988. Stephen U. Lester and Brian Lipsett, Citizen's Clearinghouse for Hazardous Wastes, Inc, (P.O. Box 6806, Falls Church, VA 22216; telephone (703) 237-2249; $6.95 (includes 4th class postage/handling). 40 pages.

The Poisoned Well: New Strategies for Ground water Protection. 1989. Ed. Eric P. Jorgensen, Sierra Club Legal Defense Fund. Washington, DC/Covelo, CA: Island Press. 415 pages.

Safety on Tap: A Citizen's Drinking Water Handbook. 1987. League of Women Voters Education Fund (1730 M Street NW, Washington, DC 20036; telephone (202) 429-1965; publication #840, $10.95 (includes postage/handling). 68 pages.

Water Quality Self-Help Checklist. American Farm Bureau Federation, Natural and Environmental Resources Division (225 Touhy Avenue, Park Ridge, IL 60068; telephone (312) 399-5700; $1). 14 pages.

Private Well Regulations, VR 355-34-100, Bureau of Sewage and Water Services, Department of Health, April 1992.

A Guide to Septic Systems and Alternatives, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060.

A Guide to Private Wells, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060.

Publications available from the American Ground Water Trust, P. O. Box 1796, 16 Centre St., Concord, NH 03301. (603)228-5444. Fax: (603)228-6557.

America's Priceless Ground Water Resource
Before You Hire a Water Witch
Domestic Water Treatment for Homeowners
Everything You Ever Wanted to Know About Septic Tanks
Ground Water Heat Pumps
Ground Water Pollution Control
Water Conservation in the Home
When You Need a Water Well
Rural Drinking Water " Private Wells or Public Water Supply?

Publications available from the Virginia Cooperative Extension Distribution Center, Virginia Polytechnic Institute and State University, Landsdowne St., Blacksburg, VA 24060, (540)231-6192.

Household Water Treatment, publication 356-481.
Interpreting Your Water Test Report, publication 356-489.
Household Water Testing, publication 356-485.
Bacteria and Other Microorganisms in Household Water, publication 356-487.
Hydrogen Sulfide in Household Water, publication 356-488.
Nitrates in Household Water, publication 356-484.
Home Water Quality Problems " Causes and Treatments, publication 356-482.
Questions to Ask When Purchasing Water Treatment Equipment, publication 356-480
Lead in Household Water, publication 356-483.
Buying Bottled Water, publication 356-486.

Appendix A. National Primary Drinking Water Standards

The following is a list of drinking water contaminants for which the U.S. Environmental Protection Agency is setting health-based standards (Maximum Contaminant Level Goals or MCLGs) and enforceable standards (Maximum Contaminant Levels or MCLs). Unless otherwise indicated, the levels presented are milligrams per liter (mg/l), which is approximately equivalent to parts per million (ppm). For some contaminants, there is also a Secondary Maximum Contaminant Level (SMCL), a level set to prevent taste or odor problems. For some contaminants, the MCL is a prescribed treatment technique. See "Setting the standards for safe drinking water" for more information.

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Fluoride	4.0	4.0	skeletal and dental fluorosis	natural deposits; fertilizer, aluminum industries, water additive
Volatile Organics				
Benzene	zero	0.005	cancer	some foods, gas, drugs, pesticide, paint, plastic industries
Carbon Tetrachloride	zero	0.005	cancer	solvents and their degradation products
p-Dichlorobenzene	0.075	0.075	cancer	room and water deodorants, and "mothballs"
1,2-Dichloroethan	zero	0.005	cancer	leaded gas, fumigants, paints
1,1-Dichloroethylene	0.007	0.007	cancer, liver, and kidney effects	plastics, dyes, perfumes, paints
Trichloroethylene	zero	0.005	cancer	textiles, adhesives and metal degreasers
1,1,1-Trichloroethane	0.2	0.2	liver, nervous system effects	adhesives, aerosols, textiles, paints, inks, metal degreasers
Vinyl Chloride	zero	0.002	cancer	may leach from PVC pipe; formed by solvent breakdown
Coliform and Surface Water Treatment				
Giardia lambia	zero	TT	Gastroenteric disease	human and animal fecal waste
Legionella	zero	TT	legionnaire's disease	indigenous to natural waters; can grow in water heating systems

Standard plant count	N/A	TT	indicates water quality, effectiveness of treatment	
Total coliform*	zero	<5%+	indicates gastroenteric pathogens	human and animal fecal waste
Turbidity*	N/A	TT	interferes with disinfection, filtration	soil runoff
Viruses	zero	TT	gastroenteric disease	human and animal fecal waste
Phase II- Inorganics				
Asbestos (>10um)	7MFL	7MFL	cancer	natural deposits; asbestos cement in water systems
Barium*	2	2	circulatory system effects	natural deposits; pigments, epoxy sealants, spent coal
Cadmium*	0.005	0.005	kidney effects	galvanized pipe corrosion; natural deposits; batteries, paints
Chromium* (total)	0.1	0.1	liver, kidney, circulatory disorders	natural deposits; mining, electroplating, pigments
Mercury* (inorganic)	0.002	0.002	kidney, nervous system disorders	crop runoff; natural deposits; batteries, electrical switches
Nitrate*	10	10	methemoglobulinemia	animal waste; fertilizer; natural deposits; septic tanks; sewage
Nitrite	1	1	methemoglobulinemia	same a nitrate; rapidly converted to nitrate
Selenium*	0.05	0.05	liver damage	natural deposits; mining, smelting, coal/oil combustion
Phase II - Organics				
Acrylamide	zero	TT	cancer, nervous system effects	polymers used in sewage/wastewater treatment
Alachlor	zero	0.002	cancer	runoff from

				herbicide on corn, soybeans, other crops
Aldicarb*	0.001	0.003	nervous system effects	insecticide on cotton, potatoes, others; widely restricted
Aldicarb sulfone*	0.001	0.002	nervous system effects	biodegradation of aldicarb
Aldicarb sulfoxide*	0.001	0.004	nervous system effects	biodegradation of aldicarb
Atrazine	0.003	0.003	mammary gland tumors	runoff from use as herbicide on corn and non-cropland
Carbofuran	0.04	0.04	nervous, reproductive system effects	soil fumigant on corn and cotton; restricted in some areas
Chlordane*	zero	0.002	cancer	leaching from soil treatment for termites
Chlorobenzene	0.1	0.1	nervous system and liver effects	waste solvent from metal degreasing processes
2,4-D*	0.07	0.07	liver and kidney damage	runoff from herbicide on wheat, corn, rangelands, lawns
o-Dichlorobenzene	0.6	0.6	liver, kidney, blood cell damage	paints, engine cleaning compounds, dyes, chemical wastes
cis,-1,2-Dichloroethylene	0.07	0.07	liver, kidney, nervous, circulatory	waste industrial extraction solvents
trans, 1-2-Dichloroethylene	0.1	0.1	liver, kidney, nervous, circulatory	waste industrial extraction solvents
Dibromochloropropane	zero	0.0002	cancer	soil fumigant on soybeans, cotton, pineapple, orchards
1-2,-Dichloropropane	zero	0.005	liver, kidney effects; cancer	soil fumigant; waste industrial solvents

Epichlorohydrin	zero	TT	cancer	water treatment chemicals; waste epoxy resins; coatings
Ethylbenzene	0.7	0.7	liver, kidney, nervous system	gasoline; insecticides; chemical manufacturing wastes
Ethylene dibromide	zero	0.00005	cancer	leaded gas additives; leaching of soil fumigant
Heptachlor	zero	0.0004	cancer	leaching of insecticide for termites, very few crops
Heptachlor epoxide	zero	0.0002	cancer	biodegradation of heptachlor
Lindane	0.0002	0.0002	liver, kidney, nerve, immune, circulatory	insecticide on cattle, lumber, gardens; restricted 1983
Methoxychlor	0.04	0.04	growth, liver, kidney, nerve effects	insecticide for fruits, vegetables, alfalfa, livestock, pets
Pentachlorophenol	zero	0.001	cancer; liver and kidney effects	wood preservatives, herbicide, cooling tower wastes
PCBs	zero	0.0005	cancer	coolant oils from electrical transformers; plasticizers
Styrene	0.1	0.1	liver, nervous system damage	plastics, rubber, resin, drug industries; leachate from city landfills
Tetrachloroethylene	zero	0.005	cancer	improper disposal of dry cleaning and other solvents
Toluene	1	1	liver, kidney, nervous, circulatory	gasoline additive; manufacturing and solvent operations

Toxaphene	zero	0.003	cancer	insecticide on cattle, cotton, soybeans, cancelled 1982
2,4,5-TP	0.05	0.05	liver and kidney damage	herbicide on crops, right-of-way, golf courses, cancelled 1983
Xylenes (total)	10	10	liver, kidney; nervous system	by-product of gasoline refining; paints, inks, detergents
Lead and Copper				
Lead*	zero	TT**	kidney, nervous system damage	natural/industrial deposits; plumbing, solder, brass alloy faucets
Copper	1.3	TT***	gastrointestinal irritation	natural/industrial deposits; wood preservatives, plumbing
Phase V - Inorganics				
Antimony	0.006	0.006	cancer	fire retardants, ceramics, electronics, fireworks, solder
Beryllium	0.004	0.004	bone, lung damage	electrical, aerospace, defense industries
Cyanide	0.2	0.2	Thyroid, nervous system damage	electroplating, steel, plastics, mining, fertilizer
Nickel	0.1	0.1	heart, liver damage	metal alloys, electroplating, batteries, chemical production
Thallium	0.0005	0.002	kidney, liver, brain, intestinal	electronics, drugs, alloys, glass
Organics				
Adipate, (di(2-ethylhexyl)	0.4	0.4	decreased body weight; liver and testes damage	synthetic rubber, food packaging, cosmetics
Dalapon	0.2	0.2	liver, kidney	herbicide on

				orchards, beans, coffee, lawns, road/railways
Dichloromethane	zero	0.005	cancer	paint stripper, metal degreaser, propellant, extraction
Dinoseb	0.007	0.007	thyroid, reproductive organ damage	runoff of herbicide from crop and non-crop applications
Diquat	0.02	0.02	liver, kidney, eye effects	runoff of herbicide onland and aquatic weeds
Dioxin	zero	0.00000003	cancer	chemical production by-product; impurity in herbicides
Endothall	0.1	0.1	liver, kidney, gastrointestinal	herbicide on crops, land/aquatic weeds; rapidly degraded
endrin	0.002	0.002	liver, kidney, heart damage	pesticide on insects, rodents, birds; restricted since 1980
Glyphosate	0.7	0.7	liver, kidney damage	herbicide on grasses, weeds, brush
Hexachlorobenzene	zero	0.001	cancer	pesticide production waste by-product
Hexachloro-cyclopentadiene	0.05	0.05	kidney, stomach damage	pesticide production intermediate
Oxamyl (Vydate)	0.2	0.2	kidney damage	insecticide on apples, potatoes, tomatoes
PAHs (benzo(a)pyrene)	zero	0.0002	cancer	coal tar coatings; burning organic matter; volcanoes, fossil fuels
Phthalate, (di(2-	zero	0.006	cancer	PVC and other

ethylhexyl)				plastics
Picloram	0.5	0.5	kidney, liver damage	herbicide on broadleaf and woody plants
Simazine	0.004	0.004	cancer	herbicide on grass sod, some crops, aquatic algae
1,2,4-Trichlorobenzene	0.07	0.07	liver, kidney damage	herbicide production; dye carrier
1,2,2-Trichloroethane	0.003	0.005	kidney, liver, nervous system	solvent in rubber, other organic products; chemical production wastes
Other Proposed (P) and Interim (I) Standards				
Beta/photon emitters (I) and (P)	zero	4 mrem/yr	cancer	decay of radionuclides in natural and man-made deposits
Alpha emitters (I) and (P)	zero	15 pCi/L	cancer	decay of radionuclides in natural deposits
Combined Radium 226/228 (I)	zero	5 pCi/L	bone cancer	natural deposits
Radium 226*(P)	zero	20 pCi/L	bone cancer	natural deposits
Radium 228*(P)	zero	20 pCi/L	bone cancer	natural deposits
Radon (P)	zero	300 pCi/L	cancer	decay of radionuclides in natural deposits
Uranium (P)	zero	0.02	cancer	natural deposits
Sulfate (P)	400/500	400/500	diarrhea	natural deposits
Arsenic*(I)	0.05	0.05	skin, nervous system toxicity	natural deposits; smelters, glass, electronics wastes; orchards
Total Trihalomethanes (I)	zero	0.10	cancer	drinking water chlorination by-products

Source: National Primary Drinking Water Standards, U.S. Environmental Protection Agency, EPA 810-F-94-001A, February 1994.

Appendix B. Secondary Maximum Contaminant Levels

The following is a list of drinking water contaminants for which the U.S. Environmental Protection Agency has set or is setting aesthetic standards related to taste, odor, or color (Secondary Maximum Contaminant Levels or SMCLS). Unless otherwise indicated, the levels presented are concentrations expressed as milligrams per liter (mg/l), which is approximately equivalent to parts per million (ppm).

Contaminant	Synonym	Description	Contaminant Effects	SMCL
aluminum	Al	element	discoloration of water	0.05 to 0.2
chloride	Cl		taste; corrosion of pipes	250
color		property	aesthetic	15 color units
copper	Cu	element	taste; staining of porcelain	1.0
corrosivity		measure of ability of water to corrode	aesthetic; may leach pipe materials (e.g., lead) into water	non-corrosive
fluoride	F	element	dental fluorosis(discoloration of teeth)	2.0
foaming agents	MBAS		aesthetic	0.5
iron	Fe	element	taste; staining of laundry	0.3
manganese	Mn	element	taste; staining of laundry	0.05
odor		property	aesthetic	3 threshold odor number
pH		may affect corrosivity	6.5 to 8.5	
silver	Ag	element	argyria (skin discoloration)	0.1
sulfate	$S0_42$		taste; laxative effects	250
total dissolved solids	TDS	measure of inorganic chemicals in water (hard water)	taste; indicator of corrosivity;can damage plumbing, limit effectiveness of soaps and detergents	500
zinc	Zn	element	taste	5.0