



Breast Cancer and Environmental Risk Factors

March 1998

FACT SHEET #7B

Reducing Potential Cancer Risks from Drinking Water

PART II: Home Water Treatment Options

No individual water treatment device removes every contaminant from drinking water. For this reason, people considering the installation of a home water treatment system should first have their drinking water tested to evaluate their water quality. People relying on public water systems can obtain regular test results from their water supplier. Unless the concentration of a contaminant exceeds the maximum contaminant level for public water supplies, home water treatment is unnecessary for health reasons based on the risks established by the Environmental Protection Agency (EPA).

Once the water has been tested, purchase or rent only the treatment devices necessary to effectively remove the contaminants of concern. Consumers should also consider the need and associated costs to maintain and periodically replace a home water treatment system so that it provides continuous, effective treatment of the drinking water. Some water supplies may be so contaminated that treatment cannot remove the contaminants to levels below the applicable drinking water standard. Under these conditions, an alternative drinking water source may be the only feasible option.

Home water treatment devices are defined as either point-of-use or point-of-entry. A **point-of-use** device treats water at specific points within the house, such as beneath the sink or mounted on the faucet. If the contaminant to be removed is only a concern for cooking or drinking, then a point-of-use treatment device may be appropriate. A **point-of-entry** device treats all the water coming into the house and is recommended for removal of radon, VOCs (volatile organic chemicals), and other contaminants that readily evaporate from the water into the air. In this capacity, a point-of-entry device minimizes the risk of inhaling or ingesting chemicals from the shower, dishwasher, washing machine, or other places where the water is heated or stirred.

Before purchasing a home water treatment device, it is important to review a variety of product information to ensure that your final selection will meet your specific needs. In New York State, water treatment device sales people are required by law to show verification of their product claims. However, there is little enforcement capability built into this legislation. In addition, the EPA does not test or approve home water treatment devices. If an EPA registration number appears on certain equipment, this merely indicates that the unit is registered with the EPA. The registration number does not imply EPA approval or certification.

Fortunately for the consumer, NSF International (NSF) is a third-party, nonprofit organization that sets performance standards for water treatment devices and tests equipment that is submitted voluntarily (but for a cost) by the manufacturer. NSF certifies individual drinking water treatment units according to six different standards as well as claims by manufacturers about reduction of specific contaminants under a given standard. All certified products have a data plate that states the minimum requirements of any applicable standards. NSF also monitors fabrication and performance of the treatment device. When changes are made or problems arise, NSF re-tests and re-certifies the equipment.

A variety of physical and chemical home water treatment options are available. It is important to understand that many water treatment devices do not eliminate a contaminant entirely, but instead reduce its concentration to below the applicable drinking water standard. In addition, severe water quality problems may require a treatment system comprising multiple devices. For certain chemicals and many carcinogens, some water treatment options may be inappropriate. The following treatment devices are recognized for reducing certain general cancer risks from drinking water. These devices may also reduce the risks of non-carcinogenic health effects from exposure to drinking water contaminants.



NSF International Standards for Home Water Treatment Units

Standard Number	Standard Description
42	Drinking Water Treatment Units—Aesthetic Effects
44	Cation Exchange Water Softeners
53	Drinking Water Treatment Units—Health Effects
55	Ultraviolet Microbiological Water Treatment Systems
58	Reverse Osmosis Drinking Water Treatment Systems
62	Drinking Water Distillation Systems

For additional information about specific home water treatment devices, contact:
NSF International
3475 Plymouth Road, PO Box 130140
Ann Arbor, MI 48113-0140
1-800-673-6275
www.nsf.org

Activated Carbon Filters

Activated carbon is an effective physical treatment process for removing radon and certain organic chemicals, including some VOCs, pesticides, and THMs (Trihalomethanes). In an activated carbon system, water is passed through a cartridge containing granular, powdered, or block carbon, and the contaminant is attracted to and held on the surface of the carbon material. The efficiency of activated carbon for removing drinking water contaminants is governed by the characteristics of both the carbon material and contaminant, the length of contact time between the water and carbon material, and the overall quality of water with respect to other contaminants. In general, granular activated carbon and block carbon filters are most effective for removing organic chemicals and other contaminants that do not dissolve easily in water.

Several types of activated carbon units are available to homeowners: pour through, faucet mount, counter-top manual fill, counter-top connected to sink faucet, plumbed-in, and point-of-entry. Of these, only a point-of-entry unit is recommended for removing radon, some VOCs, and certain other chemicals found in drinking water. These devices treat all the water entering the home, thereby reducing the risk of exposure to the chemical from inhalation or ingestion.

Activated carbon cartridges must be replaced at regular intervals, according to the manufacturer's instructions and depending on the contaminants being removed. If activated carbon is treating water containing radon, the

cartridge may have to be disposed of in accordance with local regulations or health codes. In addition, when water containing radon is passed through activated carbon, the activated carbon may become a source of low-level radioactivity. Therefore, it is important to contact your local health department before making water treatment decisions, especially if radon is a concern in drinking water.

Reverse Osmosis

Reverse osmosis is effective for reducing the concentration of inorganic chemicals such as cadmium and chromium, along with very fine suspended particles such as asbestos,

that may be found in drinking water. Reverse osmosis also removes certain organic contaminants and specific pesticides. It is not a very effective treatment method for arsenic, some pesticides, THMs, and VOCs. Most reverse osmosis systems are point-of-use devices that are placed beneath the kitchen sink to treat water used only for cooking and drinking.

In a typical reverse osmosis unit, a cellophane-like membrane separates purified water from contaminated water. This membrane allows only some compounds to pass through, resulting in different concentrations of dissolved substances on each side. The natural tendency is for pure water to pass through the membrane from the dilute to the concentrated solution until both sides contain equal concentrations. With reverse osmosis, water pressure is applied to the concentrated solution to force pure water through the membrane from the concentrated to the dilute side. Treated water is collected in a storage container and the rejected impurities on the concentrated side of the membrane are washed away in a stream of wastewater. A reverse osmosis unit may take almost three hours to produce one gallon of treated water from several gallons of contaminated water.

The removal efficiency of a reverse osmosis system depends on water pressure, water temperature, contaminant type, and the type of membrane used in the system. Reverse osmosis membranes are rated for their capacity to reject contaminants from drinking water. In general, the most common reverse osmosis membranes have a lifetime of three years and can filter contaminants in the 0.0001 to 0.1 micron size range—thousands of times smaller than a human hair. Specific membranes are used and changed depending upon the manufacturer's directions.



To enhance the removal of certain pesticides and organic chemicals (such as THMs and VOCs) from drinking water, it may be necessary to include other water treatment units in the design of the reverse osmosis system. For example, it may be necessary to install an activated carbon pre- or post-filter, sediment filter, or water softener in conjunction with the reverse osmosis system to remove large sand grains, silt particles, hardness minerals, or chemicals that otherwise may tear, clog, or degrade the sensitive reverse osmosis membrane. For this reason, it is important that you consult with a local water professional before making water treatment decisions.

Aeration

Aeration is a point-of-entry treatment option for removing high concentrations of VOCs and radon from drinking water. Until recently, the most common way to remove these contaminants was activated carbon. Aeration is the general term for introducing air into water in order to volatilize certain chemicals, which are vented outside and released into the air. The removal efficiency of aeration systems depends on the flow rate of water through the system, the air-to-water ratio, type and concentration of contaminants, and type of aeration method.

Three types of aeration devices are available to homeowners: packed tower aerators, bubble aerators, and spray aerators. In a **packed tower unit**, water flows by gravity down a tower filled with packing material while air is pumped upward by a mechanical blower. Contaminant removal is improved by increasing the height of the tower and decreasing the size of the packing material. A **bubble aerator** has several chambers through which fine bubbles are produced. Contaminant removal is improved by adding more chambers, which increases the air-to-water contact. In a **spray aerator**, water is sprayed in a fine mist into a tank, where pure water is collected and low levels of VOCs or radon are vented to the outside.

In general, aeration systems are more expensive and difficult to maintain than other water treatment systems and are most often used when high levels of VOCs or radon are detected in drinking water. However, if VOC concentrations exceed 1,000 micrograms per liter (mcg/L), or radon levels exceed 5,000 picoCurie per liter (pCi/L), then aeration may be the most viable treatment method. This is especially important considering that 95 to 99 percent contaminant removal efficiencies can be achieved if the proper aeration system is installed. Caution must be taken regarding the placement of an aeration system due to the venting of volatile gases. In addition, aerated water may increase corrosion of household

plumbing, which may lead to higher levels of lead and copper in drinking water.

Distillation

Distillation is one of the oldest water treatment methods. It is the process of heating liquid water into steam and then cooling/condensing the steam back into liquid water. Contaminants with lower boiling points are left behind in the boiling tank during the evaporation process, while purified water is captured in a separate chamber when the steam is recondensed. Distillation units are point-of-use devices that are effective for reducing the concentration of arsenic, some pesticides, and certain organic chemicals. The removal efficiency for these contaminants depends on their chemical characteristics, such as solubility in water and boiling point.

There are two types of home water distillation systems available: air-cooled and water-cooled. As their names imply, the major difference is the method by which the heated steam is condensed, which in turn affects the efficiency of treatment. Air-cooled devices are reported to make one gallon of distilled water from one gallon of tap water. Water-cooled devices are reported to make one gallon of distilled water from 5-15 gallons of tap water. For both systems, it takes several hours to produce one gallon of treated water.

Any product claims for removal of organic chemicals, such as pesticides, THMs, and VOCs, should be backed by adequate research. These contaminants are a concern for distillation treatment because they vaporize near the boiling point of water and may collect on the condenser and become concentrated in the treated water. For this reason, distillation units with volatile gas venting systems, pre-heating chambers, or post-treatment granulated activated carbon filters are available if volatile contaminants are present in drinking water.

Ion Exchange

The process of **ion exchange** replaces unwanted contaminants in drinking water with less objectionable counterparts, such as sodium or chloride. This chemical treatment process takes place in a fiberglass or plastic-lined steel tank containing a specific ion exchange material. The choice of ion exchange material depends on the untreated water quality and the contaminants to be removed. In general, two types of ion exchange units are available to consumers: **water softeners** and **anion exchange devices**.



Water softeners are a point-of-use ion exchange unit that remove **cations** from drinking water. Cations are positively charged compounds such as calcium and magnesium. Most water softeners replace cations with sodium or potassium. Anion exchange devices are point-of-use or point-of-entry devices that remove **anions** from drinking water. Anions are negatively charged compounds such as nitrate and some forms of arsenic. Most anion exchange devices replace anions with chloride.

In addition, **ion exchange units** are available which remove both cations and anions. Recent studies report that some ion exchange units used in combination with other water treatment devices may reduce radium, arsenic, and some heavy metals in drinking water. However, some ion exchange units, such as water softeners, may produce high levels of sodium in drinking water, which may pose a health concern for people on sodium-restricted diets. For this reason, homeowners should consult with a local water professional to make informed water treatment decisions.

Summary

Everyone deserves high quality drinking water, whether you rely on a private well or a public water supply. If you suspect that your water supply is unsafe to drink, you have several options. One of the first steps to consider, regardless of your water source, is to have your water tested for the specific contaminants of concern and contact a local water professional for advice and information. Under certain conditions, such as in the case of a fuel spill, it may be possible to obtain help from your local health department or State agency.

If your drinking water comes from a municipal supply, you can also check with your local water purveyor and request a copy of their latest test results, which they are required by law to report to their customers. If you rely on a private water supply, it is your responsibility to maintain the condition of your well or spring and reduce or eliminate potential sources of pollution on a regular basis. Water treatment should not be a substitute for a properly designed, constructed, and maintained water supply. Preventing pollution is one of the most direct ways of reducing health risks from drinking water.

If a contamination problem is detected, or if you question the safety of your public or private water supply, you may choose to consider broad treatment options. Home water treatment devices, such as reverse osmosis and activated carbon filters, are highly effective for removing a range of contaminants, including certain carcinogens. Also, depending on the severity

IS BOTTLED WATER A SAFE ALTERNATIVE?

Bottled water is one alternative for supplying a separate source of drinking water. For some water quality problems, bottled water may be the most practical and affordable option. Consumption of bottled water has increased dramatically in recent years. Today, approximately 700 brands of bottled water are sold in the United States.

The most common kinds of bottled water include: mineral water, purified water, sparkling water, spring water, and well water. By definition, bottled water does not contain artificial flavors and sweeteners, nor does it contain chlorine or other chemicals, such as lead. Some bottled water may contain flavors, extracts, or essences, but these additives must comprise less than one percent by weight of the final product. Seltzer and club soda, which contain sugar and sodium, are considered soft drinks.

The U.S. Food and Drug Administration (FDA) is the agency responsible for regulating bottled water. The FDA has established quality standards concerning chemical concentrations that are essentially the same as the EPA's primary drinking water standards. However, the FDA does not inspect bottling plants or test bottled water for contamination.

Fortunately for the consumer, the International Bottled Water Association (IBWA) has contracted with NSF International to inspect IBWA member plants and review their product testing. In this capacity, NSF ensures that the water produced by the bottling plants meets all applicable FDA standards, state regulations, and other IBWA requirements. Independently, NSF certifies bottled water. If the NSF symbol appears on the bottle, it indicates that both the product and the bottling plant have passed NSF testing and inspections. However, the NSF or IBWA symbol does not indicate that the product is contaminant-free, but it does guarantee that the concentrations of contaminants are below the primary drinking water standards established by the EPA. Conversely, the absence of the NSF or IBWA symbol on bottled water does not imply that the product is unsafe; it only means that the bottling plant is not involved in the IBWA or NSF programs.

*For additional information on bottled water, contact:
International Bottled Water Association
1700 Diaganol Street, Suite 650
Alexandria, VA 22315
1-800-928-3711
www.bottledwater.org*



of contamination, it may be necessary to replace your source of drinking water by developing an alternative water supply or purchasing bottled water. Some of these options can be costly and inconvenient, so it is important to have your water tested regularly and remain informed of community water quality issues and decisions.

References

- Crawford-Brown, D.J. 1997. POU/POE aids in waterborne radon removal. *Water technology*, 20(9):82-88.
- International Agency for Research on Cancer (IARC). 1997. World Wide Web site URL address: <http://193.51.164.11/monoeval/crthall.html>.
- Kneen, B., A. Lemley, and L. Wagenet. 1995. *Water treatment notes: reverse osmosis treatment of drinking water*. Cornell Cooperative Extension, College of Human Ecology. 6pp.
- Lemley, A., L. Wagenet, and B. Kneen. 1995. *Water treatment notes: activated carbon treatment of drinking water*. Cornell Cooperative Extension, College of Human Ecology. 6pp.
- Lykins, B.W., Jr., R.M. Clark, and J.A. Goodrich. 1992. *Point-of-use/point-of-entry for drinking water treatment*. Lewis Publishers, Inc. Chelsea, MI. 344pp.
- Mancl, L., M. Sailus, and L. Wagenet. 1991. *Private drinking water supplies: quality, testing, and options for problem waters*. Northeast Regional Agricultural Engineering Service. 60pp.
- Pontius, F.W. 1997. Future directions in water quality regulations. *Journal of American Water Works Association*, 89(3):40-54
- Stewart, J.C., A.T. Lemley, and R.A. Weismiller. 1994. *Drinking water standards and the health effects of drinking contaminated water*. Cooperative Extension System. 8pp.
- Stewart, J.C., A.T. Lemley, S.I. Hogan, and R.A. Weismiller. 1990. *Home water testing*. Cooperative Extension System. 4pp.
- Trautmann, N.M., K.S. Porter, and R.J. Wagenet. 1989. *Pesticides and groundwater: a guide for the pesticide user*. Cornell Cooperative Extension, Dept. of Natural Resources. 6pp.
- Trautmann, N.M., K.S. Porter, and R.J. Wagenet. 1985. *Pesticides: health effects in drinking water*. Cornell Cooperative Extension, Dept. of Natural Resources. 4pp.
- U.S. Environmental Protection Agency. 1996. *Drinking water regulations and health advisories*. USEPA Office of Water.
- . 1994. *Report to the United States Congress on radon in drinking water: multimedia risk and cost assessment of radon*. USEPA.
- Wagenet, L., K. Mancl, and M. Sailus. 1995. *Home water treatment*. Northeast Regional Agricultural Engineering Service. 120pp.
- Wagenet, L. and A. Lemley. 1993. *Water treatment notes: ultraviolet radiation for disinfecting household drinking water*. Cornell Cooperative Extension, College of Human Ecology. 4pp.
- Wagenet, L. and A. Lemley. 1988. *Water treatment notes: chlorination of drinking water*. Cornell Cooperative Extension, College of Human Ecology. 6pp.

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