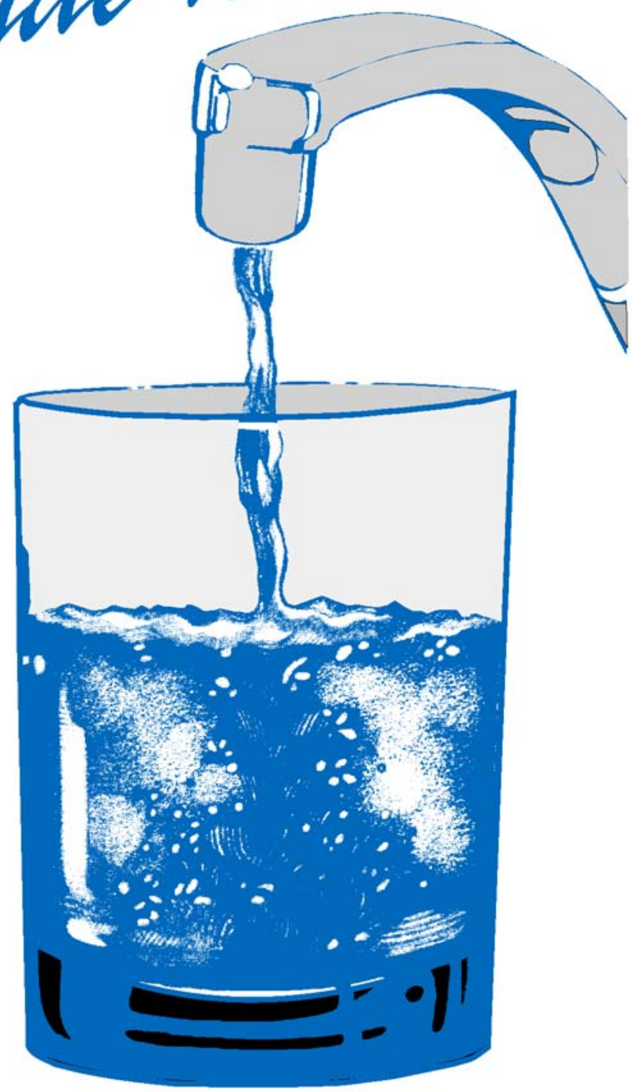
Citizen's Guide to



HOME DRINKING WATER TREATMENT DEVICES

COMMONWEALTH OF PENNSYLVANIA
Department of Environmental Protection
Edward G. Rendell, Governor
Kathleen A. McGinty, Secretary
For more information, visit DEP's website at
www.dep.state.pa.us, Keyword: "DEP Drinking Water."

Preface

This document has been written as a public service to provide information on home drinking water treatment units.

The U.S. General Accounting Office (GAO) published a report in December 1991 entitled *Drinking Water - Inadequate Regulation of Home Treatment Units Leaves Consumers at Risk.* This report states that while many responsible companies manufacture home drinking water treatment units, federal and state prosecutors, the Better Business Bureau and the Environmental Protection Agency (EPA) have found that other companies selling the units make fraudulent claims to consumers. As a consequence, consumers sometimes purchase units that are ineffective or inappropriate for their intended use. While the full extent of consumer problems and potential health risks associated with the sale and use of these units is unknown, data GAO gathered from numerous sources indicate that dishonest marketers use a variety of misleading sales practices, and ineffective units may pose a health risk to consumers if used to treat contaminated water.

Public water systems are required to periodically monitor to insure that safe drinking water is provided at all times. However, it is up to the individual home owner to insure that private domestic water supplies are safe to drink. All private supplies should be tested, at least on an annual basis, to insure that biologically-safe drinking water is being provided. Private supplies should also be tested before deciding if a home drinking water treatment device is necessary or what type is the most suitable.

Where the source is not of adequate quality, home drinking water treatment devices can be used to provide water of adequate quality that is safe to drink. The treatment options vary in both complexity and price. The less informed you are about the quality of your water, the more likely you are to purchase unnecessary, costly or inappropriate equipment.

The information provided in this document does not constitute that the Department of Environmental Protection (DEP) is promoting or encouraging the use of these devices nor recommending one unit or manufacturer over another. This information is solely intended to allow consumers to make informed decisions. Further assistance is available from DEP regional offices and additional organizations listed in the back of this document.

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General Information About Home Drinking Water Treatment Devices

What are home drinking water treatment devices?

Home drinking water treatment devices are used by a home owner to improve the quality of water entering the home. Home treatment devices are categorized as either point-of-entry devices, which treat all the water entering the home, or point-of-use devices, which treat only the water at a single tap. Common types of entry-devices or use-devices are water softeners which remove hardness from the water, particulate filters for turbidity removal and activated carbon filters for removal of taste and odor problems. It is not always necessary to treat water for household washing and sanitary purposes to the same degree as water used for drinking and cooking.

How do I know if I need a drinking water treatment device?

Problems that consumers are concerned with in drinking water can be described as **aesthetic** problems affecting taste, color and odor, but not necessarily harmful, and **health/safety** problems which many times are not apparent unless the water is tested. Most complaints about drinking water concern aesthetic problems, particularly taste, odor and hardness. Public water systems are required to maintain safe drinking water that does not exceed the maximum contaminant levels for primary contaminants listed in the appendix of this document.

As public water suppliers in Pennsylvania must meet stringent requirements for physical, chemical and biological contaminants, there is normally less need to be concerned about the quality of public water than there is for private wells. Consumers that have questions about their public water supply should first contact their local water company. The water supplier should be able to provide you with information on the quality of the water. Home treatment devices are not required for health or safety problems with water supplied from a public water system, unless public notification indicates that a maximum contaminant level is being exceeded.

Deciding whether or not a home treatment device is needed for aesthetic improvements is fairly simple since aesthetic problems are easily detected by the senses. Unfortunately, deciding whether or not a home treatment device is needed to improve the safety of the water is not as easy. Harmful contaminants, if present at all, may only be present in small concentrations which cannot be readily detected by taste and smell. Therefore, where a health/safety problem is suspected, it is essential that the water be analyzed by a laboratory to determine what contaminants, if any, are present and the concentrations of any contaminants. Buying a water treatment device without water testing can be a costly mistake.

The use of department-permitted bottled water is an option to consider before purchasing a home drinking water treatment device. The consumer should compare the cost and convenience of bottled water versus the purchasing of a home drinking water treatment device.

How do I select a laboratory for the water testing?

A DEP-certified laboratory should be used for drinking water testing. A list of such laboratories can be obtained by calling any DEP regional office (see Appendix B or through the website at http://www.dep.state.pa.us). A second analysis from a different laboratory taking a sample at a different time is also a good idea because there is a certain margin of error in water testing and contaminant problems may vary.

Talk to several laboratories and discuss your concerns with them so they have an idea of what tests should be done on your water. The laboratory will provide sample containers along with instructions for drawing your own tap-water samples. Make sure you follow the laboratory's instructions exactly. Proper sample collection is extremely important. Otherwise, the results may not be representative of the quality of your drinking water.

By far, the most common health threat in private wells is from microbiological contamination, including bacteria, viruses and pathogenic protozoans, which cause intestinal problems.

Identifying chemical contaminants can be very complicated and expensive. To test for all possible contaminants that could be found in a well supply is too expensive for most home owners. If chemical contamination is suspected, then taste, odor and the proximity to present or previous sources of pollution near the home (e.g., septic tanks, agriculture runoff, landfills, underground storage tanks and industrial plants) should be considered when determining what contaminants should be tested for. The more common contaminants found in groundwater are described below.

How do I interpret my lab report?

Laboratory analysis results may be reported in different ways. The following are frequently used terms. When referring to water, parts per million (ppm) is approximately equivalent to milligrams per liter (mg/L). One mg/L is approximately equal to a teaspoon of a contaminant in 1300 gallons of water.

$$1.0 \text{ mg/L} = 1 \text{ ppm}$$

It also is common to refer to contaminant concentrations that occur at very low levels in parts per billion (ppb). Parts per billion is approximately equivalent to and commonly reported as micrograms per liter (µg/L). One µg/L is approximately equal to a teaspoon of a contaminant in 1.3 million gallons of water.

$$1.0\ \mu\text{g/L} = 1 \text{ ppb}$$
$$1000\ \mu\text{g/L} = 1.0 \text{ mg/L}$$

An easy way to convert from one to another is to move the decimal point three places to the right when converting from mg/L to µg/L or three places to the left when converting from µg/L to mg/L.

Depending on the laboratory analysis method and reporting format used, the lab report may say none detected (N.D.) or indicate that it was less than a certain value (e.g., <0.005 mg/L). A contaminant concentration reported as less than a certain value indicates that the contaminant was not detected at the minimum value the laboratory method can reliably measure. Some laboratory result sheets will indicate if the contaminant exceeds the maximum contaminant level.

Maximum Contaminant Levels

Maximum contaminant levels are the maximum permissible level of a contaminant in the water delivered to a user of a public water system. The maximum contaminant levels are divided into two categories: primary and secondary.

The primary maximum contaminant levels regulate contaminants which may adversely affect public health such as arsenic, lead, radionuclides, volatile synthetic organic chemicals (VOCs), certain bacteria and pesticides. The secondary maximum contaminant levels regulate contaminants which may adversely affect the aesthetic quality of water, such as taste, smell, color and appearance. Public water systems are required to periodically monitor for primary maximum contaminant levels. Periodic monitoring for secondary maximum contaminant levels is not required because violations of these standards are generally noticeable to consumers who detect changes in color, taste and odor. Appendix C lists the current maximum contaminant levels.

*W**hat Health-Related Contaminants Should I Be Aware of*?

Health-related (primary drinking water) contaminants that consumers should be aware of are microbiological contamination, total coliform bacteria, *Giardia lamblia and Cryptosporidium parvum* protozoa, nitrate, radon, lead, synthetic organic chemicals (SOCs), VOCs and pesticides.

Microbiological Contamination. Microbiological contamination is normally a problem with private domestic wells which do not receive the disinfection that a public drinking water source does. The source of microbiological contamination in groundwater can be from onlot sewage (septic) systems or agricultural runoff. Improper well construction and poor location of the well can result in microbiological contamination. The presence of coliform bacteria in drinking water is easy for a certified laboratory to detect and can be used to assess the likelihood that other microbiological contaminants are present. Test kits for collecting total coliform bacteria samples are available from either DEP-certified private laboratories or the DEP regional offices listed in Appendix B. Individuals should have their well water tested for bacteria at least annually.

Total Coliform Bacteria. The total coliform bacteria test is used to determine if bacterial contamination is present. Although most coliform bacteria do not cause illness, the total coliform test is easy and inexpensive, and is used as an indicator for the possible presence of other disease-causing microorganisms in the water. If coliform bacteria are in your water, then bacteria and viruses that can make you sick may also be contaminating your supply. The acceptable level is for no coliform bacteria to be present. However, a test report for an uncontaminated sample may read coliform negative, less than one (<1) per 100 mL, or less than 2.2 (<2.2) per 100 mL, depending on the measurement and reporting technique used by the individual laboratory. Ultraviolet disinfection treatment devices can provide water that is safe from microbiological contamination. Chlorination is also an effective means of disinfection, and is normally used when problems such as high iron or hydrogen sulfide also are present.

Giardia and Cryptosporidium. Giardiasis is a waterborne disease caused by the protozoan *Giardia lamblia* that lives in the small intestine of warm-blooded mammals. Similarly, cryptosporidiosis is caused by *Cryptosporidium parvum.* Infection results from drinking water from a surface or surface water influenced source contaminated by *Giardia* cysts. *Giardia* normally is not a problem with groundwater sources, unless they are under the direct influence of surface water. Public water systems that test positive for *Giardia* cysts are required to immediately notify consumers of the problem. Additional information on *Giardia* can be found in a pamphlet entitled *Cryptosporidium & Giardia...Are They in Your Drinking Water?* available from the DEP regional offices listed in Appendix B or through the website at http://www.dep.state.pa.us (Keyword: "DEP Drinking Water"). Mechanical filtration is the most cost-effective way to remove *Giardia* cysts, although reverse osmosis and distillation also will work. It is recommended that consumers purchase a device that is in the *NSF International Listings* for *Giardia* cyst removal.

Nitrate. Nitrate is a fairly common drinking water contaminant, usually associated with wells and springs in agricultural areas. Public water supplies routinely must test for nitrate and remove it if it exceeds drinking water limits, but many private wells may contain high levels of nitrate without the owners being aware of it. High nitrate levels usually result from agricultural activities or onlot sewage systems. Chemical fertilizers and manure are rich sources of nitrogen compounds, which are converted to nitrate in the soil. People, particularly those with young children, living in farming areas who obtain their water from individual wells, springs or surface sources should have their water tested regularly for nitrate.

At high concentrations, nitrate can cause methemoglobinemia, commonly called blue baby syndrome, in infants. Infants less than three months old are at greatest risk from the illness, which deprives vital organs of oxygen. This disease, although uncommon, can occur when high concentrations of nitrate are in the drinking water. For public drinking water supplies, the maximum contaminant level for nitrate is 10 mg/L expressed as nitrogen (N) or 45.0 mg/L expressed as nitrate (NO_3). Nitrate levels can change drastically based on rainfall, fertilizer application and geology. The test for nitrate is relatively inexpensive, typically $15 to $20.

Reverse osmosis, ion exchange and distillation treatment devices are effective for removal of nitrates.

Radon. Radon is a naturally occurring radioactive gas that is found in varying concentrations in most soils and rock. Radon gas can cause lung cancer. Normally, most radon that accumulates in the home seeps from the soil into the home through cracks and holes in the foundation. However, in some cases, household water can be the primary or a contributing source. In these cases, radon is emitted into the home from water used for showering, cooking and washing. It is only a problem where groundwater is used to supply drinking water. The danger primarily is from the inhalation of radioactive gas given off, rather than consumption of the water.

To find out if you have a problem with radon in your home, have the air tested first. If the air level is less than 4 picocuries per liter (pCi/L), there usually is no need to have the water tested. If the air level in non-basement areas is above 4 pCi/L, then the water should be tested to determine if it is the primary or a major contributing source. A level of 10,000 pCi/L, in the water will increase indoor air levels by about 1 pCi/L.

Since radon levels in the air can vary substantially from day to day, it is a good idea to have at least two air samples taken with the samples spaced over several days in a closed house. Air sampling can be done with a home test kit costing $20 to $50. Long-term tests, which are a better indicator, can also be used, particularly where initial test results indicate high levels. Having a water sample analyzed by a laboratory for radon will cost from $20 to $35.

If radon levels in the water are excessive, ventilating the kitchen, laundry and bathrooms may reduce the radon concentrations in the home to an acceptable level. If additional tests show excessive levels, some type of water treatment should be considered. Two types of devices that work very well in removing radon are activated carbon and aeration treatment devices. Entry-device treatment devices should be used where radon is a problem. Because radon decays rapidly, radioactivity will not build up in the treatment devices, unless radon concentrations are exceptionally high in the raw water. If radon levels are high, lead-210, a radon decay product can build up in the carbon filter and give off harmful radioactivity. Where high radon concentrations are measured, it is advisable to shield the unit, or place the unit outside the home or in an isolated area of the basement.

To get more information on radon in the home, call DEP's **Radon Hotline** at 1-800-237-2366 or write:

DEP
Bureau of Radiation Protection
P.O. Box 8469
Harrisburg, PA 17105-8469
or visit their website at http://www.dep.state.pa.us

An information packet will be sent to you which includes information on radon testing methods, the radon concentrations at which action should be undertaken, methods of reducing radon levels in the home and a list of certified mitigation companies.

Lead. Lead from pipes and solder can dissolve into drinking water as the water flows through plumbing systems. In most cases, lead in drinking water comes from the household plumbing, not from the water source or the public water system. The highest lead concentrations are found in homes with lead service lines or lead plumbing. Lead commonly was used for service lines, the line connecting the home to the water main, in homes built up to the early 1950s. Most public water suppliers maintain records of what type of pipe was used for service lines.

High lead concentrations also can be found in homes with copper piping where lead solder was used for joining pipes. Copper is the most popular type of residential piping and is found in most homes. High lead concentrations can be found in newer homes where lead solder was used.

In July 1989, Pennsylvania passed the **Plumbing System Lead Ban and Notification Act.** The Pennsylvania "Lead Ban" prohibited the use of lead solder and lead pipe, on a state-wide basis, after Jan. 6, 1991. Local building codes in some municipalities have prohibited the use of lead solder and lead pipe for several years.

Brass and bronze in faucets and other plumbing fixtures often contain lead and may be a considerable source of lead in the drinking water of homes with brass or bronze faucets or fixtures.

Drinking water is only one possible source of lead to the human body. Other sources include paint chips, air, soil, food and dust. Infants, young children and pregnant women are at greatest risk from lead exposure. The effects of lead on children include increased hyperactivity, decreased intelligence levels, learning deficiencies and kidney disorders.

Since you cannot see, taste, or smell lead, the only way to tell if you have a lead problem in your drinking water is by having your water tested. In light of new health and exposure data, EPA has reduced the lead standard for drinking water to 0.015 mg/L. If tests show that the level in household water is in the area of 0.015 mg/L or higher, it is advisable, especially if there are pregnant women or young children in the home, to consider treatment to reduce the lead level in your tap water, use permitted bottled water, or use a flushing program to reduce the lead levels in the water that is consumed.

As water sits in the household plumbing or service line, lead can be leached from old lead pipes, lead soldered joints, or brass or bronze plumbing fixtures. Water that has a lower alkalinity or pH is more corrosive and will leach more lead into the water. The longer the water lays unused in the pipes, the greater the potential for increased amounts of lead in the water. In homes where plumbing work recently has been done, home owners should check the screen in the faucet aerator and remove any loose particles of solder. Lead concentrations can be reduced by allowing the water to run at the faucet after periods of nonuse. Anytime the water in a particular faucet has not been used for six hours or longer, the water should be run until a noticeable change in temperature can be felt. The flushing will clear out the water which has been sitting dormant in the pipes and should substantially reduce the lead concentration in the water where the plumbing system is the source of the contamination. After flushing, water can be stored for later use for drinking and cooking.

The other way to reduce lead concentrations is to use point-of-use treatment devices. Several types of treatment devices can work quite well to remove lead including reverse osmosis, activated alumina, some activated carbon absorption filters with designs such as precoat or carbon block, and distillation. If your drinking water exceeds the drinking water action level for lead of 0.015 mg/L, purchasing a device that is in the *NSF International Listings* will insure that the device has been tested and is effective for lead removal. Be sure to maintain the system as recommended by the manufacturer. If lead is the only contaminant, an activated alumina filter can be used to reduce lead concentrations. If lead is only one of several contaminants, then an activated carbon filter validated as effective for lead reduction by *NSF International Listings* or a more expensive reverse osmosis system, both of which can remove a greater number of contaminants, may be needed.

To get more information on lead in the home, including a copy of *The Pennsylvania Lead Ban and You,* contact your DEP regional office. *Lead in Drinking Water in Schools and Nonresidential Buildings* is available by contacting EPA Drinking Water Hotline, at 1-800-426-4791 or visit their website at http://www.epa.gov/safewater/consumer/leadinschools.html .

Synthetic Organic Chemicals (SOCs). The term synthetic organic chemicals refers to all man-made organic chemicals, of which thousands are known to exist.

There are many SOCs, and their applications vary from such uses as heat exchangers (polychlorinated biphenyls or PCBs) to fuel oils (kerosene). Common synthetic organic chemicals include dioxin, lindane, chlordane and endrin.

Technically, both pesticides and volatile organic chemicals are all SOCs. Due to their unique characteristics, pesticides and volatile organic chemicals typically are placed in separate categories.

Pesticides. Pesticides are a broad class of compounds that include herbicides, insecticides and rodenticides. Pesticides can enter a drinking water supply from direct application for the control of vegetation or insects and from nonpoint sources such as runoff from agricultural, urban and suburban areas. The majority of health effects data that has been accumulated has been based upon exposure to relatively high concentrations resulting from spraying operations or industrial accidents. Activated carbon filters are effective for the removal of pesticides.

If you believe that pesticides may have contaminated your drinking water, several sources can provide you with additional information. These sources include DEP regional offices, the Pennsylvania Department of Agriculture, the Penn State Cooperative Extension and the National Pesticide Telecommunications Network listed in Appendix A. Laboratories also can be of assistance in determining what to test for if you are unsure of what pesticides may have been used.

Volatile Synthetic Organic Chemicals (VOCs). Volatile synthetic organic chemicals are man-made substances that have been responsible for the contamination of both surface and groundwater supplies. VOCs have a wide variety of uses in many types of industrial, commercial, agricultural and household activities. VOCs may also form from the natural breakdown of SOCs in the environment.

Public water suppliers must meet stringent requirements for VOCs. However, some private wells or springs may contain VOC levels that are cause for concern. You are far less likely to find VOCs in your water than bacteria or nitrate. VOC contamination has been found near petroleum refineries, chemical plants, manufacturing plants, landfills, leaking underground storage tanks and as the result of careless storage or disposal around the home. If you live near one of these types of facilities or are concerned about possible contamination, you should have your water tested for VOCs. Many VOCs will not be detectable by the taste or odor of the water.

VOCs can be removed from water by boiling the water in a well ventilated area for 10 to 15 minutes, by aeration treatment devices, or by filtering the water through activated carbon treatment units.

Chlorination of water that is high in naturally occurring organic compounds can produce small amounts of trihalomethanes or THMs (chloroform, bromodichloromethane, dibromochloromethane and bromoform). The drinking water standard that public water systems are required to maintain for total trihalomethanes is 0.08 mg/L (80 ppb). Long-term exposure to levels above this standard may contribute to a small additional cancer risk. Despite these risks, however, the disease prevention benefits of chlorination still outweigh the small negative effects of trihalomethanes. Activated carbon filters are commonly used to reduce SOCs.

More information on VOCs can be obtained from DEP's *Citizen's Guide to Volatile Synthetic Organic Chemicals in Drinking Water*, which is available from DEP regional offices or through the website at http://www.dep.state.pa.us (Keyword: “DEP Drinking Water”).

What Contaminants Can Cause Aesthetic Problems?

Secondary drinking water contaminants are regulated to prevent taste, odor, color and other aesthetic drinking water quality problems. These contaminants include iron, manganese, sulfate, organic material, hydrogen sulfide and hardness.

Iron. Iron can be a major nuisance in a private water supply. It stains laundry and fixtures, promotes the growth of iron bacteria slimes in plumbing and gives water a bitter, metallic taste. Iron can be present in the water in two forms—soluble and oxidized. As each form can require a different type of treatment device, you need to determine which form is present in your water so that the proper treatment device can be selected. Trained personnel in the water treatment field can help you with this. The secondary drinking water standard for total iron is 0.3 mg/L.

Soluble iron, also called clear water iron or reduced iron, is easily recognized because the water is clear when first drawn, but soon becomes filled with red rust if left standing. Soluble iron causes reddish-brown stains on plumbing fixtures, porcelain, cooking utensils and laundry.

Soluble iron, usually up to 3.0 mg/L, can be removed by an ion exchange treatment device. A manganese greensand oxidizing filter will be effective for concentrations up to 10.0 mg/L. For concentrations above 10.0 mg/L, chlorination followed by filtration is usually needed.

Oxidized iron, frequently referred to as red water iron, is formed when water containing soluble iron reacts with air. The iron found in surface water is usually oxidized. Water containing oxidized iron will show rust particles or black specks suspended in the water. Red water iron, like clear water iron, causes reddish-brown stains on clothes, porcelain and cooking utensils. Oxidized iron can be removed by mechanical filtration or chlorination.

Small particles of oxidized iron that do not settle out are referred to as colloidal iron. These small particles cannot be removed by ordinary filtration. Colloidal iron, like other forms of iron, causes reddish-brown stains on laundry, plumbing fixtures and cooking utensils. Colloidal iron may be found in water from shallow wells, but is seldom found in deep well supplies. The presence of colloidal iron can be shown by the use of filter paper. In some cases, the addition of alkalinity to the water may allow the colloidal particles to agglomerate into settleable, filterable particles that can be removed by mechanical filtration. Colloidal iron can be removed by chlorination.

Manganese. Manganese causes dark brown to black stains on plumbing fixtures and will cause laundry to be stained black. Manganese can cause an unpleasant taste and appearance in coffee, tea and other beverages. Manganese can be removed with a water softener. The secondary drinking water standard for manganese is 0.05 mg/L.

Sulfate. Water containing high concentrations of sulfates will have a laxative effect and a bitter taste. The secondary drinking water standard for sulfates is 250 mg/L. Sulfates can be removed by ion exchange and reverse osmosis.

Organic Material. One source of color in water is from small amounts of organic material from the decomposition of fallen leaves, algae and other plant matter. This decaying vegetation produces humic acids also referred to as tannins. The color in the water may not be visible in a glass of water but will be evident when viewed against a white background in a sink or bath tub. These materials are found in surface water and are normally harmless. Phenols produced by this organic decomposition may result in objectionable taste and odor even when present in small amounts. Activated carbon filters can remove most organic material.

Hydrogen Sulfide. Hydrogen sulfide is a gas produced by the decomposition of underground organic deposits. It readily dissolves in water and gives it a characteristic rotten egg odor and obnoxious taste. Hydrogen sulfide is very corrosive and will rapidly tarnish silver causing it to turn black. In some cases, hydrogen sulfide may be present in the hot water, but not the cold. In this situation, a chemical reaction is occurring in the water heater between the magnesium anode of the water heater and sulfate in the water. Removal of the magnesium anode will usually eliminate the problem. Treatment to reduce hydrogen sulfide includes manganese greensand filtration or chlorination followed by filtration and aeration.

Hardness. Hardness is caused by dissolved minerals, primarily calcium and magnesium, which are picked up by water as it travels through rocks and soils. Hardness is a common problem where ground water is used as a water supply. The highest concentrations of these minerals come from wells in limestone rock. High concentrations can result in mineral deposits in water heaters and pipes, and film on sinks and bathtubs. Hardness also requires increased soap usage in dishwashers and washing machines. A major problem caused by hardness is reduced efficiency of water heaters resulting in premature replacement. The following table shows a rating system commonly used to describe the hardness of water.

Lab results frequently will refer to minerals in water as grains per gallon (gpg). One grain per gallon of calcium for example is equal to 17.12 mg/L as $CaCO_3$. Thus multiply grains per gallon by 17.12 to obtain the equivalent value in milligrams per liter.

Hardness usually is treated using ion exchange water softeners. The level of hardness at which treatment is used to soften the water varies, depending on consumer preference. Reducing the hardness of the water too much may make the water corrosive to the plumbing system and can in some instances result in increased lead concentrations.

Chlorine. Chlorine is used to kill and prevent the regrowth of harmful microorganisms in water supply systems. However, high levels of chlorine can result in taste and odor problems. Chlorine also can combine with other drinking water contaminants to form chloramines, which can create noticeable taste and odor problems.

Activated carbon filters are effective in removing taste and odor problems associated with chlorine.

Hard Water Levels

Grains Per Gallon	***Parts Per Million (mg/L as $CaCO_3$)***	***Rating***
less than 1.0	less than 17.1	soft
1.0 - 3.5	17.1 - 60	slightly hard
3.5 - 7.0	60 - 120	moderately hard
7.0 - 10.5	120 - 180	hard
over 10.5	over 180	very hard

What Agencies Approve Home Drinking Water Treatment Devices?

Neither EPA nor DEP tests, certifies or endorses home drinking water treatment devices. Occasionally, you may come across a device with a label saying "Registered With EPA." This registration is required for devices, usually carbon filters, that contain a chemical treatment of the filter, typically impregnated silver that inhibits the growth of bacteria on the filter material. Registration does not necessarily mean that the device works effectively or that it kills harmful bacteria. EPA registration only ensures that the filter will not leach unacceptable levels of the silver bactericide into the drinking water. Recent studies have shown that the impregnated silver has little effect on killing harmful bacteria and other microbiological contaminants.

One nonprofit organization that tests and certifies treatment devices is **NSF International**. NSF International is a private, independent, non-profit organization that develops and maintains standards for devices and equipment related to public health. NSF International has certification programs for testing and approving treatment devices for the removal of specific contaminants. Use-/entry-devices certified and listed by NSF International will have the **NSF International** mark printed on the device.

If your water is contaminated with health-related contaminants such as cysts or excessive lead levels, look for devices certified under ANSI/NSF Standard 53 for those particular contaminants. The following is a list of standards under which NSF International tests and certifies home drinking water treatment devices.

Standard	**Title**
ANSI/NSF 42	Drinking Water Treatment Units -- Aesthetic Effects
ANSI/NSF 44	Cation Exchange Water Softeners
ANSI/NSF 53	Drinking Water Treatment Units-- Health Effects
ANSI/NSF 55	Ultraviolet Microbiological Water Treatment Systems
ANSI/NSF 58	Reverse Osmosis Drinking Water Treatment Systems
ANSI/NSF 62	Drinking Water Distillation Systems

Certification indicates that the product has met performance standards for removing a test concentration of a particular contaminant. Devices that are certified under ANSI/NSF Standard 53 for Health Effects will indicate if the device has been approved for cyst reduction, lead reduction, VOC reduction, turbidity reduction, etc.

A listing of home treatment devices meeting NSF Standards can be obtained by contacting:

NSF International
789 Dixboro Rd.
Ann Arbor, MI 48105
Telephone: 800-NSF-MARK
734-769-8010
or visit their website at http://www.nsf.org

What Should I Know About Companies Selling Home Drinking Water Treatment Units?

There are many responsible businesses and companies in the home water treatment business that offer products that live up to their claims. However, some companies and salespersons resort to gimmicks and false claims about the safety of drinking water, including water provided by public water systems, in order to sell their products. In some cases consumers have purchased products that are unnecessary, costly or provide treatment in excess of what is required. The less informed you are about the quality of your water, the more likely you are to purchase unnecessary, costly or inappropriate equipment.

Installation and Maintenance of Home Drinking Water Treatment Devices

Should I provide treatment for all the water in the home or just at one tap?

The type of treatment chosen, point-of-entry for the whole house versus point-of-use for an individual tap, will depend on the nature of the problem. For taste and odor problems, use-devices normally will suffice. Minerals that cause scaling on water heaters (calcium and magnesium) or staining of laundry (iron and manganese) should be removed by entry-devices. Entry-devices also should be used to remove or disinfect health-related contaminants such as bacteria, organic chemicals and radon. If use-devices are used to remove health-related contaminants, home owners must make sure that water is not consumed by children or visitors from faucets without home treatment devices.

How much maintenance is required with home drinking water treatment devices?

All devices require routine maintenance to remain effective. Do not expect to install a home treatment device and be able to walk away from it. In many cases maintenance is not expensive or time consuming. In most cases part of the device will have to be replaced at least once a year including filter cartridges, reverse osmosis membranes and ultraviolet light lamps. It is important to note that the treatment device was tested under conditions that probably are different from those in your home, and the actual service life may differ from the manufacturer's rated service life.

Before purchasing a device, find out about the maintenance requirements and costs from the dealer. Filters that are manufactured without a replaceable filter element are usually more costly to operate, as the entire unit is replaced each time. If you purchase a device, have it maintained according to the manufacturer's instructions. An improperly maintained device could cause more harm than good. Keeping accurate maintenance records on treatment devices is very important.

Can home drinking water treatment devices reduce drinking water quality?

Yes, bacteria can grow in some devices, particularly activated carbon units. These bacteria are normally harmless. In other cases contaminants that have been removed by a filter could overload the filter and eventually wash out into the drinking water if the filter is not replaced. In order to avoid these problems, the devices must be used and maintained properly.

Some items to keep in mind when considering the purchase of a home drinking water treatment device:

- Neither DEP nor EPA certifies or endorses these devices. Beware of sellers who make such claims.
- Beware of false claims about the quality and safety of public drinking water. Despite all the publicity about drinking water pollution, drinking water from public water suppliers should be considered safe unless your water supplier has issued the required public notification to the contrary.
- When deciding whether you need to purchase a device for **health-related** contaminants, have the water tested by a DEP-certified laboratory. Use a laboratory not affiliated with the seller of home treatment devices.

- Beware of home demonstrations **that visually show problems with the water,** such as cloudiness or solids in the water. These are usually gimmicks designed to scare the consumer into purchasing the treatment device immediately. **Be especially cautious if anything is added to the water to develop this effect.** The substance added is usually a flocculating agent, which causes dissolved minerals, present in all water, to form larger particles and settle in the bottom of the container.
- Prices can vary widely, so shop around and compare prices and features from different suppliers and manufacturers. Be sure that you are purchasing the right kind of device. A salesperson may recommend a more expensive device such as a reverse osmosis unit, when a less expensive activated carbon or an entry-device water softener may be what is needed. Remember that price is not the only consideration. Be sure that the equipment can solve your particular water problem.
- Look for devices certified and listed by NSF International that have been tested and certified as meeting their standards.
- Ask to see the manufacturer's test information on the percentage removal for the contaminants of concern and compare that with the levels in your drinking water. Removal efficiencies vary among different types of devices and different manufacturers, and in most cases are not 100 percent. Do not take a sales representative's word that the device is effective for a particular problem or contaminant unless such claims can be documented.
- Check with the Better Business Bureau to find out if there are unresolved complaints against the seller. Their web address is http://www.bbb.org .
- Beware of promotional gimmicks such as prizes, gifts or free trips. If it seems too good to be true, it usually is.
- Before buying, find out about warranties, maintenance, the cost and availability of replacement filters and other parts and any installation costs. Also ask the dealer about other installations in the area. Sellers or dealers should be able to provide references allowing you to contact previous purchasers of the treatment device in your area.
- Salespeople should provide you with a written estimate and allow you to consider and review your options before making a decision.

Installation of point-of-use devices:

Point-of-use treatment devices can be connected to the water system in several ways.

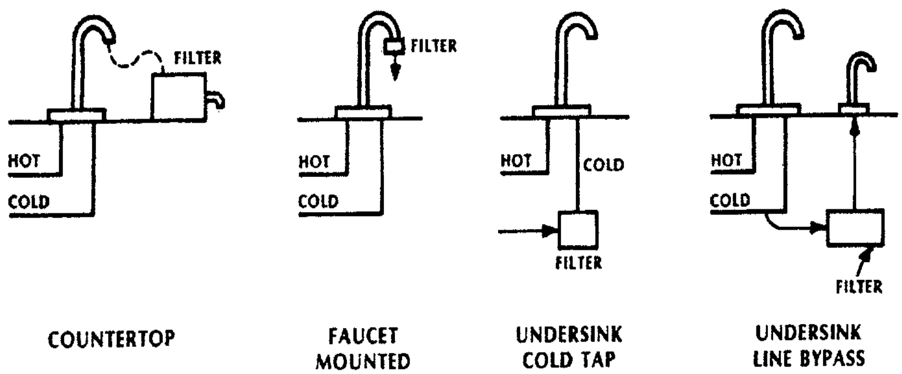
Countertop devices are not connected directly to the plumbing system, but require the user to pour water into the unit on a routine basis. Because the units are fairly small, this type of device usually is only capable of producing a small amount of water during a given time period. Other countertop devices are designed to be temporarily connected to the faucet with a hose. Reverse osmosis, distillation and activated carbon units are available in countertop models. Little or no installation work is required for countertop devices.

Faucet-mounted devices are permanently connected to the faucet and treat all of the water coming through the faucet. This class of device is limited to activated carbon and mechanical filters. Because of the small size and insufficient contact time, this type of device is not recommended except to provide for taste and odor concerns.

Undersink cold tap devices are placed under the sink and are directly attached to the cold water line. Thus, all cold water going to the tap is treated.

Undersink line bypass devices, also called third faucet devices, are connected to the cold water line underneath the sink but bypass the regular faucet. Instead, water is fed to a separate faucet that is installed on the sink. Water flows through a line bypass device in a slow, controlled manner allowing for greater contact time than other types of installations. For this reason, these types of devices are the most effective. Every type of use-device described in this guide is available in a line bypass model. Most line bypass point-of-use units can produce approximately one gallon of treated water per minute.

Installation of Point-of-Use Devices



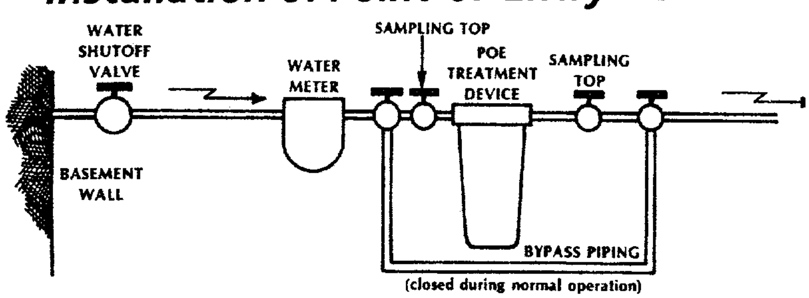
Installation of point-of-entry devices:

Because the installations are fairly complex and improper installation can result in the units not operating properly, entry-devices should be installed only by experienced plumbers. In most cases, entry-devices are installed near the point where the water line enters the home and where it is accessible for maintenance.

Depending on the type of treatment, it may be possible to bypass some of your water around the treatment system so that only a portion of the water is treated. For example, in some water softening systems, it may be possible to soften only the water entering the water heater, leaving the cold water line untreated. This would reduce the cost of water treatment and would provide softened water where it is most needed such as dishwashers, showers and laundries. Entry-devices used for health-related contaminants should treat all the water entering the home, although treatment is not needed for faucets used for non-drinking or non-consumption purposes such as lawn watering or car washing.

Entry-device systems should include a sampling tap prior to and after the units to allow the performance of the unit to be monitored. They should include a bypass valve and piping which will prevent interruption of the water supply during backwashing, maintenance or breakdown of the unit. To adequately supply a typical home, entry-device systems should be capable of producing seven to ten gallons of treated water per minute.

Installation of Point-of-Entry Devices



List of Devices For Treating Some of the More Common Contaminants and Undesirable Minerals

Treatment Device

Contaminant and Minerals	UV Light	Ion Exch.	Mech. Filter	Actd. Carbon	Actd. Alum	Reverse Osmosis	Distillation	Aeration	Chlorination
Bacteria and Viruses	●								●
Taste and Odor				●		●	●		
Lead		●		●	●	●	●		
Nitrate		●				●	●		
Chlorine, Trihalomethanes				●					
Radon				●				●	
Hardness		●							
VOCs and other Organics				●				●	
Pesticides, PCBs				●			●		
Iron and Manganese		●				●			●
Sulfate		●				●	●		
Giardia and *Crytosporidium* Cysts			●			●	●		
Sediment, Turbidity			●						
Total Dissolved Solids						●	●		
Aluminum						●	●		
Arsenic					●	●	●		
Barium		●				●	●		
Cadmium		●				●	●		
Chloride						●	●		
Chromium						●	●		
Copper						●	●		
Fluoride					●	●	●		
Mercury						●	●		
Radium		●				●	●		
Selenium					●	●	●		
Silver						●	●		
Zinc						●	●		

*T*ypes of Home Drinking Water Treatment Devices

This section describes how some of the more common types of home treatment units work and some of the advantages and disadvantages of each type of treatment device.

A list of some of the more common types of contaminants and the types of devices used to treat each contaminant is listed in the table on page 15.

Ultraviolet Light Disinfection Systems

Ultraviolet (UV) light systems are used solely for disinfection. In a typical UV system, water enters a chamber containing a mercury lamp. When operating properly, the ultraviolet light emitted from the lamp destroys harmful bacteria and viruses. No chemicals are added to the water so there are no added taste problems.

An ultraviolet system will not be effective on water that has high turbidity (cloudy) because the light cannot penetrate to kill all harmful micro-organisms. Water with high turbidity levels should be filtered and in some cases treated by an ion exchange process before it passes into the ultraviolet unit. Ultraviolet units are not effective for inactivation of *Giardia* or *Cryptosporidium* cysts, which should be removed by a mechanical filter certified by NSF International for cyst reduction.

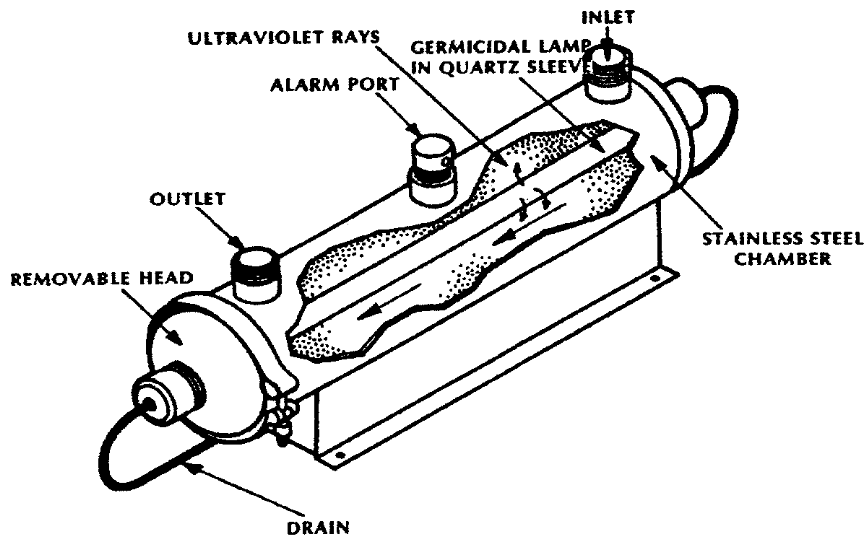
The intensity of the ultraviolet light emitted by the lamp gradually decreases and eventually the unit becomes ineffective for killing bacteria. The decrease in lamp output can be caused by a weak or burned-out light or by sediment coating the lamp. To avoid this problem, units should have a means to alert the user when the intensity of light reaching the outside chamber falls below a minimum acceptable level. The best method is a shutoff or audible alarm that sounds when the ultraviolet lamp is not maintaining the required intensity to ensure proper disinfection. The sight port on most existing UV treatment devices will accept a warning alarm. Besides the added assurance that the water is receiving adequate treatment, the additional cost of the alarm is offset by the longer service life for each lamp if cleaning is all that is required.

The lamps inside the unit are replaced on an annual basis or when the alarm indicates that the lamp output has decreased to a level where it is no longer effective. To be effective, the lamp must be kept clean. Devices are designed to be cleaned using chemical solutions, usually on an annual basis when the UV light is replaced. Mechanical wipers are sometimes included to provide additional removal of dirt from the UV lamp between cleanings.

To ensure the safety of all the water used throughout the home, entry-device systems are recommended, although smaller use-devices are also available.

Entry-device systems should be rated for a minimum of 7-10 gallons per minute, with larger units necessary where there is greater peak water usage due to the size of the household or additional bathrooms. If more water is passed through the unit than the unit is rated for, the water will not be adequately disinfected. To prevent this from happening, a flow control device should be installed with each unit.

Ultraviolet Light Disinfection System



Ion Exchange

The most common and oldest application for ion exchange is water softening which removes hardness. In water softening, calcium and magnesium ions are exchanged for sodium or potassium ions. There are many reliable softeners on the market.

Ion exchange treatment devices can remove different dissolved inorganic minerals from water, such as calcium, magnesium, sulfates, etc. Inside an ion exchange device, water passes through a filter resin. Calcium and magnesium in the water are exchanged for sodium or potassium. Thus one mineral is replaced by another.

Eventually, the resin becomes saturated and must be regenerated. This is done automatically by flushing the material in the softening tank with the salt or potassium brine. An automatic timer on the ion exchange unit commonly is used to regulate when this regeneration cycle occurs. The length of time between regeneration cycles is set for a given period of time depending on the hardness of the water, the amount of resin in the tank, and your water usage. Other units called demand-initiated regeneration (DIR) measure the amount of water used since the last regeneration, or measure increasing hardness to determine the timing of the regeneration cycle. The less expensive timer-controlled units will work well if your water usage remains relatively constant.

Persons on a strict low sodium diet should discuss with their physician the use of a softener which uses sodium chloride, as the sodium concentration of the water will increase. However, the amount of sodium consumed from water treated by a softener is small in comparison to typical sodium amounts contained in prepared foods such as snacks, soups, cereals and prepared meats. For consumers concerned about sodium, water softeners are available that use potassium as the exchange ion rather than sodium. Drinking water taps also may be bypassed to provide softened water for bathing, cleaning and laundering. The use of bottled water is another option to consider.

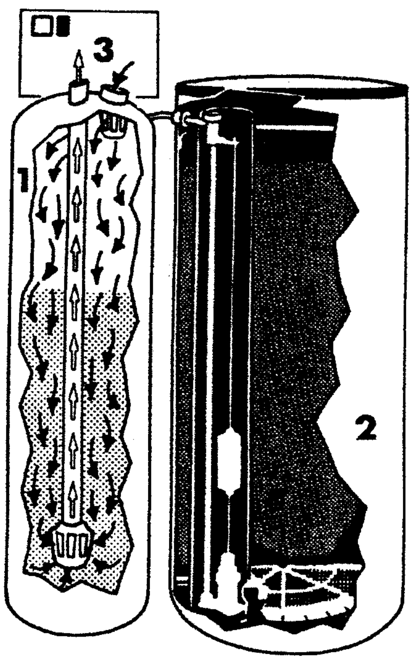
The exchange process used in water softening is called a cation exchange process. There is also an anion exchange process in which a different resin is used for nitrate, chloride and sulfate removal. If the water is high in both sulfate and nitrate, it may be necessary to use a two-stage system that removes sulfate first and nitrate second. Otherwise, the sulfate will interfere with the performance of the unit. Anion exchange systems are the most common systems chosen for nitrate removal.

A variety of other inorganic minerals can be removed by ion exchange systems. These are listed in the table on page 15.

The use of softener units not designed for iron removal can result in coating of the resin with iron and premature replacement of the unit. Normal ion exchange treatment devices can be used for iron and manganese removal only when these minerals occur in fairly low concentrations of less than 1 mg/L. For higher iron concentrations, a specialized unit utilizing an iron stripping agent in the salt or an oxidizing manganese greensand filter will be required. A manganese greensand filter is similar in design to other ion exchange units. The greensand resin provides oxygen to oxidize the iron, manganese or hydrogen sulfide. Potassium permanganate is used to regenerate the greensand, once it becomes depleted of oxygen.

Ion exchange devices used for lead removal should be specifically designed by the manufacturer for this purpose. If lead comes from the household plumbing, lead removal devices should be use-devices installed at the tap.

Ion Exchange Water Conditioner



1. Raw water flows into the mineral resin tank containing the resin, where calcium and magnesium ions are exchanged for sodium ions.
2. Salt storage container, the salt brine formed here is used to regenerate the resin in the mineral resin tank.
3. Control valves and timer used for control when regeneration takes place.

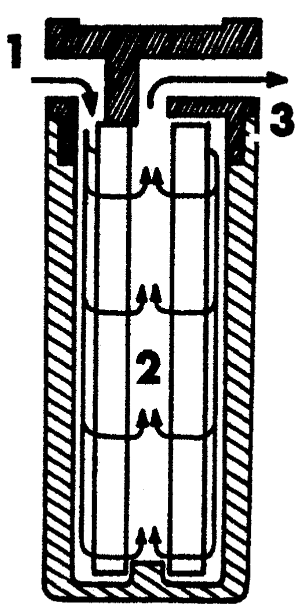
Mechanical Filters

Filters are the simplest of home drinking water treatment devices. They trap particles in a porous material while allowing water to pass through the material. Filters can be made of sand, fibers, anthracite, ceramics or other man-made materials. Filters can remove particles such as rust and sediment. Some filters are also effective for turbidity (cloudy water) and *Giardia* or *Cryptosporidium* cyst removal. Due to the potential health effects of ingesting cysts, mechanical filtration units purchased for cyst removal should have the **NSF International** mark and be in the NSF International listings indicating that they have been tested as being effective for cyst reduction. Mechanical filters cannot remove dissolved constituents in the water. For this reason, they are ineffective at removing many common contaminants such as hardness, salt, nitrate, organic chemicals and most metals. Mechanical filters are commonly used as pretreatment for reverse osmosis, ultraviolet disinfection and other treatment processes.

As filters remove particles from the water, they get clogged and have to be replaced or cleaned. The more solids in the water, the faster the filter will clog. The need for maintenance will be signaled by a decrease in flow through the filter. Dirty filters can cause an increase in bacteria in the water.

Oxidizing filters (e.g., manganese greensand) are a particular type of filter used for iron, manganese and hydrogen sulfide removal. These filters use an oxidizing chemical that converts minerals to an insoluble form which is more easily removed by filtration. Oxidizing filters usually require some type of continuous chemical addition—normally chlorine or potassium permanganate.

Mechanical filters can be used for either point-of-entry or point-of-use treatment. For entry-devices, the filter material is normally cleaned by automatic backwashing. For use-devices, it is typically more economical to simply replace the filter cartridge and dispose of the spent cartridge. Some filters utilize a standard filter size that is available from many different manufacturers, while others require a filter that can only be purchased from that particular manufacturer. In both permanent and disposable filter types, backwashing or cartridge replacement must be done on a routine basis.



Mechanical Filter

1. Water enters top of the filter and passes alongside and into the filter material.
2. Contaminants are trapped in the filter while water passes through.
3. Filtered water leaves the unit.

Activated carbon filters use carbon material (e.g., coal, charcoal, wood or bone) to absorb dissolved organic material, radon and chlorine from water. The carbon contains a vast network of minuscule channels and a large surface area on which contaminants are absorbed as the water passes through the charcoal.

Activated carbon will remove chlorine, trihalomethanes, radon, pesticides and most organic compounds. However, it will not remove most inorganic compounds, such as nitrate, and is **not** meant to remove particulate matter, such as suspended solids. Activated carbon filters are often used to improve the aesthetic quality of water since they are very effective at reducing taste, odor and color problems. The presence of solids in the raw water will shorten the expected life of the filter by clogging it. Certain types of carbon filters, such as some carbon block filters, are effective for lead removal. Carbon block filters have the carbon pressed into a solid block and are able to filter small particles.

Normally, the price for an activated carbon unit is less than other types of treatment devices. Unlike some of the other treatment processes, activated carbon does not require electric power and does not waste water.

Activated carbon is used in both point-of-entry and point-of-use treatment devices and is installed in various fashions including **faucet mount, pour through countertop and separate faucet line bypass models.** The most effective units are high volume filters that are installed under the sink.

Activated carbon treatment devices used for radon removal must treat **all** the water entering the home, so entry-devices must be used. The minimum volume of activated carbon needed for effective radon removal is normally 1.5 cubic feet. However, this is greatly dependent on the level of radon in the raw water. In addition, some types of activated carbon are more effective for radon removal than others. Consumers considering purchasing units for radon removal should confirm that the dealer has experience in this area.

The organic compound removal efficiency of activated carbon filters depends on the length of time contaminated water is in contact with the activated carbon. Keeping the flow rate at the tap low will improve the efficiency of an activated carbon filter. The greater the amount of carbon, the greater the contaminant removal efficiency. For this reason, small filters that mount directly on the faucet are very inefficient and should be avoided. For water contaminated with organics, use only a filter with a large volume.

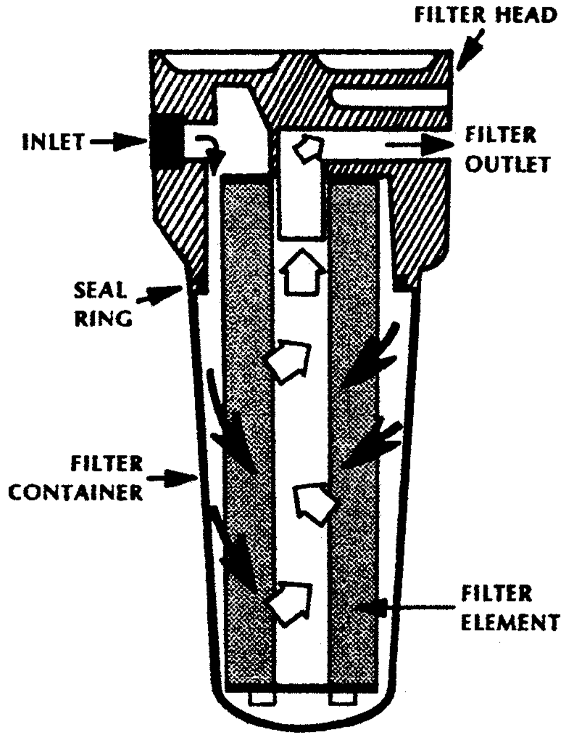
To keep the unit operating properly, frequent replacement of the filter cartridge is necessary. Replacements are usually needed once every six months or after treating a certain amount of water, usually 300 to 1000 gallons. NSF-certified devices will list the time interval as well as the capacity on the device's data plate. Pour-through and faucet-mounted filters need to have their filters replaced more frequently. The manufacturer should be able to provide data on the expected life of the filter for the contaminants of concern. Devices that do not have the capability to replace only the filter should be avoided. The life of the filter will be shortened significantly if the contaminant load increases or if the tap is used more than expected. If the filters are not replaced at the required time, the amount of contaminants in the drinking water can be greater than if no treatment device was used.

Research has shown that activated carbon filters can promote the growth of certain types of bacteria. The bacteria that grow on the carbon are usually harmless unless some type of contamination has occurred from the source water or contact with humans during installation or replacement, etc. The following safeguards are recommended:

- Use activated carbon filters, without additional disinfection, only on a microbiologically safe water supply that is properly disinfected.
- Before using the device after a period of nonuse, such as overnight, run the water for 30 seconds or longer at full flow before using. A longer flushing time is recommended after a prolonged nonuse period of several days.

- Change the filter cartridges at least as frequently as recommended by the manufacturer.
- Adhere to the manufacturer's maintenance recommendations and specific instructions on changing the filter cartridges.

Activated Carbon and Activated Alumina Filters



Activated Alumina Filters

The activated alumina process is very similar to the activated carbon process. Water flows through a cartridge containing a filter material consisting of activated alumina. The material has a large, highly irregular surface area that removes contaminants from the water.

Activated alumina filters have been used to remove fluoride, arsenic and certain heavy metals including lead, from drinking water. Since there are several different types of activated alumina, each with different properties, the filter selected should be one designed to specifically remove the contaminant of concern.

As with activated carbon filters, the greater the volume of filter media, the longer the life of the cartridge and the better the removal efficiency. The filters can experience problems with bacterial growth similar to carbon filters. The expected life of activated alumina filters is similar to that of activated carbon.

The advantages of using activated alumina filters are that they do not require electric power, as distillation does, and do not use water, as reverse osmosis does. The purchase price of an activated alumina unit also will be lower than either distillation or reverse osmosis treatment devices.

However, activated alumina will not remove as many contaminants as either of the other two processes. As with other processes, periodic replacement of the activated alumina filter cartridge is required.

Reverse Osmosis

Reverse-osmosis treatment devices use a membrane with pores small enough to screen out contaminants. Pressure in the water line pushes water through the pores in the membrane, while large contaminant molecules are retained and eventually washed down the drain. No electrical power is required as the system operates from line pressure. Most reverse-osmosis devices are installed as point-of-use treatment.

Reverse osmosis is an effective method for removing several different types of contaminants. Reverse osmosis can remove most inorganic materials (including lead, iron and chlorine) and some organic materials. Nitrate removal varies depending on the type of membrane. Thin film composite membranes are more effective than cellulose acetate membranes for nitrate removal. Point-of-use reverse-osmosis units operate efficiently at water pressures above 40 pounds per square inch on raw waters with up to 2,000 mg/L of total dissolved solids.

Factors affecting the performance of reverse-osmosis treatment devices include water pressure, type of membrane, and the type and amount of contaminants. Several different types of reverse-osmosis membranes are available, but the most effective membranes are cellulose acetate and thin film composite membranes. Membrane selection must be made based on the type of contaminants to be removed and other water quality characteristics. Before purchasing a reverse-osmosis treatment system, consult the dealer or manufacturer about the type of membrane most suited for your particular needs.

Hardness can hinder the working of the reverse-osmosis membrane by clogging its pores, so it may be necessary to have a water softener before the reverse-osmosis unit where water is very hard. Several manufacturers recommend that hardness levels not exceed ten grains per gallon or 171 mg/L as $CaCO_3$ when a reverse-osmosis treatment unit is used. In addition, some reverse osmosis membranes should not be used on wells that contain high iron concentrations or coliform bacteria. The manufacturer can supply information regarding the level of hardness and iron that the reverse-osmosis treatment device can tolerate.

High chlorine concentrations can damage some reverse-osmosis membranes, particularly thin film composite membranes. Consult the dealer or manufacturer to find out what chlorine levels the membrane can tolerate. If a reverse-osmosis treatment device is used on a chlorinated water source, a carbon filter should be utilized to remove chlorine from the water prior to the reverse-osmosis unit. More frequent replacement of the carbon filter is required in these situations to prevent premature failure of the more expensive reverse-osmosis membrane.

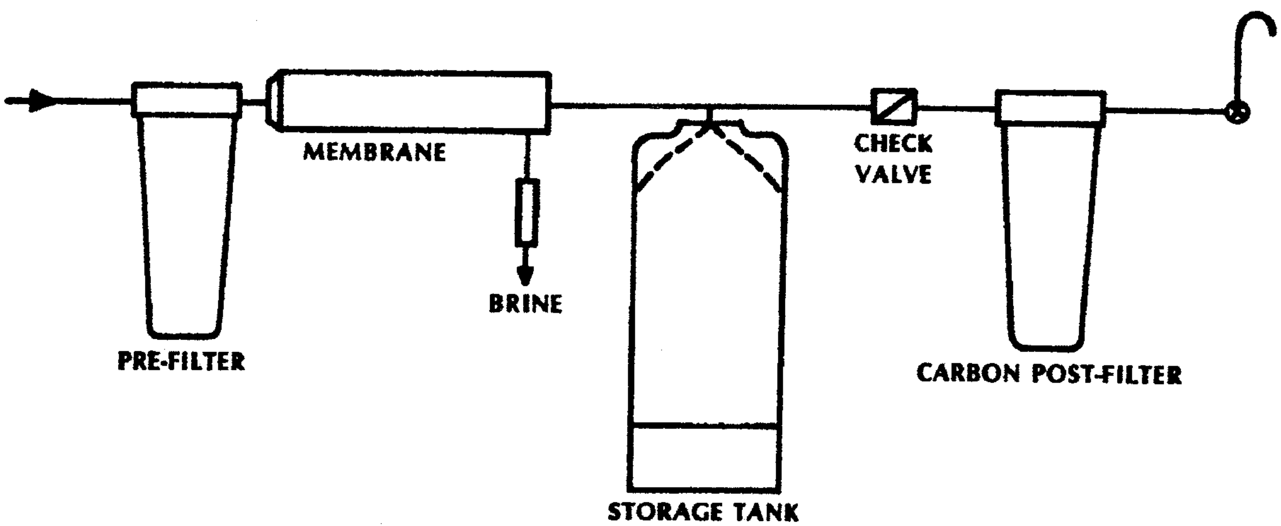
Complete reverse-osmosis treatment devices generally come equipped with a mechanical pre-filter to remove sediment, a reverse-osmosis module that contains the membrane, an activated carbon filter to remove organics not removed by the reverse-osmosis module, a pressurized storage tank and a special spigot for the sink. Most reverse-osmosis units are mounted under the sink where the greatest volume of drinking water is drawn and connected to the cold water line with a line bypass. This type of installation does not provide treated water throughout the home or building, but effectively can provide a very high degree of treatment to the two to five percent of household water used for drinking and cooking.

All reverse-osmosis treatment devices contain a drain line which is connected to the sink drain through which contaminants and minerals are continually washed with the rejected water. To prevent contamination of the treatment unit by the sanitary drain, an approved air gap must be utilized between the treatment unit and the drain. Be certain that the air gap is included as part of the installation. Reverse-osmosis units provide the home owner with finished water at 10 to 30 percent of the total water run through the system. Thus, a unit would require up to 20 gallons of water to produce two gallons of finished water.

Removal efficiency with reverse osmosis is dependent on water pressure in the home. The higher the pressure, the higher the level of contaminant removal. Most homes have a tap pressure of at least 40 psi, which should be sufficient for most reverse-osmosis treatment devices. For homes with lower pressure, a booster pump may be needed for the reverse-osmosis treatment device to properly operate.

Proper maintenance is important. Most manufacturers recommend annual replacement of the filters and replacement of the reverse-osmosis cartridge every one to five years. Reverse-osmosis is a very effective, although more expensive treatment method. Consumers should consider whether less expensive treatment methods would meet their needs before purchasing reverse-osmosis units.

Reverse Osmosis



Distillation

Distillation boils water to steam and then cools the steam until it condenses. The contaminants—metals, salt, sediment and anything else that will not boil or evaporate—are left behind in the boiling pot. The only contaminants that distillation will not remove are VOCs. Since VOCs have boiling points close to that of water, they are carried off with the steam and end up in the distilled water. Some distillation units come equipped with a small activated carbon filter which is designed to remove VOCs from the distilled water.

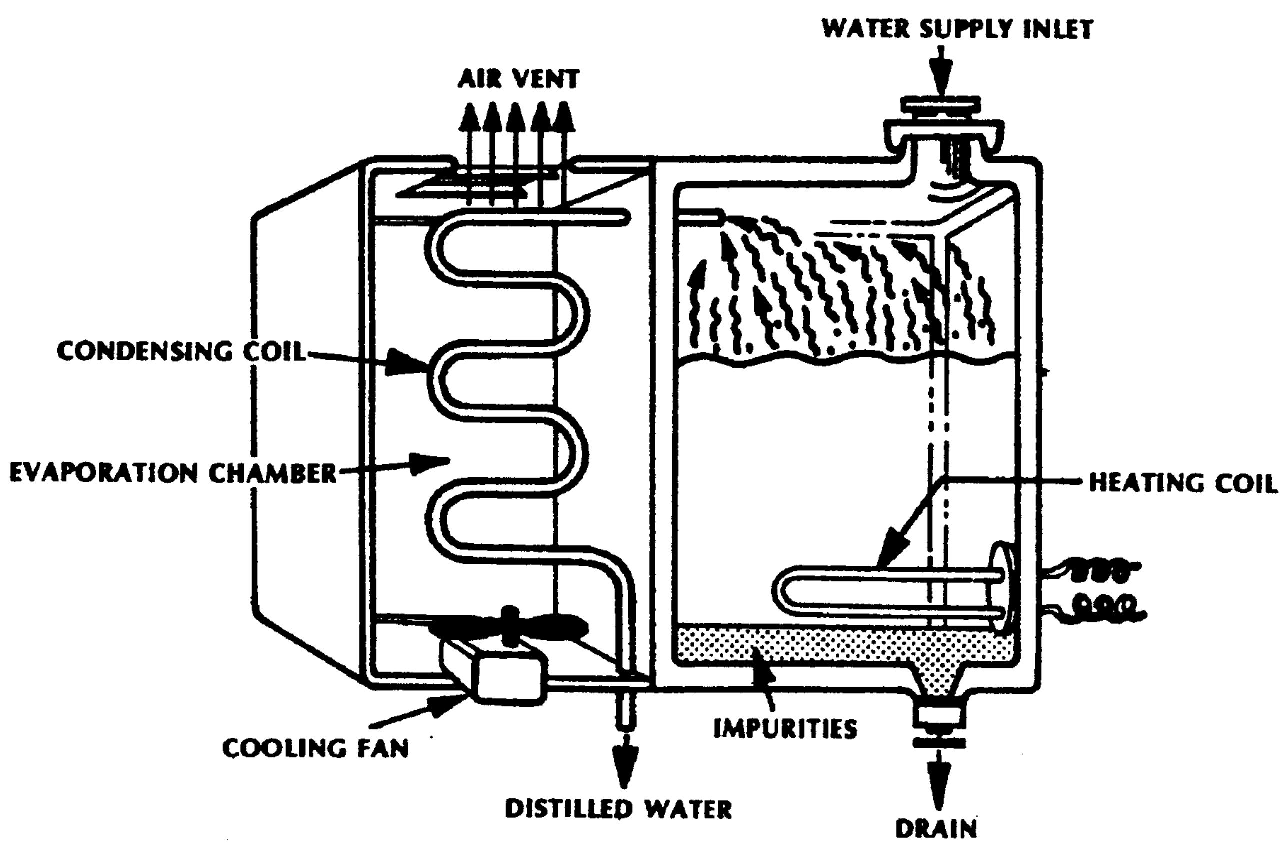
Distillers are made to rest on the countertop and be filled manually or are installed under the sink, where they are connected to a cold water line.

Although distillation can be very effective at removing a wide variety of contaminants, there are several drawbacks with these systems. First, distillation devices need frequent maintenance. Minerals and other contaminants accumulate in the heating tank and form scale, which interferes with the heating process. If the home has hard water, the heating tank will have to be cleaned or flushed frequently.

Distillers also use electricity to heat the water. Typical electric costs are 20 to 35 cents per gallon of water produced.

Another disadvantage is that distillation is a slow process. Most devices take at least five hours to make one gallon of water. For these reasons, distillation is rarely used as a home drinking water treatment device.

Distillation



Home aeration systems primarily are used for the removal of radon from drinking water. Radon is exclusively a problem where groundwater is used to supply drinking water. Aeration also will reduce volatile organic chemical levels. Although aeration treatment devices are costly to purchase and install, it is the best technology available for removing high radon levels.

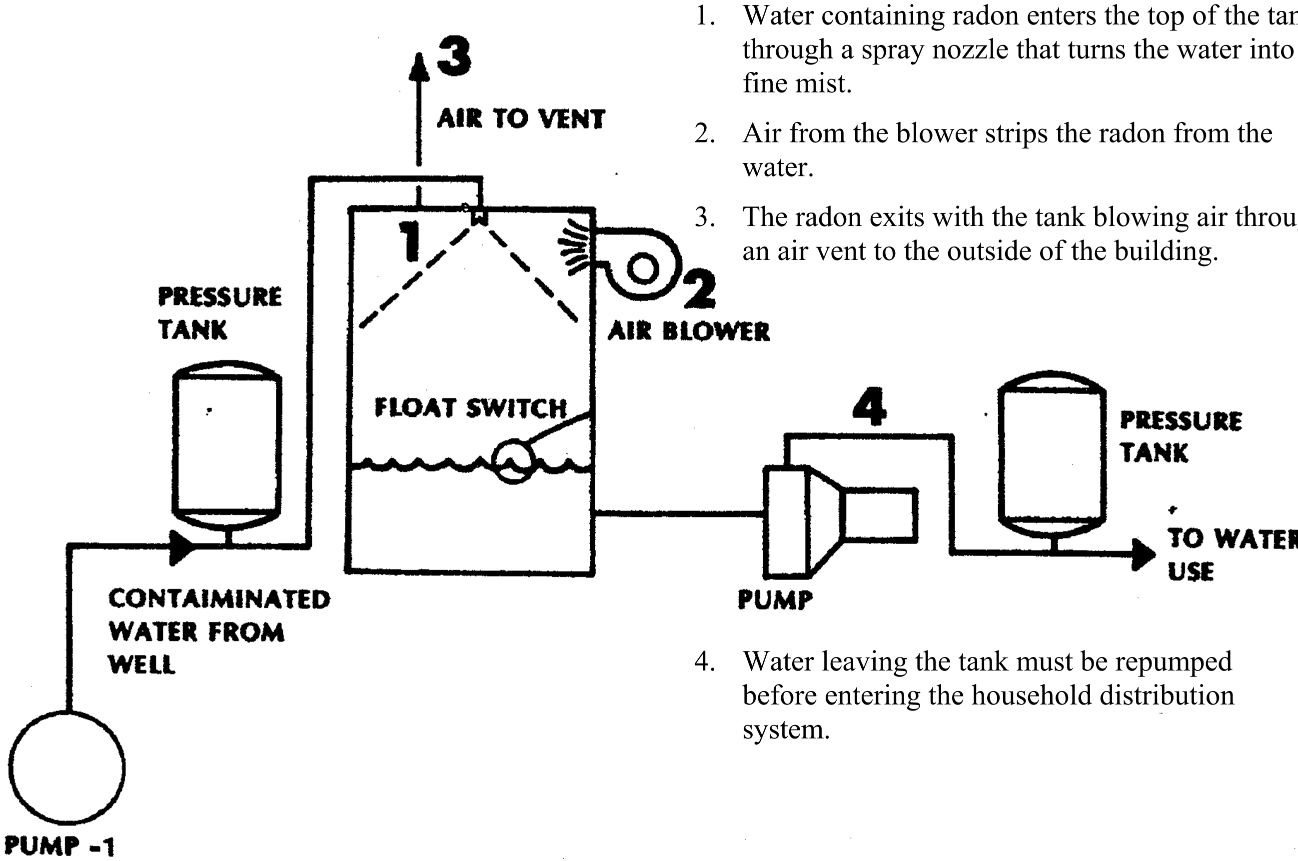
The treatment device consists of a tank equipped with a blower and a vent system. Water from the well is sprayed into the aerator. Air flow from the blower then removes the radon, which is vented to the outside of the house. Since radon is a gas, it is removed fairly easily by the induced air current in the tank.

After water leaves the aeration unit, it must be repressurized with a second pump. This means that homes with individual wells may have to pump the water twice. First, from the well into the home where the aeration tank is placed, and second, from the tank into the home plumbing system. A second pressure tank may be required depending on how the home plumbing system has been installed.

The vent pipe and flap from the aeration system should extend to the roof of the house so the radon will be released at a level where it can not re-enter the home or be inhaled by persons outside of the home. The blower will make noise comparable to that from a forced air furnace, so the unit should be placed in an isolated area if possible.

Depending on the water characteristics, the air flow in the tank may cause mineral coatings such as iron or calcium to form on the inside of the tank. Routine cleaning of the unit is necessary.

AERATION



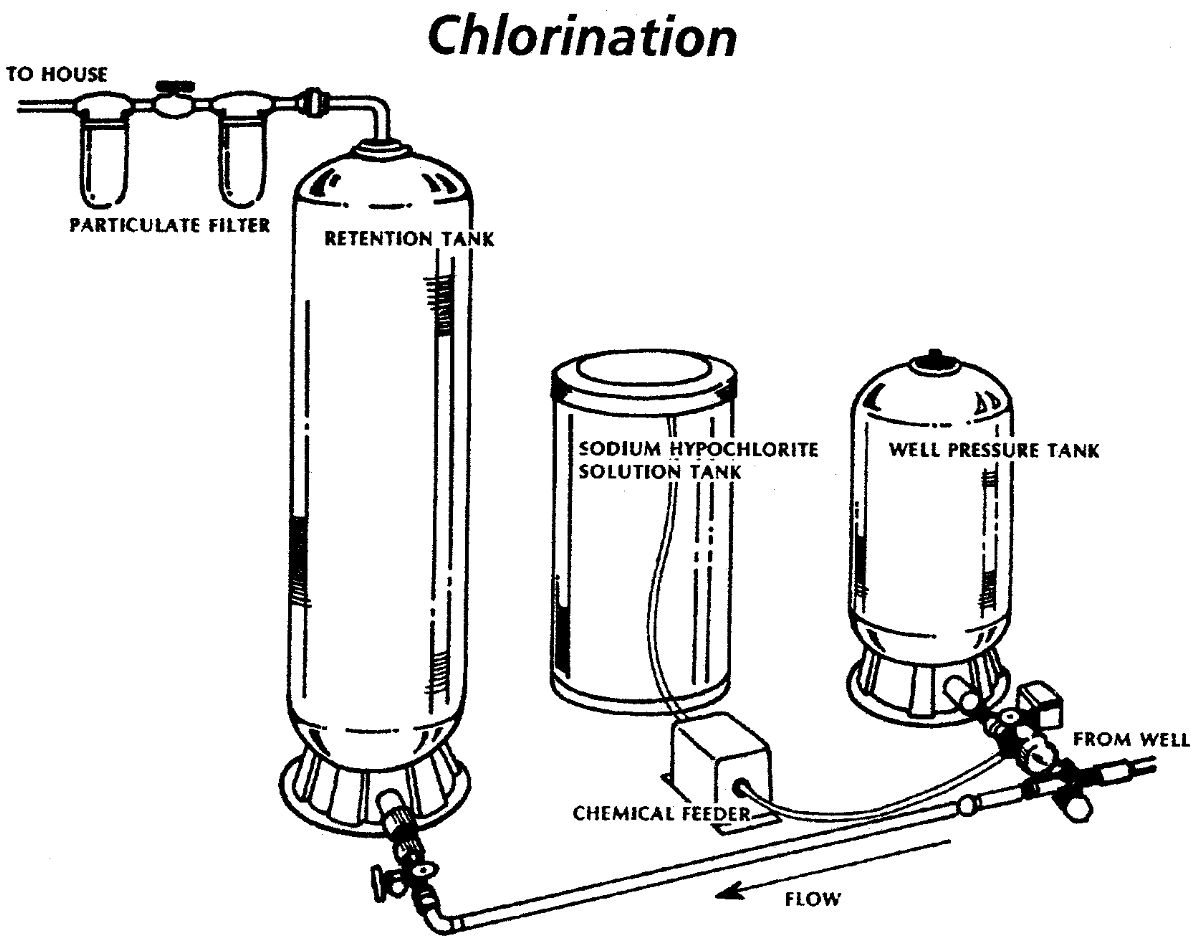
1. Water containing radon enters the top of the tank through a spray nozzle that turns the water into a fine mist.
2. Air from the blower strips the radon from the water.
3. The radon exits with the tank blowing air through an air vent to the outside of the building.
4. Water leaving the tank must be repumped before entering the household distribution system.

Chlorination

Chlorination systems are the only effective way to handle large amounts of iron, hydrogen sulfide and colloidal inorganics. Chlorination systems are effective in eliminating bacterial contamination. Although in most cases it is more cost effective and simpler to use an ultraviolet (UV) light disinfection unit. This is true even when the water must be treated for turbidity removal prior to the UV treatment device.

A chlorination treatment device consists of a chlorine solution tank, a chemical feeder, a retention tank, a particulate filter and frequently an activated carbon filter. The homeowner prepares a solution of sodium hypochlorite in a solution tank. Sodium hypochlorite is available in different strengths typically in the 10 to 15 percent range, which is diluted when placed in the chemical solution tank.

The homeowner should purchase sodium hypochlorite that is certified under ANSI/NSF Standard 60 as being acceptable for disinfection of potable water. The use of common household laundry bleach, which contains a 5.25 percent sodium hypochlorite solution, is not recommended, because the chemical purity of the product may not be suitable for addition to drinking water. The solution is fed into the drinking water by a chemical feed pump set to run with the well pump. A retention tank is required when using chlorine systems to allow the contaminants to precipitate and adequate contact time for proper disinfection. A detention time of 20 minutes is a minimum and, in many cases, a 30-minute detention time will be needed.



Summary of Advantages, Disadvantages and Costs of Various Types of Entry/Use Treatment Devices

Ultraviolet Light

Advantages: Effective for destroying bacteria and viruses and disinfecting drinking water.

Disadvantages: Will not remove contaminants other than bacteria and viruses.

Not effective for *Giardia* and *Cryptosporidium* cyst removal.

Costs: Units typically cost between $300 and $700.

Ion Exchange (excluding manganese greensand)

Advantages: Effective for removing minerals such as hardness, barium, radium, nitrate, sulfate, calcium and magnesium. Effective for removing iron (provided concentrations do not exceed about 1 mg/L).

Disadvantages: Requires regeneration (usually with sodium chloride or potassium chloride).

Costs: Typical costs vary from $500 to $1200 depending on the resin (anion exchange resins cost more than cation exchange resins) and type of equipment.

Mechanical Filters

Advantages: Effective for removing suspended particles such as rust, dirt and sediment. Filters tested and approved for *Giardia* and *Cryptosporidium* cysts are available.

Disadvantages: Not effective for removing dissolved contaminants such as lead, nitrate, VOCs, etc.

Costs: Use-device mechanical particulate filters typically cost between $30 and $100, with filter replacement cost of $15 to $40.

Activated Carbon Filters

Advantages: Effective at removing a wide range of organic contaminants such as VOCs and pesticides.

Carbon block and precoat designs have been validated as effective for lead reduction.

Often effective for reducing taste and odor problems.

Does not use electricity or generate wastewater.

Disadvantages: Not effective at removing inorganic materials such as hardness, iron, nitrate or fluoride.

Bacteria growth may occur in the carbon filter if not maintained properly.

May require post-disinfection facilities.

Costs: Point-of-Use activated carbon filters typically cost between $75 and $350. Replacement filter cost is in the $20 to $40 range.

Point-of-Entry treatment devices typically cost between $500 and $1,250. Replacement filters cost $200 to $400.

Activated Alumina Filters

Advantages: Effective for removal of arsenic, fluoride and lead. Does not use

Activated Alumina Filters (con't.)

	electricity and does not waste water.
Disadvantages:	Will usually not remove minerals other than those listed above.
Costs:	Similar to activated carbon.

Reverse Osmosis

Advantages:	Can remove a wide variety of inorganic and organic contaminants including lead, nitrate and sodium.
	Normal household water pressure provides good performance.
Disadvantages:	Uses from three to five gallons of water for each gallon produced.
	Some membranes are damaged by chlorine.
Costs:	Under the sink use-devices that include a mechanical prefilter and an activated carbon post filter typically cost $400 to $1,000. Replacement membranes cost $30 to $100.

Distillation

Advantages:	Removes the greatest variety of contaminants.
Disadvantages:	Uses approximately three kilowatts of electricity per gallon of water.
	Water-cooled units waste a considerable amount of water.
	Will require frequent cleaning, especially where the water is hard.
	Removal of minerals may leave bland taste to the water.
	Process is slow.
Costs:	Between $99 and $500 for a countertop model.

Aeration

Advantages:	Effective for removing radon and volatile organic chemicals.
Disadvantages:	Expensive to purchase and install.
	Requires secondary pumping and pressurization.
Costs:	Between $2,200 and $3,800.

Chlorination

Advantages:	Only effective way of dealing with large amounts of iron, hydrogen sulfide and colloidal iron.
	Is also an excellent disinfectant.
Disadvantages:	Requires handling and storage of hazardous chemicals.
	Requires time to insure that chemicals are mixed properly and available when needed.
Costs:	Between $800 and $1,500.

APPENDIX A

List of Organizations Providing Information and Assistance to Consumers on Home Drinking Water Treatment Devices

1. **NSF International.** NSF International is a source of information on treatment devices and specific manufacturer's products.

   NSF International
   789 Dixboro Rd.
   Ann Arbor, MI 48113-0140
   800-NSF-MARK
   734-769-8010 or their website at http://www.nsf.org

2. **Water Quality Association (WQA).** WQA is an international trade association representing firms engaged in the manufacture of water treatment equipment. WQA is a source of information on treatment devices and has a voluntary certification program for home treatment devices used for the treatment of nonhealth (i.e., aesthetic) related contaminants.

   Water Quality Association
   4151 Naperville Road
   Lisle, IL 60532-1088
   630-505-0160 or their website at http://www.wqa.org

3. **DEP Regional Offices.** The regional offices of DEP are available to answer questions that you might have concerning the quality of your drinking water. The addresses and telephone numbers for the regional offices are listed in Appendix B.

4. **EPA's Safe Drinking Water Hotline.** This is a toll-free hotline that connects you to experts on drinking water quality. Several free brochures are also available. The hotline is sponsored by EPA and can be reached at 1-800-426-4791, Monday through Friday, 9:00 a.m. to 5:30 p.m. EST. Information about EPA's Safe Drinking Water Hotline can also be obtained at http://www.epa.gov/safewater .

5. **National Pesticide Information Center.** This is a toll-free hotline that can provide you with information on the health effects of particular pesticides and pesticide poisoning. The hotline is sponsored by EPA and the Oregon State University and can be reached 24 hours a day at 1-800-858-7378. Information about the National Pesticide Information Center can also be obtained at http://www.npic.orst.edu .

6. **Penn State Cooperative Extension.** The Penn State Cooperative Extension has Agricultural and Biological Engineering fact sheets on several items related to home drinking water. The Agricultural and Biological Engineering Department can be reached at 814-865-7792. These fact sheets can also be obtained at http://www.abe.psu.edu/extension/factsheets/f/index.html .

7. **Consumer Reports** magazine reviews different types of home treatment devices (e.g., in the July 1995 issue). Check your local library or order your own copy by contacting Consumer Reports, P.O. Box 53016, Boulder, CO 80322, 1-800-234-1645. Information about Consumer Reports can also be obtained at http://www.consumerreports.org .

8. **Better Business Bureau.** The Better Business Bureau maintains records of unresolved complaints. Check to see if there are any against the seller of water treatment devices. Consult your local telephone directory to find the nearest office. Information on the Better Business Bureau can also be obtained through their website at http://www.bbb.org .

9. **The Pennsylvania Attorney General's Office, Bureau of Consumer Protection.** The Bureau of Consumer Protection, has a Consumer Protection Booklet which is available by calling the Consumer Protection Hotline at 1-800-441-2555 or visit their website at http://www.attorneygeneral.gov/pei/know/know.cfm . The hotline can also provide guidance with particular problems.

APPENDIX B

List of DEP Regional Offices and Counties Served

DEP Regional Offices	Counties Supervised		
Southeast Region 2 E. Main St. Norristown, PA 19401 Main Telephone: 484-250-5900 24-hour emergency: 484-250-5900	Bucks Chester	Delaware Montgomery	Philadelphia
Northeast Region 2 Public Square Wilkes-Barre, PA 18711-0790 Main Telephone: 570-826-2511 24-hour emergency: 570-826-2511	Carbon Lackawanna Lehigh Luzerne	Monroe Northampton Pike Schuylkill	Susquehanna Wayne Wyoming
Southcentral Region 909 Elmerton Ave. Harrisburg, PA 17110 Main Telephone: 717-705-4700 24-hour emergency: 1-877-333-1940	Adams Bedford Berks Blair Cumberland	Dauphin Franklin Fulton Huntingdon Juniata	Lancaster Lebanon Mifflin Perry York
Northcentral Region 208 W. Third St., Suite 101 Williamsport, PA 17701 Main Telephone: 570-327-3636 24-hour emergency: 570-327-3636	Bradford Cameron Centre Clearfield Clinton	Columbia Lycoming Montour Northumberland Potter	Snyder Sullivan Tioga Union
Southwest Region 400 Waterfront Drive Pittsburgh, PA 15222-4745 Main Telephone: 412-442-4000 24-hour emergency: 412-442-4000	Allegheny Armstrong Beaver Cambria	Fayette Greene Indiana Somerset	Washington Westmoreland
Northwest Region 230 Chestnut St. Meadville, PA 16335-3481 Main Telephone: 814-332-6945 24-hour emergency: 1-800-373-3398	Butler Clarion Crawford Elk	Erie Forest Jefferson Lawrence	McKean Mercer Venango Warren

APPENDIX C

Pennsylvania Maximum Contaminant Levels

PRIMARY CONTAMINANTS

Volatile Organic Chemicals (VOCs):

Benzene	0.005	mg/L
Carbon Tetrachloride	0.005	mg/L
o-Dichlorobenzene	0.6	mg/L
para-Dichlorobenzene	0.075	mg/L
1, 2-Dichloroethane	0.005	mg/L
1, 1-Dichloroethylene	0.007	mg/L
cis - 1, 2-Dichloroethylene	0.07	mg/L
trans - 1, 2-Dichloroethylene	0.1	mg/L
Dichloromethane	0.005	mg/L
1, 2-Dichloropropane	0.005	mg/L
Ethylbenzene	0.7	mg/L
Monochlorobenzene	0.1	mg/L
Styrene	0.1	mg/L
Tetrachloroethylene	0.005	mg/L
Toluene	1	mg/L
1, 2, 4-Trichlorobenzene	0.07	mg/L
1, 1, 1-Trichloroethane	0.2	mg/L
1, 1, 2-Trichloroethane	0.005	mg/L
Trichloroethylene	0.005	mg/L
Vinyl Chloride	0.002	mg/L
Xylenes (Total)	10	mg/L

Synthetic Organic Chemicals (SOCs):

Alachlor	0.002	mg/L
Atrazine	0.003	mg/L
Benzo(a)Pyrene	0.0002	mg/L
Carbofuran	0.04	mg/L
Chlordane	0.002	mg/L
2, 4-D	0.07	mg/L
Dalapon	0.2	mg/L
Dibromochloropropane (DBCP)	0.0002	mg/L
Di (2-Ethylhexyl) Adipate	0.4	mg/L
Di (2-Ethylhexyl) Phthalate	0.006	mg/L
Dinoseb	0.007	mg/L
Diquat	0.02	mg/L
Endothall	0.1	mg/L
Endrin	0.002	mg/L
Ethylene Dibromide (EDB)	0.00005	mg/L
Glyphosate	0.7	mg/L
Heptachlor	0.0004	mg/L
Heptachlor Epoxide	0.0002	mg/L
Hexachlorobenzene	0.001	mg/L
Hexachlorocyclopentadiene	0.05	mg/L
Lindane	0.0002	mg/L
Methoxychlor	0.04	mg/L
Oxamyl (Vydate)	0.2	mg/L
PCBs	0.0005	mg/L
Pentachlorophenol	0.001	mg/L
Picloram	0.5	mg/L
Simazine	0.004	mg/L
2, 3, 7, 8-TCDD (Dioxin)	3×10^{-8}	mg/L
Toxaphene	0.003	mg/L
2, 4, 5-TP (Silvex)	0.05	mg/L

Disinfection Byproducts

Total Trihalomethanes (TTHMs) (Chloroform, Chlorodibromomethane, Bromoform & Bromodichloromethane)	0.080	mg/L
Haloacetic Acids (HAA5) (Monochloroacetic Acid, Dichloroacetic Acid, Trichloroacetic Acid, Bromoacetic Acid, & Dibromoacetic Acid)	0.060	mg/L
Bromate	0.010	mg/L
Chlorite	1.0	mg/L

Radionuclides:

Uranium	0.03	mg/L
Gross Alpha	15	pCi/L
Combined Radium (226 + 228)	5	pCi/L
Beta Particle & Photon Activity	4	mrem/yr

The GROSS ALPHA MCL excludes Radon and Uranium particle activity. The BETA PARTICLE & PHOTON ACTIVITY MCL is for man-made radionuclides.

Inorganic Chemicals (IOCs):

Antimony	0.006	mg/L
Arsenic*	0.010	mg/L
Asbestos	7 million	fibers (longer than 10µm)/L
Barium	2 mg/L	
Beryllium	0.004	mg/L
Cadmium	0.005	mg/L
Chromium	0.1	mg/L
Copper	1.0	mg/L
Cyanide (free CN)	0.2	mg/L
Fluoride	2	mg/L
Lead	0.005	mg/L
Mercury	0.002	mg/L
Nickel	under evaluation	
Nitrate (as Nitrogen)	10	mg/L
Nitrite (as Nitrogen)	1	mg/L
Nitrate + Nitrite (as Nitrogen)	10	mg/L
Selenium	0.05	mg/L
Thallium	0.002	mg/L

*The arsenic MCL will take effect for public water systems on January 23, 2006

Microbiological Contaminants: A positive Fecal Coliform or *E.coli* sample.

TURBIDITY 1 NTU

SECONDARY CONTAMINANTS

Aluminum	0.2	mg/L
Chloride	250	mg/L
Color	15	color units
Corrosivity	non-corrosive	
Foaming Agents	0.5	mg/L
Iron	0.3	mg/L
Manganese	0.05	mg/L
Odor	3	T.O.N.
pH**	6.5-8.5	
Silver	0.1	mg/L
Sulfate	250	mg/L
Total Dissolved Solids	500	mg/L
Zinc	5	mg/L

mg/L = milligrams per liter = parts per million; µm = micrometers; T.O.N. = threshold odor number
pCi/L = picocuries per liter (particle activity); mrem/yr = millirems/yr. (annual dose equivalent)
**The pH MCL represents a “reasonable goal for drinking water quality.”

Bureau of Water Supply and Wastewater Management
P.O. Box 8467
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