North Carolina Cooperative Extension Service

Water Quality & Waste Management

Home Drinking Water Treatment Systems

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Water quality is of concern to everyone. Quality is the acceptability of the water for uses like drinking, cooking, bathing, and laundering.

Drinking water supplies may be contaminated by many sources. Hazardous household wastes, septic systems, lawn and garden chemicals, leaking fuel storage tanks, animal waste, agricultural chemicals, landfills, and leaching of metals from plumbing systems may contaminate water.

Contaminated water may have off-tastes, odors, or visible particles. However, some dangerous contaminants in water are not easy to detect. Accurate water testing is needed to determine safety and quality. Water testing also identifies the need for water treatment equipment.

When water is contaminated, it is best to **eliminate the source of the contamination**, if at all possible. If this cannot be done, then water may need to be treated. Treatment can reduce common contaminates, such as sediment, calcium, iron, magnesium, sulfate, nitrates, arsenic, or lead. Water treatment can produce a clearer, safer, better tasting, and better smelling water, better suited for household use. Some typical water quality problems and recommended treatment systems are listed in Table 1. There are eight general types of treatment systems available for household use. These include carbon filters, fiber filters, reverse osmosis units, distillation, neutralizers, chemical-feed pumps, disinfection, and softeners. These systems range in cost from a few dollars to several thousand dollars, depending on the type of system and the type of contaminants.

Before buying, consider:

- Type and amount of water contaminants
- Equipment cost.
- Operating and maintenance costs.
- Operating and storage space.
- Ease of use.

Some systems treat all the water in the house, while others primarily improve safety and quality of drinking water. Before buying water-treatment equipment, have your water supply tested by a recognized, certified water-testing lab. You need to identify the type and level of contaminants if you are to get the right system.

Table 1. Typical Water Qually Problems and Recommended Treatment Systems

Problem	Recommended Treatment SystemsDisinfection
Bacteria and other microorganisms	Disinfection
Taste and odor	Carbon filter
Hydrogen sulfide gas (rotten egg odor)	Oxidizing filter followed by carbon filter; chlorination followed by sediment filter
Sediment (suspended particles)	Fiber filter
Hardness (calcium and magnesium)	Softener
Dissolved iron	Softener ffor up to 5 milligrams per liter); Iron filter; chlorination followed by sand filter and carbon filter
pH (acid or alkaline conditions)	Neutralizing filter or chemical-feed pump

Organic chemicals (pesticides, fuel products)	Carbon filter
Metals (lead, mercury, arsenic, cadmium), and other minerals (nitrate, sulfate, sodium)	Reverse osmosis unit; distillation

Carbon Filters

Carbon filters remove most of the organic compounds that cause taste and odor problems. A filter's effectiveness depends on the amount of carbon in the unit and how long the water stays in the unit. The longer the water is in contact with the filter medium, the more of the impurities are removed. Some carbon filters harbor bacteria. Flushing fresh water through the filter for at least 30 seconds may remove bacteria.

Carbon filter cartridges must be replaced when taste or odor problems reappear. Carbon filters and replacement cartridges range in price from a few dollars to several hundred dollars. Some units may require professional installation. Four types of carbon filters, based on their location in the plumbing system, are shown in Figure 1. These are: (1) faucet mount; (2) in-line; (3) line bypass; and (4) point of entry (POE). Other types of carbon filters are pour through (portable) and specialty filters.

Faucet-mounted carbon filters attach to the faucet where drinking water comes out. These filters contain only a small amount of carbon and are not as effective as other types of carbon filters. One design includes a bypass option, which diverts non-drinking water around the filter to prolong the life of the carbon cartridge.

In-line carbon filters are installed beneath the kitchen sink in the cold water supply line. This does not allow for bypassing the unit for non-drinking water uses.

Only the cold water from the tap is treated. Warm or hot tap water will contain untreated water.

Line bypass carbon filters also are added to the cold water supply line, but a separate faucet is installed at the sink to provide treated drinking water. The regular tap delivers untreated water. The carbon filter lasts longer because only water used for drinking is treated.

Point of entry (POE) carbon filters treat all water entering the home. This type of filter is recommended for treating volatile organic compounds (VOCs) that easily evaporate into the air. These are the most expensive filters to purchase and maintain.

Pour through carbon filters are similar to drip coffee makers and are the simplest and least expensive type. They are portable, require no installation, and are convenient for camping or similar uses. They treat only a little water at a time and are not as good at removing impurities as other types of carbon filters.

Specialty carbon filters attach to the cold water supply line to appliances. Ice maker filters are placed on the supply line to refrigerators, and scale filters are placed on the supply line to water heaters or humidifiers.

Fiber Filters

Fiber filters contain spun cellulose or rayon. They remove suspended sediment (or turbidity). The water pressure forces water through tightly wrapped fibers around a tubular opening leading to the faucet. These filters come in a variety of sizes and meshes from fine to coarse, with the lower micron rating being the finer. The finer the filter, the more particles are trapped and the more often the filter must be changed. Fiber filters may not remove all contaminants. If taste and odor problems remain, use a carbon filter after the fiber filter. Fiber filters and replacement cartridges range in price from a few dollars to several hundred dollars. Remember, filters do not purify or soften water - they only remove some suspended particles and dissolved organic compounds that cause disagreeable odors and tastes.

Reverse Osmosis Units

A reverse osmosis (RO) unit removes a variety ot inorganic chemicals, such as nitrates, calcium, and magnesium. A reverse osmosis unit is up to 95 per- cent effective. Unfortunately, reverse osmosis also removes beneficial chemicals (fluoride). Typically, this unit is used to treat only drinking and cooking water.

An RO system usually includes:

- A prefilter to remove sediment.
- An activated carbon filter to remove odors and taste.
- A semi-permeable membrane through which water flows under pressure.
- A tank to hold the treated water.
- A drain connection for discharging concentrated contaminants.

Different sizes are available. They can be installed under the sink or in a remote location, depending on the size of the water-holding tank. Match its capacity to the number of gallons used per day. A household of four people normally finds 5 gallons per day enough.

A reverse osmosis unit is expensive (typically $600 to $900), and renting is an option. There are maintenance costs, because the RO membrane needs replacing according to the manufacturer's recommended schedule. Weigh the cost of a unit against the type and amount of contaminants and your concern for safety. Also compare the cost of an RO unit to other alternatives, like bottled water.

Distillers

Distillers produce almost pure water. They remove minerals, such as nitrate and sodium, many organic chemicals, and virtually all impurities. Distilled water is suitable for wet batteries and other household equipment requiring mineral-free water.

When the distiller is operating, tap water in a boiling tank (often made of stainless steel) is heated to boiling. Steam is produced, rises, and leaves most impurities behind. The steam enters condensing coils, where it is cooled and condensed back to water. The distilled water then goes into a storage container or is piped to a special faucet.

Consider:

- Capacity of the boiling tank.
- Type and size of the water-storage container.
- Rate at which distilled water is produced.
- Presence of automatic features.
- Location of unit for convenience of use and ease of maintenance.
- Wattage rating (650 to 1,500-plus watts).
- Batch or continuous process mode of operation.

Storage containers can be glass, metal, or plastic. Each type is satisfactory when cared for as the manufacturer directs.

Large distillers can distill about one-half gallon of water per hour. Smaller units produce less than one quart of water per hour. The cost of producing distilled water depends on the appliance and the local electric rate. Although the distiller has no parts to replace, it is not maintenance-free. Scale must be removed from the boiling tank. Frequency of cleaning the distiller varies with the quantity of impurities in the water and the amount of water distilled. White vinegar or a manufacturer's cleaner is used for cleaning.

It may cost $250 for a small unit to over $1,450 for a large unit. Electricity makes operating costs higher than alternative treatment systems. Consider how much water you need, how contaminated your water supply is, costs, and alternatives like bottled water before buying a distiller.

Neutralizing Filters and Chemical-Feed Pumps

Neutralizing filters and chemical-feed pumps adjust the pH of water. A pH of 7 is neutral, while a pH less than 7 is acidic, and a pH greater than 7 is alkaline. Water should be as close to pH 7 as possible. Very low or very high pH water is corrosive, which can cause leaching metals from plumbing systems or forming scale in pipes. Signs of very low or very high pH water are blue-green stains from copper plumbing or red stains from galvanized plumbing.

Tank-type neutralizing filters or chemical-feed pumps that inject a neutralizing solution into the well neutralize acid water. If iron treatment is needed, the chemical-feed pump system is required. Tank-type neutralizing filters pass the water through granular calcite (marble, calcium carbonate, or lime) or magnesia (magnesium oxide). They treat water as low as pH 6. They must be installed after the pressure tank. These systems make the water harder.

For water less than pH 6, chemical-feed pumps inject a neutralizing solution of soda ash (sodium carbonate) or caustic soda (sodium hydroxide) into the well. This raises the sodium content of the water. Potassium can be substituted for sodium, but potassium is more expensive. Keep the solution tank full and adjust the feeder to provide the correct rate to result in a pH of near 7. For water between pH 4 and pH 6, use soda ash mixed at one pound of soda ash per gallon of water. Feed this solution into the well at a rate to raise the pH to near 7 at the faucet farthest from the well. For water less than pH 4, use caustic soda. This material is extremely dangerous. Wear gloves and goggles. Slowly feed a solution of one pound of caustic soda per gallon of water into the well at a rate sufficient to result in pH 7 at the faucet farthest from the well.

Neutralize alkaline water (greater than pH 7) by feeding diluted sulfuric acid in the same manner as soda ash. Use caution in making solutions from strong acids. Always add acid to water slowly. Never add water to acid: Use gloves and goggles when preparing solutions.

Disinfection

Disinfection kills bacteria and other microorganisms. Chlorination is the most common method. Other disinfection systems use ultraviolet light or ozone. These are not as readily available for home use.

Continuous chlorination systems consist of a chemical metering device that feeds chlorine in sufficient amounts to kill bacteria. Chlorine must be in contact with water at least 1 minute to kill all bacteria. A chlorine residual of about 3 to 5 parts per million should remain to indicate that disinfection is complete. Typical chlorine feed rates are about 1 cup of 5 percent laundry bleach per 300 gallons of water. This rate depends on water temperature, pH, and pumping rate. Use an inexpensive chlorine residual kit to determine if the feed rate should be adjusted up or down to obtain the proper chlorine residual. If chlorine taste is a problem, use a carbon filter to remove excess chlorine from drinking water.

Before investing in a continuous chlorination system, it is wise to try repeated shock chlorinations. This simple process involves adding high concentrations of chlorine directly to the well to kill all existing microorganisms. Use this process to disinfect all new and repaired water systems. Shock chlorination can be done using ordinary laundry bleach (containing 5.25 percent sodium hypochlorite). The goal is to add enough chlorine to raise the concentration in the well to about 200 milligrams per liter to kill potentially harmful bacteria and viruses. If iron bacteria are a problem, concentrations of 800 milligrams per liter may be necessary.

Follow these safety precautions when using shock chlorination procedures:

- Do not chlorinate activated carbon or charcoal filters. Use the "bypass" valve on the filter if there is one. Otherwise, disconnect the filter temporarily during shock chlorination.
- Wear rubber gloves, goggles, and a protective apron when handling chlorine solutions. If chlorine gets on the skin, flush immediately with fresh water.
- Never mix chlorine solutions with other cleaning agents, especially ammonia, because toxic gases may be formed.
- Use plain laundry bleach. Do not use products such as "Fresh-Scent" bleach or other special laundry products to disinfect a well.
- Water containing chlorine bleach is not safe to drink. Follow shock chlorination procedures carefully and be sure there is no chlorine odor before drinking the water.

Shock chlorination procedure:

- Select a time when well water will not be used for at least 24 hours. Store enough drinking water for this period or do the procedure before leaving for a short trip
- Determine how much laundry bleach is needed. This depends on the diameter of the well and the height of standing water in the well. The height of standing water is the difference between the well depth and the distance from the top of the well down to the water level. For example, if the well is 250 feet and the water level is 150 feet down from the top, then the height of the standing water is 100 feet. If it is a 4-inch well, 2 quarts of laundry bleach are needed to raise the chlorine concentration to 200 milligrams per liter. Recommended amounts of laundry bleach are shown in Table 2.
- Mix the proper amount of bleach with water in a 5-gallon or larger container and pour the solution directly into the well.
- Turn on the outdoor faucet nearest the well and let the water run until a strong odor of chlorine is de- tected. Add more bleach if a strong odor is not present.
- Turn the faucet off. Connect a garden hose to the faucet and attach a spray nozzle to the end of the hose. Thoroughly wash down the entire inside surface of the well casing with the spray nozzle for at least 15 minutes.
- After washing the inside of the well casing, turn on all outdoor and indoor faucets one at a time until a strong chlorine odor is detected at each location. Turn each faucet off when the chlorine odor is detected
- Let the chlorinated water stand in the well and plumbing for at least 24 hours. Do not drink the chlo- rinated water during this period. You may flush the toilets, but try to minimize the number of flushes.
- After 24 hours, completely flush the system of chlorine by turning on all outdoor faucets and running them until the chlorine odor is gone. Do not run the indoor faucets until the odor dissipates to prevent damage to the septic system.
- Finally, turn on the indoor faucets until the chlo- rine odor is gone. You may notice a slight chlorine taste or odor in the water for a few days.

Test the water for bacteria two weeks after shock chlorination to see if you have a recurring problem. Contact your local Health Department for information on water testing and well protection.

Table 2. Recommended Amounts of Laundry Bleach for Well Disinfection Height of standing

Height of standing water (feet)	**4-inch well**	**6-lnch well**	**8-inch well**	**12-inch well**	**24-inch well**
50	1 quart	2quarts	1 gallon	2 gallons	8 gallons
100	2 quarts	1 gallon	2 gallons	4 gallons	16 gallons
200	1 gallon	2 galions	4 gallons	8 gallons	32 gallons

Water Softeners

Hard water is caused by dissolved calcium and magnesium in the water. Hard water interferes with laundering, washing dishes, bathing, and personal grooming. It also affects appliances. For example, scale builds up in water heaters, increasing the costs of heating water and reducing the life of the appliance.

The calcium and magnesium that cause hardness are reported as grains per gallon, milligrams per liter (mg/ L), or parts per million (ppm). Hard water, when used with soap, causes soap deposits that will not dissolve.

Water is softened by passing through a bed of ion-exchange resin. The softening process exchanges calcium and magnesium ions in the water for sodium ions in the resin. About 15 mg of sodium are added per gallon for each grain of hardness reduced.

When the sodium is used up, the softener needs to be regenerated. This is done by backwashing to clean the ion-exchange material, brining with salt (sodium chloride) to replace sodium ions, and rinsing to remove any excess salt.

A water softener removes small amounts of dissolved iron (5 to 10 ppm). However, if there is oxidized iron or iron bacteria in the water, the ion exchange resin becomes coated or clogged and loses its softening ability. In this case, use an iron filter or chlorination to remove iron.

The size water softener needed depends on the hardness of water, the quantity to be softened, and the length of time between recharging. There are three types of ion-exchange softeners for the home.

MANUAL. Each step for recharging the unit must be activated by hand. Salt is added directly to the single tank of this softener.

SEMI-AUTOMATIC. The homeowner sets the switches when the system needs recharging. The system completes the process by itself. A second tank is needed for the brine system.

AUTOMATIC. All steps of the recharging process are controlled by a timing mechanism that the homeowner sets, based on water usage. Some models can measure water usage or remaining softening capacity and recharge themselves only when needed. Most water softeners have a fully automatic recharging feature. These softeners also require a second tank for the brine solution.

Water softeners can be installed in various ways. Most people soften hot and cold water but bypass outside water lines.

The increased sodium in softened water is a concern to people on a sodium-restricted diet. Therefore, some water softener installations bypass the cold water line in the kitchen only.

Water softeners can be rented or purchased. Renting a softener or ion-exchange resin tank is convenient since the user does not worry about maintenance or regeneration. The dealer regularly replaces the ion-exchange resin tank, so a second tank for the brine solution for recharging is not needed.

A water softener can cost $500 to over 41,500, but owning the equipment could be more economical in the long run than renting it. The cost of the water softener is balanced against the savings of soft water. Using soft water reduces the quantity of cleaning products needed by as much as 500 percent. The home's plumbing system and water-using appliances will last longer. Other benefits include the time saved in cleaning and removing scale and better results in laundry, dish washing, and personal grooming.

Selecting a Treatment System

Always test your water before purchasing water treatment equipment. This ensures that the system you purchase will adequately treat your problem. Consult with water quality professionals, health departments, and equipment manufacturers and suppliers to identify the best system to meet individual needs. Before purchasing expensive water treatment systems, con- sider lower-cost alternatives, such as bottled water or a new well.

For additional informatlon on water testing and treatment, contact your local North Carolina Cooperative Extension Service center. Some publications that may be useful are:

> *Should You Have Your Water Tested?* AG-473-2/WQWM-2
>
> *Health Effects of Drinking Water Contaminants* HE-393

Iron and Manganese in Household Water HE-394/WQWM-11

Lead in Drinking Water HE-395/WQWM-8

Metals in Drinking Water AG-473-1 /WQWM-6

Nitrate in Drinking Water AG-473-4/WQWM-5

Radon in Drinking Water HE-396-WQWM-13

Volatile Organic Chemicals (VOCs) in Drinking Water AG-473-5/WQWM-16

Questions to Ask When Purchasing Water Treatment Equipment AG-473-3/WQWM-7

Protect Yourself When Selecting a Home Water Treatment System HE-418/WQWM-135

Not shown: Figure 1.

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Water Quality & Waste Management

Should You Have Your Water Tested?

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Most water in North Carolina is suitable for drinking and other home uses. There are, however, circumstances which can lead to contamination of water supplies. The question of whether or not to test your water is a serious one which concerns the health of you and your family. The purpose of this fact sheet is to give you general guidelines to follow when deciding to test your home water quality.

Half of North Carolina residents are served by public water supplies (more than 15 connections or 25 people served by the same water source). The other half receive water from private systems, most of which are wells. Public water supplies are regularly tested for such contaminants as pathogenic organisms, radioactive elements, and some toxic chemicals regulated by federal and state standards. Municipal water supply systems will provide water quality reports upon request. Even if you have public water, it is possible to have contamination due to contact with pipes or inadequate water

treatment facilities.

Private Water Supplies

If you have a private water supply, you alone are responsible for assuring that it is safe. Routine testing for a few common contaminants is strongly recommended, especially if your well is located near some pollution source. Even if you have a safe water supply now, regular testing is wise because it establishes a water quality record. This record will be valuable in the future if your water quality is damaged by some activity near your well.

Routine testing of private water supplies should follow these general guidelines:

- Test for coliform bacteria, nitrate, pH, and total dissolved solids (TDS) every year. The best time to test is during the spring or summer following a rainy period. These tests are also recommended after repairing or replacing a well, pump, or plumbing system.
- Test for sulfate, chloride, iron, manganese, lead, and hardness every three years.

In addition to routine testing, you may have special circumstances which make contamination of your private water supply more likely. If any of the following situations applies to you, consider having your water tested:

- *You live near a dump, landfill, factory, or dry cleaning operation:* Test for volatile organic compounds (VOCs), pH, total dissolved solids, chloride, sulfate, and metals.
- *You live near an old underground storage tank or your water smells like gasoline:* Test for petroleum components and volatile organic compounds.
- *You live near a mining operation:* Test for iron, manganese, aluminum, corrosivity, and pH.
- *You live near a gas-drilling operation:* Test for chloride, sodium, barium, and strontium.
- *You live near seawater or a heavily salted roadway and your water tastes salty:* Test for chloride, total dissolved solids, and sodium.
- *You live in an area of intensive agriculture:* Test for pesticides commonly used near the well, bacteria, nitrate, pH, and total dissolved solids.

- *You are expecting a new baby:* Test for nitrate early during pregnancy and just after the baby is born.

All Water Supplies

Whether you have a public or private water supply, have your water tested if the following situations are applicable to you:

- *You are planning to purchase a new home and wish to evaluate the water quality:* Test for coliform bacteria, nitrate, lead, iron, hardness, pH, sulfate, total dissolved solids, corrosivity, and other parameters depending on the proximity to potential contamination sources.
- *Your water leaves scaly residue and soap scum and decreases the cleaning action of soaps and detergents:* Test for hardness. If a water softener is needed to treat hard water, test for iron and manganese, which decrease the efficiency of cation exchange softeners, before purchasing treatment equipment. Test for lead after purchasing a water softener.
- *Your water appears cloudy, frothy, or colored:* Test for color, turbidity, and detergents.
- *Your plumbing contains lead pipe, fittings, or solder joints:* Test for pH, corrosivity, lead, copper, cadmium, and zinc.
- *Your plumbing fixtures or laundry are stained, or plumbing shows signs of corrosion:* Test for pH, corrosivity, iron, manganese, copper, and zinc.
- *Your water has an odd taste or smell:* Test for hydrogen sulfide, pH, copper, lead, iron, manganese, zinc, sodium, chloride, coliform bacteria, corrosivity, and total dissolved solids.
- *Family members or guests experience gastrointestinal illness:* Test for coliform bacteria, nitrate, and sulfate.
- *You wish to monitor the performance of home water treatment equipment:* Test for the specific water quality problem being treated at the time of installation, at regular times after installation, and if water quality changes noticeably.

Water Quality Laboratories

If you determine that your water should be tested, contact a reputable water quality laboratory to discuss prices and procedures. Private laboratories are listed in telephone books. Your County Extension Office can provide you with a list of certified water quality laboratories in North Carolina. You may also contact your County Health Department about testing your water. Water treatment equipment companies and plumbing supply stores may offer free water testing. Check any water quality problems identified by these companies with an independent laboratory before investing in treatment systems or new plumbing.

Most laboratories supply their own sample containers and provide detailed instructions for sample collection. The instructions must be followed carefully for a meaningful water quality assessment. Keep a record of all water test results as a reference for future testing. Changes in water quality over time may indicate a problem you can address before it becomes more serious. Take previous water test results with you when visiting a private laboratory, County Health Department, or County Extension Office to discuss the status of your water quality.

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Water Quality & Waste Management

Health Effects of Drinking Water Contaminants

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People are increasingly concerned about the safety of their drinking water. As improvements in analytical methods allow us to detect impurities at very low concentrations in water, water supplies once considered pure are found to have contaminants. We cannot expect pure water, but we want safe water.

The health effects of some contaminants in drinking water are not well understood, but the presence of contaminants does not mean that your health will be harmed. In North Carolina, drinking water is generally of high quality and free from significant contamination. Public water supplies are tested, and regulated to ensure that our water remains free from unsafe levels of contamination. Small private water supplies, including wells, are not regulated by drinking water standards, and the owner must take steps to test and treat the water as needed to avoid possible health risks.

What is in your drinking water? The only way to know is to have it tested.

Drinking water can become contaminated at the original water source, during treatment, or during distribution to the home.

- **If your water comes from surface water (river or lake)**, it can be exposed to acid rain, storm water runoff, pesticide runoff, and industrial waste. This water is cleansed somewhat by exposure to sunlight, aeration, and micro-organisms in the water.
- **If your water comes from groundwater (private wells and some public water supplies)**, it generally takes longer to become contaminated but the natural cleansing process also may take much longer. Groundwater moves slowly and is not exposed to sunlight, aeration, or aerobic (requiring oxygen) micro-organisms. Groundwater can be contaminated by disease-producing pathogens, leachate from landfills and septic systems, careless disposal of hazardous household products, agricultural chemicals, and leaking underground storage tanks.

Possible Health Effects

The levels of contaminants in drinking water are seldom high enough to cause acute (immediate) health effects. Examples of acute health effects are nausea, lung irritation, skin rash, vomiting, dizziness, and even death.

Contaminants are more likely to cause **chronic** health effects - effects that occur long after repeated exposure to small amounts of a chemical. Examples of chronic health effects include cancer, liver and kidney damage, disorders of the nervous system, damage to the immune system, and birth defects.

Evidence relating chronic health effects to specific drinking water contaminants is limited. In the absence of exact scientific information, scientists predict the likely adverse effects of chemicals in drinking water using human data from clinical reports and epidemiological studies, and laboratory animal studies.

Drinking Water Standards

The Safe Water Drinking Act of 1974 directed the U.S. Environmental Protection Agency (EPA) to ensure that public water systems (systems serving more than 25 people) and noncommunity water systems (hotels, campsites, restau- rants, migrant workers' encampments, and work sites) meet minimum standards for protecting public health. Its main provisions directed the EPA to establish minimum drinking water standards to limit the amounts of various contaminants found in drinking water. Because of growing concerns about the safety of the water supply, amendments were made to strengthen this law in 1986. These amendments required the EPA to do the following:

- Develop a **maximum contaminant level goal (MCLG)** and a **maximum contarninant level** (MCL) for all regulated contaminants. MCLGs are nonenforceable health-based goals and represent the maximum level of a contaminant that is expected not to cause any adverse health effects over a lifetime. MCLs are enforceable contaminant levels. They are set as close to the MCLG as possible and are based on protecting public health within economical and technical reason.

- Increase the number of regulated contaminants to a total of 83 by June, 1989. MCLs must be set for an additional 25 contaminants every 3 years thereafter.
- Set required schedules for water systems to monitor for contaminants in drinking water.
- Identify best available technologies (BATS) for removing excess contaminants from water, based on efficiency, availability, and cost.
- Issue variances and exceptions to systems that cannot comply with MCLs despite the application of BATS, unless an "unreasonable risk" to health exists. "Unreasonable risk" has not yet been defined.
- Provide for public notification when drinking water standards are violated.
- Ban the use of lead pipes, solder, fittings, and flux in public water systems.
- Bolster enforcement of penalties for violators of drinking water standards at the state and local level.
- Provide for protection of groundwater sources.

Contaminants are regulated when they occur in drinking water supplies and are expected to threaten public health. Most levels established by the EPA allow a sufficient margin of safety, but acceptable contaminant levels vary widely among individuals and population groups. For example, high sodium levels, harmless for most people, can be dangerous for the elderly, people with high blood pressure, pregnant women, and people having difficulty in excreting sodium.

North Carolina has adopted EPA standards and the state has responsibility for enforcing drinking water standards.

Risk Assessment

Every day, you can be exposed to combinations of many toxic substances and these substances may interact.

What is in water may represent only a small part of your overall exposure to a specific contaminant. Scientists who investigate how contaminants affect human health get information in several ways. They may study how a toxic substance has affected people in a community over time. In some cases, this can show relationship between exposure to a contaminant and a health effect They may also use animal studies to collect information on the acute and chronic health effects.

Research helps scientists determine toxic doses and levels below which toxic effects are not observed. For noncancer-causing toxic substances, scientists use "acceptable daily intake" to estimate risk. The acceptable daily intake is the amount of a contaminant or toxic substance that humans can consume daily for a lifetime without any known ill effects. It includes a margin of safety. For a cancer-causing substance, no safe level has been set. Toxicity is estimated by calculating a risk estimate, or the concentration of a substance that presents the least acceptable risk. In the case of cancer-causing toxins, regulations are based on a level of risk that is acceptable, not a safe amount or concentration of a substance.

Four Groups of Contaminants

Microbial Pathogens. Pathogens in drinking water are serious health risks. Pathogens are disease-producing micro-organisms, which include bacteria (such as giardia lamblia), viruses, and parasites. They get into drinking water when the water source is contaminated by sewage and animal waste, or when wells are improperly sealed and constructed. They can cause gastroenteritis, salmonella infection, dysentery, shigellosis, hepatitis, and giardiasis (a gastrointestinal infection causing diarrhea, abdominal cramps, and gas). The presence of coliform bacteria, which is generally a harmless bacteria, may indicate other contamination to the drinking water system.

Organics. People worry the most about potentially toxic chemicals and metals in water. Only a few of the toxic organic chemicals that occur drinking water are regulated by drinking water standards. This group of contaminants includes:

- Trihalomthanes (THMs), which are formed when chlorine in treated drinking water combines with naturally occurring organic matter.
- Pesticides, including herbicides, insecticides, and fungicides.
- Volatile organic chemicals (VOCs), which include solvents, degreasers, adhesives, gasoline additives, and fuels additives. Some of the common VOCs are: benzene, trichloroethylene (TCE), styrene, toluene, and vinyl chloride. Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.

Inorganics. These contaminants include toxic metals like arsenic, barium, chromium, lead, mercury, and silver. These metals can get into your drinking water from natural sources, industrial processes, and the materials used in your plumbing system. Toxic metals are regulated in public water supplies because they can cause acute poisoning, cancer, and other health effects.

Nitrate is another inorganic contaminant. The nitrate in mineral deposits, fertilizers, sewage, and animal wastes can contaminate water. Nitrate has been associated with "blue baby syndrome" in infants.

Radioactive Elements. Radon is a radioactive contaminant that results from the decay of uranium in soils and rocks. It is usually more of a health concern when it enters a home as a soil gas than when it occurs in water supplies. Radon in air is associated with lung cancer.

Summary

As people hear about the possibility of contaminants in their drinking water, they worry about potential health effects. Water supplies once considered to be pure may have various contaminants, often from natural sources. These are usually at levels below those considered to be harmful.

If you are concerned, test your water. For more information on water quality, testing, and treatment, contact the Extension Center or health department in your county or your physician.

References

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Iron and Manganese in Household Water

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Iron and manganese are minerals found in drinking water supplies. These minerals will not harm you, but they may cause reddish-brown or black stains on clothes or household fixtures. Under guidelines for public water supplies set by the Environmental Protection Agency (EPA), iron and mangenese are considered secondary contaminants. Secondary standards apply to substances in water that cause offensive taste, odor, color, corrosion, foaming, or staining but have no direct affect on health. The standard Secondary Maximum Contaminant Level (SMCL) for iron is 0.3 milligrams per liter (mg/L or ppm) and 0.05 mg/L for manganese. Private water supplies are not subject to federal standards, but these standards can be used as guidelines to evaluate the quality of water from wells or springs.

The four forms of iron and manganese commonly found in drinking water are ferrous, ferric, organic and iron bacteria. Normally, water appears clear when first drawn from the cold water faucet. If yours is not, it may contain ferric iron or organic iron. Both color the water. Ferric iron precipitates or settles out. Organic iron does not settle out. In well water, insoluble iron oxide is converted to a soluble form of ferrous (dissolved) iron. Ferrous iron is colorless, but when in contact with air, it oxidizes readily, creating reddish- brown, solid particles that then settle out as ferric oxide. Manganese is similar to iron but forms a brownish-black precipitate and stains. Manganese is less commonly found in groundwater than iron, rarely found alone in a water source, and generally found with dissolved iron.

Health Considerations

The presence of iron and manganese in water is not considered health problem. In fact, small concentrations are essential to human health. However, high concentrations of iron may give the water an unpleasant metallic taste while still being safe to drink. When iron combines with tea, coffee, and alcoholic beverages, it produces an unappetizing inky, black appearance and a harsh, offensive taste. Vegetables cooked in iron-contaminated water turn dark and look unappetizing.

Iron bacteria (a harmless bacteria), occur in soil, groundwater, and some surface waters. Iron bacteria are considred harmless to health, how- ever, they may give water an off taste or color, cause splotchy yellow stains on laundry, and clog water systems. Iron bacteria usually appear as stringy, slimy, mucous-like substances sus- pended in fresh water and may be colored brown, red, or white. They thrive on iron in the sink or metal parts of the water system and are most easily seen on the inside surface of the toilet tank.

Testing

A water analysis should be done to determine the source of the iron and manganese. Iron and manganese may be present in the water supply or be caused by corroding pipes (iron or steel). Iron from pipe corrosion indicates low pH that may need to be corrected.

A water treatment equipment company or testing laboratory can test water for dissolved or oxidized iron or manganese. Call the North Carolina Cooperative Extension Service center in your county or the public health of fice for names of laboratories that perform tests for colloidal or organic-complexed iron and manganese.

Ask the testing laboratory how to collect a water sample for an iron and manganese test. Generally, you should take the sample from the faucet closest to the pump. Allow the water to run for 5-10 minutes before sampling to obtain fresh water that has not been exposed to air. Do not sample water that has gone through a water heater or a water treatment unit such as a softener. If the water is clear when first drawn, but red or black particles appear after the water settles, dissolved iron and manganese are present. If the water has a red tint but no particles settle out after a time, colloidal iron is the cause. Reddish brown or black brown slimy masses inside the toilet tank indicate iron or manganese bacteria. Laboratory tests are recommended in all cases to determine iron and manganese concentrations.

Treatment

Iron and manganese treatment should be based on a chemical analysis of the water show- ing the type and concentration present. There are five treatment methods for the removal of iron and manganese from home water systems.

WATER SOFTENER (CATION EXCHANGE)

A water softener can remove small amounts of ferrous iron and manganese. Iron and manganese in untreated water are flushed from the softener medium (ion exchange) by backwashing (forcing sodium-rich water back through the unit). This process adds sodium to the resin medium, and iron and manganese are carried away in waste water.

The amount of iron and manganese a softener can remove depends on the water properties, the types of regeneration and backwash controls, and the ion exchange resin or zeolite used. You must maintain a clean resin bed by frequent and thorough backwashing and regeneration. Manufacturer literature should be carefully studied and system set-up and operation instructions followed. Caution: Water softeners treat hard water by adding sodium to the water, a health concern for people on sodium-restricted diets. For this reason, you may want to connect a softener only to the hot water line leaving cold, unsoftened water for cooking and drinking. In iron and manganese removal, the softener must treat both hot and cold water since sinks, laundry, and dishwashing equipment are affected. A separate tap can be installed to provide unsoftened water for cooking and drinking.

AERATION

Dissolved iron and manganese are easily oxidized to a solid form by mixing with air. A pressure aerator mixes air with the water, the air is vented, and then the solid particles are filtered from the water.

This method adds no chemicals to the water and is most effective in warm climates. The filter must be backwashed frequently to properly maintain the system. To protect the water from contamination by bacteria in the air, the system should be totally enclosed and only biologically safe water should be used. The appropriate pumping capacity must be maintained for adequate air intake.

OXIDIZING (CATALYST) FILTER

When the total combined iron and manganese concentration is less than 15 mg/l, an oxidizing filter (natural managanese greensand, manufactured silica gel zeolite coated with manganese dioxide, plastic resin beads, or pumicite), is recommended. Some filters are coated with a manganese oxide and are regenerated by using a potassium permanganate solution. An oxidizing filter supplies oxygen to convert ferrous iron into a solid form which can be filtered out of the water.

Frequent backwashing and stirring of a manganese greensand bed helps prevent an iron-fouled bed. After several weeks of use, the greensand filter should be backwashed with potassium permanganate to remove solid particles and regenerate (recoat) the greensand to allow absorbation of more dissolved minerals. Synthetic filters, such as zeolite, requires less backwash water and softens the water as it removes the iron and manganese.

CHLORINATION AND FILTRATION

When the iron and manganese content of the water is extremely high (above 10 ppm), a combination of chemical treatment and filtration is necessary. Small chemical pumps are used to add chlorine bleach, potassium permanganate, or hydrogen peroxide into the water. After a retention time of at least 20 minutes to allow for oxidation of ferrous iron into the insoluble ferric form, the solid particles are filtered out.

When chlorine is used, the treated water can have an unpleasant taste if a particle filter of calcite, sand, anthrocite, or aluminum silicate is used. Use an activated carbon filter to remove both excess chlorine and solid iron and manganese particles. Backwash frequently. Some units have an automatic backwash cycle.

OTHER TREATMENTS

Complexation is a simple and low cost method for removing iron and manganese up to 3 mg/L. A phosphate compound is added to the water to complex (tie up) the dissolved iron or manganese. However, adding phosphates to water supplies is not allowed by law in North Carolina.

If organic-complexed or colloidal iron/ manganese is present in the untreated water, a longer contact time and higher levels of chemical are necessary for the oxidation reaction to take place. Aluminum sulfate (alum) eases filtration by causing larger iron/ manganese particles to form.

A multistage treatment operation may be necessary if your water has high levels of iron and manganese and they are in both the dissolved and solid forms. For example, the water could first be aerated, than chlorinated to oxidize residual iron and kill iron bacteria, and then filtered through a mechanical device to remove particles. This can be followed by activated carbon filtration to remove excess chlorine and a water-softener for hardness control as well as removal of any residual dissolved iron and manganese.

Summary of Treatment Options for Iron and Manganese

Symptom	Cause	Treatment

Water clear when drawn, mg/L of reddish-brown or black particles appear as water stands; reddish- of iron). brown or black stains on fixtures than 15 or laundry. (greater than	Dissolved iron or manganese.	Water softener (less than 5 iron) Aeration (less than 25 mg/L Oxidation/Filtration (less mg/L of iron plus manganese). Chlorination-Filtration 10 mg/L of iron).
Water contains reddish-brown filter that particles when drawn; particles settle out as water stands.	Iron particles from corrosion of pipes and equipment.	Raise pH with neutralizing also filters particles.
Water contains reddish-brown of oxidized or black particles when drawn; filter than particles settle out as water stands.	Oxidized iron, manganese, or both due to exposure of water to air prior to tap.	Particle filter (if quantity material is high, use larger in line, e.g. sand filter).
Reddish-brown or black slime shock treat- appears in toilet tank or from potassium faucet. may re- chlorine or filter.	Iron bacteria. Manganese bacteria.	Kill bacteria masses by ment with chlorine or permanganate, then filter; quire continuous feed of potassium permanganate, then
Reddish or black color that chlorine or remains after 24 hours.	Colloidal iron, manganese, or both. Organic-complexed iron, manganese, or both.	Chemical oxidation with potassium permanganate.

Summary

Iron and manganese are common household water contaminants with no known direct health effects at levels found in water. Their presence may cause staining and offensive tastes and odors. Treatment of these secondary contaminants de pends on the form in which they occur, and the levels of concentration. Iron and manganese removal, bacteria

control, water softening and treatment for any other contamination may be separate problems, yet they must be considered together. Accurate testing is important prior to selection of a treatment system. The table on page 3 may help you identify and determine treatment(s) for iron and manganese in household water supplies.

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Lead in Drinking Water

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What Are the Effects of Lead?

Exposure to low levels of lead over an extended period of time can have severe effects. Too much lead can damage your brain, kidneys, nervous system, and red blood cells. Those at the greatest risk, even with short-term exposure, are young children and pregnant women.

According to the U.S. Environmental Protection Agency (EPA), lead dosage that would have little effect on an adult can harm a small child. Lead in drinking water can be a problem for infants whose diet consists of liquids-such as baby formula made with water. Since they are growing, children absorb lead more rapidly than adults. That lead can then impair a child's development, resulting in learning disabilties or stunted growth.

How Does Lead Contaminate Drinking Water?

Most of the lead in drinking water in North Carolina comes from the lead in the plurnbing in the house, not from the local treatment plant or well.

Lead-contaminated drinking water is most common in recently constructed or very old homes. Many homes built in the early 1900's used lead pipes for interior plumbing. Lead piping was also used for many service cormections that join homes to public water supplies. In 1986, a nationwide ban restricted the use of lead pipes for drinking water supplies.

When copper pipes replaced lead pipes, lead solder and flux were often used to join the pipes. Lead solder is a major cause of lead contamination in drinking water today. The N.C. Building Code Council banned lead solder in 1985. Since 1988, solder that has a lead content over 0.2 percent must be labeled to say that it cannot be used for joints or fittings in any private or public drinking water system.

Homes with plastic drinking water lines, which are glued rather than soldered, should not have problems with lead contamination from pipes. However, household faucets may be a significant source of lead contamination. Chrome-plated faucets are generally made of brass, which contains 3 to 8 percent lead. Contamination can occur when water comes in contact with these fixtures.

The *pH* (acidity or alkalinity) of the water affects how easily lead dissolves from pipes, solder, or fixtures into the water. *Corrosive water* (which has a very high or very low pH) can dissolve lead from the supply pipes, faucets, or solder and flux used to connect copper pipes. Water can be tested to determine whether it is corrosive. *Soft* (water with a low mineral content), *acidic water* can dissolve lead from the pipes or solder of household water systems.

Water with a high mineral content may offer some protection from lead pipes or solder, as a mineral buildup on the inside of pipes prevents contact between water and the lead pipes or solder.

Does Your Home Drinking Water Contain Lead?

Have the water in your home tested. Some cities and counties conduct lead tests for free or a small charge. Private laboratories can test water; the fees range from $25 to $75. The North Carolina Cooperative Extension Service center in your county or the public health department can help identify certified private labs who do these tests. Mail-order labs can also be used to test for lead and other drinking water contaminants. Testing is the only way to tell if there are harmful levels of lead in your drinking water. You should consider testing if:

- your home has lead pipes (pipes are dull grey, soft enough to be scratched with a knife or key).
- your home has copper plumbing and / or chrome- plated fixtures.
- you see signs of corrosion from your water (frequent leaks, rust-colored water, stained sinks, dishes or laundry).
- you use water from a private well. Private water supplies can contain lead in the plumbing or the fixtures, or both.

If you live in a high-rise building, you may also want to test, because lead may not be as easily flushed out of the water system in these structures. You may also want to contact your water supplier to learn if the service cormection that joins your home to the public water supply contains lead.

How Do You Test?

A certified lab will analyze water samples using the EPA's sampling and analysis procedures. Be sure to have a "first drawn sample and a Ufully flushed" sample analyzed. The first draw sample should be collected after water has sat undisturbed for at least six hours. The first draw sample should have the highest level of lead. The fully flushed sample should be collected after the water has been running from the tap for several minutes, at least until the water becomes noticeably cooler.

This two-sample procedure indicates whether flushing the tap can reduce the lead to safe levels. You may be asked to take samples from all the drinking water taps in your home.

How Can You Treat Water To Remove Lead?

There are simple steps you can take if you suspect lead contamination or if testing shows that flushing the tap reduces lead levels.

- Flush the water taps or faucets. Do not drink water that has been sitting in the plumbing lines for more than six hours. The longer that water sits in pipes, the greater the exposure to lead and possible contamination. Before using water for drinking or cooking, run the cold water faucet for two to three minutes, until you can feel that water has become as cold as it can get. You should do this for each drinking water faucet. Allowing the water to run an extra 15 seconds after it feels cold should flush the service connector as well.
- Use only cold water for cooking and dnnking. Hot water dissolves lead more quickly than cold water. Using cold water is especially important if you are preparing baby formula. Heat the water you need for formula on the stove or in the microwave oven. (Do not mix the water with formula or baby food and then heat it in the microwave. Uneven heating could result in "hot spots" that could burn baby's mouth.)
- Use bottled or distilled water. This water can be used for drinking and cooking if flushing the taps does not lower lead levels, or if your home has lead pipes.
- Treat well water to make it less corrosive.

- If you are building a home, state in writing that only lead-free materials are to be used for plumbing installation.
- Use lead-free materials when repairing plumbing or remodeling.

Do Filters Reduce Lead Levels?

Calcite filters can be installed between the faucet and any lead service connectors or lead-soldered pipes. Point-of-use filters like reverse osmosis and distillation units can also be used. They must be maintained to be effective. Activated carbon filters, sand filters, and cartridge or microfilter filters do NOT reduce lead levels, according to the EPA. When lead is a problem, water softeners should not be connected to pipes leading to drinking water taps.

New Legislation for Lead

People can be exposed to lead from many sources, including air, soil, dust, food and water. Because of concerns about the health effects of lead, standards have been tightened to reduce total exposure to lead. The EPA has also reduced the amount of lead permitted in drinking water.

Since much of the lead which appears at the tap comes from household lines, rather than from the water supply itself, there is no longer a "Maximum Contaminant Level" (MCL) in place for lead. (An MCL is defined as the limit on the amount of a contaminant which may legally be present in municipally-supplied water). Instead, an "action level" of *15 parts per billion* (15 ppb) has been established for lead in tap water. Other ways to express this level are 15 micrograrns per liter (ug / L), 0.015 parts per million (ppm) or 0.015 milligrams per liter (mg / L).

In addition, water systems have been informed that they should supply water which is free of lead. This is a non-enforceable goal, unless significant contamination is detected at the tap in homes supplied by the system.

Each municipal system must now target ahigh riskn households (based on materials used in the delivery system and other factors) and analyze tap water samples from these households for lead. If the lead level exceeds the 15 ppb action level in 10 percent or more of the taps sampled, then these three steps must be initiated by the supplier:

1. *Corrosion control* to adjust water pH so that it is less likely to damage pipes, solder, or fixtures, or any combination of the three. This will reduce the release of lead into the drinking water.
2. *Source water treatment* to reduce the amount of lead in the water as it leaves the municipal supply.
3. *Public education* to inform customers of the health effects of lead.

   Finally, if the above steps do not reduce the lead level at the tap to the 15 ppb action level, then the municipal system must replace lead delivery system components which contribute more than

15 ppb to tap water lead levels.

Contact the North Carolina Cooperative Extension Service center in your county for additional in- formation and publications on water quality. Also, the EPA has a toll-free DrirMing Water Hotline to answer your questions about drirMing water testing and drinking water safety. Their number is 1-800-426-4791.

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Nitrate in Drinking Water

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Drinking water high in nitrate is potentially harmful to human and animal health. Nitrate (NO3) is a naturally occurring form of nitrogen (N) which is very mobile in water. It is essential for plant growth and is often added to soil to improve productivity. Water moving down through soil after rainfall or irrigation carries dissolved nitrate with it to ground water. In this way, nitrate enters the water supplies of many homeowners who use wells or springs. It is estimated that about three percent of residential wells in North Carolina contain nitrate at levels exceeding the safe drinking water standard.

Health Concerns

Infants under six months of age are susceptible to nitrate poisoning. Bacteria that live in the digestive tracts of newborn babies convert nitrate to nitrite (NO_2). Nitrite then reacts with hemoglobin, which carries oxygen in blood, to form methemoglobin. Methemoglobin cannot carry oxygen, thus the affected baby suffers oxygen deficiency. The resulting condition is referred to as methemoglobinemia, commonly called *"blue baby syndrome."*

The most noticeable symptom of nitrate poisoning is a bluish skin coloring, called cyanosis, particularly around the eyes and mouth. A baby with bluish skin should be taken to a medical facility immediately and tested for nitrate poisoning. The blood sample of an affected baby is chocolate brown instead of the normal bright red due to lack of hemoglobin. Methemoglobinemia is relatively simple to treat, and in most reported cases, the affected baby makes a full recovery.

Within several months after birth, the increasing level of hydrochloric acid in a baby's stomach kills most of the bacteria which convert nitrate to nitrite. By the age of six months, the digestive system is fully developed, and the risk of nitrate-induced methemoglobinemia is greatly reduced.

Water quality standards for human consumption have been set at ten milligrams of nitrate-nitrogen per liter of water (10 mg/L NO_3-N). This level of nitrate-nitrogen is equivalent to 45 mg/L of nitrate (NO_3). When reading laboratory reports of water quality, be sure to note whether reported values are for nitrate-nitrogen or nitrate. Note that one mg/L equals one ppm (part per million). Most reported cases of blue baby syndrome due to contaminated water have occurred when infant formula was prepared using water with greater than 40 mg/L NO_3-N.

Consumption of high-nitrate water by pregnant women and nursing mothers is not as likely to be harmful to babies as direct consumption. The health effects in these cases are not completely understood, so it is recommended that pregnant women and nursing mothers limit nitrate consumption. Possible connections between nitrate and other health problems such as nervous system disorders, cancer, and heart damage are not well documented and are currently being researched.

Ruminant animals (cattle and sheep) and infant monogastrics (baby pigs and baby chickens) are also susceptible to nitrate poisoning because of bacteria living in their digestive tracts. Horses, even though they are monogastric, are susceptible to nitrate poisoning throughout their lives. Livestock may be exposed to large quantities of nitrate in their feed as well as in contaminated water. Animals which are treated in time can recover fully from nitrate poisoning. Scientific studies indicate that water with greater than 25 mg/L NO_3-N can be harmful to animals.

Treatment Options

Because nitrate is tasteless and odorless, water must be chemically tested to determine contamination. Your County Health Department and many private laboratories will test for nitrate. County Extension offices have lists of certified private laboratories in North Carolina which test for nitrate. Before investing in treatment equipment or a new water supply, have your water tested at a reputable laboratory.

If your water contains greater than 10 mg/L NO3-N, your options for reducing health risks are substitution, in-home treatment, and source elimination. Substitution of bottled water for drinking and cooking is a simple and relatively inexpensive means of reducing nitrate intake.

Nitrate is easily dissolved in water, which means that it is difficult to remove. Three water treatment systems that remove nitrate are **distillation, reverse osmosis, and ion exchange.**

- Distillation boils water, then catches and condenses the steam while nitrate and other minerals remain in the boiling tank.
- Reverse osmosis forces water under pressure through a membrane to filter out contaminants.
- Ion exchange introduces another substance, normally chloride, to "trade places" with nitrate in water.

Treatment of drinking water to remove nitrate is expensive. Consider not only the initial purchase price but also the cost of regular maintenance when purchasing a water treatment system.

Simple household treatment procedures such as boiling, filtration, disinfection, and water softening do not remove nitrate from water. Boiling actually increases the nitrate concentration of the remaining water.

Protecting Your Water Supply

The source of nitrate contamination should be identified and eliminated whenever possible. Potential sources of nitrate include septic systems, animal waste, commercial fertilizer, and decaying organic matter. Surface water which comes in contact with a source of nitrate and then moves downward through soil will carry nitrate to groundwater. Shallow wells are susceptible to nitrate contamination because there is less soil and rock to serve as a filter between the soil surface and the ground water supply. Nitrate contamination levels may vary with time of year depending on the source of the pollutant.

Ideally, drinking water supplies (wells or springs) should be up hill and at least 100 feet away from all possible sources of contamination. Remember that any fertilizers or organic materials which are placed near a well are potential contamination sources for your water. It takes only a very small quantity of nitrate entering your water supply to raise the concentration to an unsafe level.

Several measures may be taken to protect your well from direct contamination by surface water. Earth berms should be built to divert surface runoff away from the wellhead. The well casing should extend above ground. If the casing was cut off below ground, an extension may be welded onto the the top of the existing casing. Proper well protection also includes grouting around the outside of the well casing and placing a concrete slab around the wellhead. Contact your County Extension Office or County Health Department for more information on well protection, water quality testing, and water treatment systems.

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Radon in Water

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Radon is a naturally occurring radioactive element found in most groundwater in North Carolina.

In water, radon is measured in picocuries per liter (pCi/L). Ten thousand pCi/L in water translates to about 1 pCi/L in air. The current "action level" for airborne radon is 4 pCi/L. The U.S. Environmental Protection Agency (EPA) recommends that action be taken to lower airborne radon if it exceeds 4 pCi/L in your home. While there are no EPA standards for radon in water now, a maximum contaminant level (MCL) of 300 pCi/L for public water supplies is being considered.

Based on an EPA pilot study, the average waterborne radon level in public groundwater supplies is 353 pCi/L. This same study showed the average for North Carolina groundwater was 545 pCi/L, somewhat above the national average.

Although these averages seem high compared to the EPA's proposed standard of 300 pCi/L, the average of 545 pCi/L reflects the fact that there were some water supplies with high radon levels, which made this average higher than most of the public groundwater radon levels sampled in North Carolina. If the data were written on paper, ranked from lowest to highest, the tested radon level in the center would be 48 pCi/l. This is called the "geometric mean," which is different than the average that is usually used with most data.

Radon

> (Radon 222) is a naturally occurring radioactive element measured in picocuries per liter (pCi/L). Radon is produced during the radioactive decay process of uranium that has been in the earth's crust since the earth was formed. In water, radon is measured in picocuries per liter (pCi/L). A picocurie is 0.037 radioactive disintegrations per second. The EPA estimates that 10,000 pCi/L in water translates to about 1 pCi/L in air.

Concentrations vary widely in North Carolina groundwater. Public groundwater supplies seem to have the highest radon levels where the water moves through granites in the piedmont. The highest readings there have been over 10,000 pCi/L. The lowest concentrations occur in the coastal plain region, where many readings are below 100 pCi/L. Concentrations from about 500 to 10,000 pCi/L occur in groundwater water samples drawn from metamorphic rocks, such as the gneisses and schists found in the piedmont and mountain regions.

A high concentration of radon in the groundwater in your area does not necessarily mean that there will be a high concentration of radon in your drinking water. Radon escapes harm- lessly into the air when water is being treated for use in a municipal system. Also, radon decays into other substances over time while the water is being stored. Municipal systems that use surface water—a lake or a river—instead of groundwater will probably have low waterborne radon levels.

High levels of waterborne radon tend to occur in homes on an individual well or a community well system (serving up to about 100 homes) *if* the groundwater has a high level of radon.

The largest releases of waterborne radon in your home come from those activities and appliances that spray or agitate water, such as taking showers and washing dishes or clothes.

Health Effects

Drinking water that contains radon is not believed to cause a significant health risk, but a high airborne radon level is linked to increased risk of lung cancer.

Approximately one out of every 10 homes in North Carolina has an airborne radon level above 4 pCi/L. Radon in water contributes to the airborne radon level in some of these homes, adding to the airborne radon that enters the house as a soil gas. Over a long period, airborne levels of radon above 4 pCi/L may increase your family's risk of lung cancer.

Radon Testing

Test your home for radon. Test the air level first. If the level is above 4 pCi/L and you get your water from a private well system, you may want to test your water for radon.

To test for radon, draw a water sample from an indoor faucet after the removing the aerator. Collect the sample in a special vial supplied by the testing lab. Take the sample after running the cold water at a slow but steady rate. Then send the sample to the lab for analysis.

If initial tests indicate a problem, use follow- up tests to verify the results. If follow-up tests show that a substantial portion of the radon in your home comes from your household water supply, consider taking some action to lower radon levels in your water supply.

Treatment

Good **ventilation** of bathroom, laundry, and kitchen areas may be enough to prevent the buildup of airborne radon coming from water.

If this is not effective, consider a granular activated carbon filtration system or an aeration system.

Granular activated carbon (GAC) filter systems have been very effective at lowering water- borne radon levels, but the radioactivity that builds up in the filter bed may be of some concern. Install GAC systems only outside of your home.

Aeration systems are also effective and do not accumulate radioactivity. Aeration systems mix the water with air in an outside-vented chamber. After aeration, the water is piped into the house free of radon. Aeration systems require periodic cleaning to remove particulates that come from minerals in the water.

Summary

Since 10,000 pCi/L in water translates to about 1 pCi/L in air, relatively few people have to worry about the health risks posed by water- borne radon.

Everyone should test for airborne radon levels in their homes. The test is inexpensive and you can do it yourself. If you do find that you have a level higher than 4 pCi/L, and your water comes from a private well, you may want to test that water for radon. If radon levels in your water are 40,000 pCi/L or greater, action may be taken to lower the waterborne radon levels.

Contact the extension center in your county or the North Carolina Division of Radiation Protection in Raleigh for more information on radon testing and removal systems.

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Volatile Organic Compounds (VOCs) in Drinking Water

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Drinking water containing high levels of volatile organic compounds (VOCs) may be harmful to human health. VOCs are a class of chemicals that have important properties in common: They evaporate, or vaporize, readily (they are volatile), and they contain carbon(and are therefore called organic). When present in water at low concentrations, some VOCs produce a sweet, pleasant odor.

The U.S. Environmental Protection Agency (EPA) estimates that VOCs are present in one-fifth of the nation's water supplies. They can enter ground water from a variety of sources. Benzene, for example, may enter ground water from gasoline or oil spills on the ground surface or from leaking underground fuel tanks. Other examples of commonly detected VOCs are dichloromethane (methylene chloride), an industrial solvent; trichloroethylene, used in septic system cleaners; and tetrachloroethylene (perchloroethylene), used in the dry-cleaning industry. Table 1 lists possible sources and potential health effects for some VOCs commonly detected in water supplies.

Health Concerns

Volatile organic compounds may have a variety of harmful health effects. At high levels of exposure, many VOCs can cause central nervous system depression (drowsiness, stupor). All can be irritating upon contact with the skin, or to the mucous membranes if inhaled. Table 1 lists the eight VOCs currently regulated by EPA in public water supplies (those which serve 25 or more people). Also listed are other VOCs commonly found in drinking water. For each chemical, EPA has established a maximum contaminant level (MCL). Water containing a chemical in an amount lower than the MCL is considered safe to drink. Drinking water containing one or more VOCs at levels above standards should not be consumed. In addition, because little is known about the additive effects of these chemicals, special attention should be paid to detecting and eliminating VOC sources if two or more chemicals are found in water. In any case, sources of VOC contamination should be eliminated if possible.

Protecting Your Water

The most effective method for preventing VOC contamination is to ensure that these compounds are not used or disposed of near wells or surface water supplies. Protecting your water source is the most effective method to eliminate exposure to these chemicals. Be sure that your well is constructed properly and is protected to prevent surface water from moving down the well casing into your drinking water supply. See Cooperative Extension service publication AG-469, *Your Water Supply: Well Construction and Protection*, or contact your county Cooperative Extension Center or local health department for information on proper well protection.

Public water systems are required to be monitored on a routine basis for contamination. For private water supplies, however, it is the homeowner's responsibility to regularly have water quality evaluated.

If VOCs or other contaminants are found at levels approaching or above drinking water standards, the source of contamination should be eliminated. Prior to transfer of property, the prospective owner may wish to request in writing that well water be analyzed to determine water quality. This testing is especially important in cases where the property is a current or former agricultural or industrial site, or where buried fuel tanks are located nearby. Costs of VOC testing range from less than $100 up to $300 per sample. Cooperative Extension Offices and Health Departments can provide lists of certified private laboratories.

Treatment Options

Options for homeowners with contaminated water include preventing further contamination, locating an alternative water supply, or treating water to remove contaminants. Identifying and removing the contamination source is the safest and most permanent solution. However, it is not always possible to identify and eliminate the source.

In some cases, ground water is contaminated to the extent that cleanup may take many years and be extremely expensive. Alternative water supplies include new wells, public water systems, and bottled water. If a new well is constructed, be sure that it is not susceptible to contamination from the same source as the polluted well.

Bottled water can be used as a short-term source of drinking water. Keep in mind, however, that VOCs may also enter the body through skin absorption or through inhalation of water vapor.

Home filter systems may provide a high-quality water supply if properly installed and maintained. Filters may be purchased for point-of-use (POU) treatment at the faucet or point-of-entry (POE) treatment where water enters the home. POE treatment systems are recommended for VOC removal to ensure that all water used for drinking, cooking, cleaning, and bathing is free of contamination. There are a variety of filter systems available. Before purchasing a filter system, it is wise to consult with several reputable water treatment companies to ensure that the equipment purchased will treat the specific water quality problem.

Granular activated carbon (GAC) filters are typically used to reduce VOC levels in home drinking water. The effectiveness of carbon filters is related to (1) the type and amount of contaminant, (2) the rate of water usage, and (3) the type of carbon being used. Large contaminant concentrations and high water use rates reduce the carbon life. The manufacturer's guidelines for replacing carbon filters should be followed. Water entering and leaving the filter should be tested periodically to ensure that the treatment system is working properly.

Bacteria may grow on the surface of a carbon filter. Water should be disinfected after it passes through the filter to ensure its safety. Many types of disinfection systems are available. Ultraviolet (UV) radiation is one type of system shown to work effectively and efficiently to eliminate bacteria problems in water.

Summary

Effective drinking water protection includes source protection and regular testing to ensure that the water is safe. Source elimination and proper well protection are the most effective methods for protecting ground water. If you live in an area where there is potential for organic compounds in your water, have it tested periodically for VOCs. If testing indicates contamination, water treatment systems can be used to remove chemicals. Be sure that systems purchased for home treatment of VOCs are certified to remove those found in your water.

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Questions to ask when Purchasing Water Treatment Equipement

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The home water treatment industry has expanded tremendously in recent years. New products are constantly being introduced which claim to solve a variety of water quality problems. Consumers often make costly decisions about water treatment equipment without being well-informed. Many people simply do not know what questions to ask to ensure wise investments. The following questions should be asked of water treatment manufacturers or distributors. These are guidelines to help you make informed choices about treating your home drinking water.

- **1. How long has the company been in business? Can I obtain a list of referrals?**

You can contact the Better Business Bureau or State Attorney General's Office to determine if any complaints have been received about the company. Ask other customers if they have been satisfied with the performance of the equipment and with the service of the company. If you cannot obtain satisfactory answers to these questions for a particular company, do not purchase their equipment.

- **2. Are the product and the manufacturer rated by the National Sanitation Foundation (NSF) or the Water Quality Association (WQA) for performance?**

  A product tested by an independent testing agency such as NSF or WQA will have a seal indicating that it meets industry standards for water treatment performance. Do not buy a device which does not have a seal indicating it meets standards.

- **3. Was the product tested for the specific contaminant in question, over the advertised life of the treatment device, under household conditions?**

  You should examine test results of the device to determine if manufacturer's claims are realistic. If no test results are available, consider purchasing a different brand.

- **4. What exactly do water test results show, and should more testing be done?**

  Many water treatment companies offer free analyses of your water before trying to sell you their products. You should have a qualified individual examine your test results before making any purchasing decisions based on free water tests. Your physician, County Health Department, or County Extension Office can help you evaluate water test results. Be wary of any in-home test which claims to determine more than basic water quality parameters such as pH, hardness, iron, and sulfur.

- **5. Does the specific water problem require whole-house treatment (point of entry) or a single-tap device (point of use)?**

  The water treatment device selected depends on the contamination problem. Some contaminants may be hazardous when inhaled or absorbed through skin, as well as when ingested. In this case, all water used in the house should be treated. For most contaminants, treatment of only drinking and cooking water will provide safety at a much reduced cost.

- **6. Will the manufacturer retest the water in a month or two to check the performance of the recommended treatment device?**

  You should ask for a written guarantee that the device will correct the specific problem, or the company will replace it or refund your money.

- **7. Will the device produce enough treated water to meet daily household requirements?**

  The maximum flow rate should be adequate for peak home use rate. You may also need to check whether the water system has the capacity for the treatment unit's maintenance requirement. For example, be sure you have adequate pressure for a reverse osmosis unit.

- **8. Is there a shutoff system in case of malfunction? Is there an indicator light or alarm to alert me of a problem?**

  Some units have shutoff systems and indicators to prevent you from consuming untreated water.

- **9. Does the device require maintenance, and how do I know when maintenance is necessary?**

  Devices such as activated carbon units, reverse osmosis (RO) units, and iron filters require regular maintenance. Make sure you understand the cost and effort necessary to properly maintain equipment. Know how to contact company representatives if you have any questions after the device is installed.

- **10. Can I install the device and perform required maintenance, or do I have to rely on company service?**

  You may be able to save a great deal of money with do-it-yourself equipment, but make sure the job is done right. Your money is wasted if equipment is not working properly. Find out if the warranty is voided if you perform maintenance on the device.

- **11. What are the total costs for purchase and maintenance, including labor for installation and service?**

  Watch for hidden costs such as installation fees, regular maintenance fees, equipment rental fees, or costs associated with disposal of reject water or spent cartridges. Also ask about the electrical usage of the device.

- **12. What is the expected lifetime of the device? How long does the warranty last, and what does it cover?**

  Consider the long-term cost of replacement or repair when making your purchase decision. Know all the requirements to keep the warranty in effect.

These questions serve as guidelines for consulting with water treatment equipment representatives. It is wise to shop around and get the best deal possible on the water treatment equipment you really need. Always get all guarantees and promises in writing and know how to contact the company selling you the equipment.

In addition to home water treatment, consider alternatives such as bottled water for drinking and elimination of the contamination source. Contact your County Extension Office for information on water testing, health effects of contaminated water, and treatment systems.

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Protect Yourself When Selecting a Home Water Treatment System

Prepared by:
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The shortage of water, the quality of water, the safety of water for drinking, and the conservation of water have all made headlines in recent years.

Many effective products are available for home use that improve water quality. However, the increased attention on water safety serves as an invitation for con artists and unscrupulous sellers, who use deception and scare tactics when selling home water treatment equipment. Water treatment devices or systems may be referred to as water "purifiers," "filtration systems" or water "conditioners.

The Federal Trade Commission (FTC) and consumer protection divisions of state attorney general offices report that water purifier fraud is growing rapidly all across the United States. People engaging in fraud are not sneaky-looking characters slinking around with slouchy hats and shiny shoes, as sometimes portrayed in warnings about consumer fraud. Successful con artists are appealing individuals who can gain your full trust and confidence. They have an unusual understanding of human nature. They know how to use people's feelings of fear, insecurity, vanity, power, or desire to get "a good deal." Rather than selling a water treatment system on its merits, some companies choose to prey on the public's fears that the water isn't safe.

No tap water is 100 percent pure, and many people have limited knowledge about what is safe water. Also, consumers may have little information about the functions and limitations of home water treatment systems. As a consequence, some people buy expensive water treatment equipment they don't need, to cure problems that don't exist.

Fraudulent Selling by Mail and Telephone

Here are some approaches used to sell water treatment devices by mail or telephone:

Hundreds of letters are sent telling consumers that they are "prize winners" if they call within a time limit, such as three days. This creates pressure on the consumer to act. Or, a television spot or a print media advertisement may give a number to call for more information.

IN FACT - Even though consumers are "guaranteed" to be winners of "prizes," claimed to be worth several thousand dollars, often the more valuable prizes are not awarded. "Grand prize winners" may receive a cash value certificate but often find that the certificate may be used only to purchase certain water treatment services, supplies, or devices. Other "winners" receive a less expensive award, such as a year's supply of a special system cleaner. Consumers who receive a "travel package" may discover it does not include airfare or meals, and there may be stringent restrictions as to when and where the travel package can be used. Jewelry prizes are usually of low value, and home entertainment systems may be of inferior quality.

The water treatment devices are represented as having a high dollar value, such as $500.

IN FACT - Typically, devices sold by mail or telephone promotions are faucet attachments or cartridges which sit on the counter or under the sink. True estimated value is often $50 or less.

The seller describes the nation's drinking water as being in a deplorable state and claims that his or her company's product is one of only a few water purification systems tested and registered with the Environmental Protechon Agency (EPA).

IN FACT - The EPA does not "test," "approve," "disapprove," or "recommend" water treatment devices. An EPA number is assigned if a manufacturer claims that the device inhibits or reduces bacteria in the water or on the filter. Some ratings of water purifier devices and manufacturers are done by the National Sanitation Foundation, a non-profit organization, and the Water Quality Association, which is a trade association. EPA develops and oversees the implementation and enforcement of regulations for drinking water by public water systems.

The seller claims that the water purifier can completely remove a variety of contaminants such as bacteria, salmonella, chloroform, radon, arsenic, lead, mercury, pesticides, solvents, and asbestos.

IN FACT - No single home water purification system is capable of removing all contaminants. Different types of substances require different types of treatment systems.

Customers may be assured that if they are not sahsfied with the water purifier they can cancel the purchase and get a full refund within 30 to 60 days.

IN FACT - It may be impossible to get a refund. There may be stipulations such as a "restocking fee" (e.g., 25 percent of the purchase price) which means the consumer loses some of the money paid. This information typically is not revealed until after the consumer has made the purchase.

Customers may be told that the filtering system is virtually maintenance free, or that a filter will last 12 to 15 months.

IN FACT - Not only are claims about minimal maintenance false and misleading, they can create a potential health threat if they are taken seriously. Regular maintenance of any water treatment system is critical to its effectiveness. Inadequate cleaning and/ or failure to replace the filtering parts of the treatment system may create serious health hazards because bacteria and other contaminants become concentrated in the filtering system.

Exaggerated promises are made about the amount of water that the treatment device will process.

IN FACT - The amount of water a treatment device can process is related to both its size and type. Some water treatment devices require several hours to produce one gallon of treated water.

The caller may offer to have a check or money for the water purifier system picked up at the consumer's home. And the consumer is told that this is necessary to meet the deadline for the "special promohon" and be eligible for the "prizes." Or, the customer is given a special number for free Express Mail.

IN FACT - Legitimate businesses do not engage in such practices.

Other Methods Used to Sell Home Water Treatment Systems

"Researchers" and Water Quality Inspectors

Some callers represent themselves as "water quality inspectors" or "researchers" doing a survey on water quality in your area. The surveys allow sellers to gain information on households and to identify people who have concerns about water quality. Depending on their response, certain people will receive a follow-up contact about water treatment systems.

Free Water Testing Done in the Home

Another approach used in selling water treatment devices is offering a free in-home test of your drinking water. Some sales people leave a bottle on your doorknob, offer to pick it up, run the tests, and then contact you with the report. Other sales people may visit your home wearing lab coats to make an impression.

The in-home test will show there are minerals in your water, and perhaps the acidity/alkalinity level. The testing procedures use a chemical that combines with dissolved minerals, such as calcium and magrlesium, and causes them to settle to the bottom of the bottle. Keep in mind that all water, except distilled water, contains some minerals. In general, the presence of minerals is not a health threat. In fact, many of the minerals are beneficial to the body. However, some do cause water hardness and an undesirable taste.

Another demonstration uses a face cloth that you previously washed. The demonstrator will put the cloth and a water softening agent into a jar of your tap water and shake vigorously. Suds will occur in the bottle. This is normal as some detergent residue remains in all washed articles.

These free, in-home "water quality tests" are merely sales ploys designed to sell you a water treatment system. Often the "test report" on your tap water is given in a way that implies that your water contains a lot of minerals that are not good for your family's health.

Usually the people who do the home testing will require that both spouses of a married couple be present for the demonstration. This prevents one spouse from using a delaying tactic by insisting on talking to the other spouse before making a decision to buy a water treatment system.

The Electric Precipitator

Some unethical operators use a more dramatic demonstration with an "electric precipitator." This machine resembles a coffee pot in which two metallic electrodes (metal rods) are placed. The demonstration produces a dark sludge, which is caused by electricity decomposing the rods. The electric precipitator device is a sham, but it is a convincing sales tool because of its visual shock effect. Impressive demonstrations like these, often are directed to low-income and non-English speaking families. High pressure selling tactics are used to convince people to buy.

Taste and Appearance

Claims that a water treatment device can improve the taste of your water may be accurate. Also, softened water saves some energy because it takes less to heat water and because you need less detergent for laundry. However, claims about saving hundreds of dollars in laundry and water heating costs may be exaggerations.

Harmful contaminants in water are often more difficult to test for than the common minerals in tap water. For example, lead is odorless, colorless, and tasteless, but may be harmful at even very low concentrations in water. Tests for lead, and most other contaminants that are health concerns, require special equipment and complex procedures. Tests for most potentially harmful water contaminants cannot be done in your home.

Protection from Deceptive Sales Practices

Your best defenses are knowledge about a product and a healthy skepticism of advertising and sales pitches. Recognize that a considerable amount of "puffery" is used in promoting most products. Be particularly wary of "scare tactics."

- When dealing with telephone sales, learn what city the company is calling from; get a specific address.
- Ask the caller his or her name.
- Ask for information about the product in writing before you agree to buy.
- Check the company's record with the Better Business Bureau in the city where it is located.
- Don't buy something merely because you'll get a "free gift."
- Don't give your credit card number to anyone who calls on the phone.
- Don't send money by messenger or overnight mail. If you use money rather than a credit card, you will lose some power to dispute the charges.
- If you are uncomfortable with being pressured to buy, HANG UP!
- Use the work sheet, "Purchasing a Water Treatment Device," to help you prepare for a visit from a salesperson.

Be cautious about letting someone into your home for "free testing" of your drinking water. Understand that this is merely a sales ploy to convince you that you need a water treatment system. Do not feel you must give personal information (such as "Do you own your home?") to someone doing a survey. When a "water problem" is identified for you, do not panic. Thank the person for the information and say you will check on the problem. Keep in mind that salespersons are not scientists. They are not trained to make judgments on the safety of your tap water.

Be an Informed Consumer

If you have concerns that your drinking water is unsafe and you are on a public water system, contact your local water system officials (those who send you a water bill if you are on a public water system). Ask for the latest complete analysis of the water. Ask what the results mean.

If you have a well, your local health department can test your water or tell you who to send it to for testing.

If you still want to have other tests done on your water, there are several options you may exercise. For a bacterial test, contact your county health department office. Charges for a bacterial test range from $10 to $50 dollars. To test for chemical contamination, contact your local water system or a certified laboratory. Private testing laboratories are listed in the yellow pages of the telephone book; make sure they are certified by the state health department. Tests for chemical contaminants range from $10 to several hundred dollars.

Invest time reading about water quality and health "risk" factors. Understand the difference between harmful "contaminants" and the minerals commonly found in our water supply that pose no health risks. Such information can be quite enlightening.

In summary, learn what home water treatment systems can (and cannot) do so you can evaluate what a seller is promising. Asking a lot of questions is okay! Asking for additional information is okay! Asking to have another testing agency verify the results is okay! It is okay to be skeptical! You are much better off not buying than spending your money for something that may have limited or no benefits.

Purchasing a Water Treatment System

Use this work sheet to prepare for a visit from a water treatment salesperson. Steps 1-4 in Part A should be completed in advance of the visit. Complete the work sheet as you discuss various water treatment system alternatives for your home. You may want to have several copies of this work sheet available for notes about different treatment systems you are considering.

Worksheet Part A - Review your water treatment needs

. 1. Have your water tested and list test results below.

____ acidity	____ cadmium	____ hydrogen sulfide gas	____ nitrate
____ alkalinity	____ chloride	____ iron	____ organic chemicals
____ arsenic	____ conductivity	____ lead	____ sediment
____ bacteria	____ hardness	____ mercury	____ sodium sulfate

2. Review information about health and appearance impacts of your water contaminants. Note the special concerns.

____

3. Review treatment choices and list those that might be approDriate for your particular water problem(s).

____

4. Is the supplier reputable and reliable? ____ Yes _____ No

Worksheet Part B - Evaluate the quality of the water treatment system.

5. Is there a product approval letter for the system which lists the types and amounts of contaminants it will reduce?

____ Yes _____ No

6. How much space does the treatment system need?

____

7. Does the treatment system need specially treated water to function properly?

____ Yes _____ No

8. How many gallons of water does your family use per day?
(Base your estimates on: 2 quarts per fami/y member per day for drinking and cooking; 60 gallons per family member per day for treating all the water in the home; and 25 gallons per person per day for treating hot water only.)

9. Have you compared the volume of water available from the treatment system to the volume needed by your family?

____ Yes ____ No

10. Check the rate of water flow that you prefer where the treatment device will be installed. Does the flow rate of the device meet the needs of your family?

____ Yes ____ No

11. Have you reviewed and understood the instructions for operation and maintenance that come with the treatment system?

____ Yes ____ No

12. How much water can the treatment system process before replacement parts or maintenance will be needed?

____ gallons

13. Have you installed a device to monitor your water use? Do you understand how to reasonably estimate when maintenance will be needed?

____ Yes ____ No

14. Will you need to hire a technician to replace parts or maintain the treatment unit?

____ Yes ____ No

15. Do you know what the cost of maintenance will be each year?

____ Yes ____ No

16. Other comments about this system:
____

Worksheet Part C - Estimate the cost of the treatment system.

17. Water system purchase and installation:

Cost of water treatment system ....$______
Cost of installation ....$______
Other installation costs................$_______

18. Replacement costs:

Frequency of replacemenVservice needs ..$______
Parts to be serviced or replaced ....$______

Total annual service costs ....$______

19. Special design considerations:

Additional electrical costs per month to operate system..... $______
Additional water costs per month per month to operate system.$______

20. **Total annual operation costs........................$______**

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Biological and Agricultural Engineering

Extension Publications

- Drinking Water -

Title	Publication Number	Source
Should You Have Your Water Tested?	WQWM-3\ AG-473-2	AC
Nitrate in Drinking Water	WQWM-5\AG-473-4	AC
Metals in Drinking Water --- **Sorry out-of-date**	WQWM-6\AG-473-1	AC
Questions to Ask When Purchasing Water Treatment Equipment	WQWM-7\AG-473-3	AC
Health Effects of Drinking Water Contaminants	WQWM-8\HE-393	AC
Your Water Supply: Well Construction and Protection	WQWM-10\AG-469	AC
Iron and Manganese in Household Water	WQWM-11\HE-394	AC
Lead in Drinking Water	WQWM-12\HE-395	AC
Radon in Water	WQWM-13\HE-396	AC
Volatile Organic Chemicals (VOCs) in Drinking Water	WQWM-16\AG-473-5	AC
Drinking Water Quality for Poultry	WQWM-69\PS&T Guide #42	PS
About Wells: What You Need to Know --- **Sorry out-of-date**	WQWM-119	BE
Protect Yourself When Selecting a Home Water Treatment System	WQWM-135\HE-418	AC
Home Drinking Water Treatment Systems	WQWM-136\HE-419	AC

Protecting Water Supply Springs	WQWM-142\AG-473-15	AC
Emergency Drinking Water Supplies	N/A	BE
Farm*A*Syst: Protecting Water Supply	WQWM-165/AG-566-1	AC
Farm*A*Syst: Improving Fuel Storage	WQWM-166/AG-566-2	AC
Farm*A*Syst: Improving Storage and Handling of Hazardous Waste	WQWM-167/AG-566-3	AC
Farm*A*Syst: Improving Septic Systems	WQWM-168/AG-566-4	AC
Farm*A*Syst: Improving Storage and Handling of Pesticides	WQWM-169/AG-566-5	AC
Farm*A*Syst: Improving Storage and Handling of Fertilizers	WQWM-170/AG-566-6	AC
Farm*A*Syst: Improving Storage, Handling, and Disposal of Livestock Waste	WQWM-171/AG-566-7	AC
Home*A*Syst: Protecting Water Supply	WQWM-172/AG-567-1	AC
Home*A*Syst: Improving Fuel Storage	WQWM-173/AG-567-2	AC
Home*A*Syst: Improving Storage and Handling of Hazardous Waste	WQWM-174/AG-567-3	AC
Home*A*Syst: Improving Septic Systems	WQWM-175/AG-567-4	AC
Home*A*Syst: Improving Lawn Care and Gardening	WQWM-176/AG-567-5	AC
Home*A*Syst: Stormwater Management for Homeowners	WQWM-200/AG-567-6	AC

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Water Quality and Waste Management

Care and concern for our environment is the biggest public issue of the 1990s. But long before overflowing landfills and groundwater pollution became front-page news, the North Carolina Cooperative Extension Service recognized the problems and began looking for solutions. The Water Quality and Waste Management Initiative has evolved in response to the dire need to protect and preserve our world. Through North Carolina State University and the North Carolina Cooperative Extension Service, we can link the science of today with the environment of tomorrow.

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Biological and Agricultural Engineering

Extension Publications

- Protecting Water Resources -

Title	Publication Number	Source
Maintaining the Forestry Exemption Under the Sedimentation Pollution Control Act	WQWM-36\WON-22	FR
Nitrogen Management and Water Quality--- **Sorry out-of-date**	WQWM-46\AG-439-2	AC
Soils and Water Quality --- **Sorry out-of-date**	WQWM-47\AG-439-1	AC
Agriculture and Coastal Water Quality --- **Sorry out-of-date**	WQWM-48\AG-439-10	AC
Best Management Practices for Agricultural Nutrients--- **Sorry out-of-date**	WQWM-71\AG-439-20	AC
Protecting Water Supply Springs	WQWM-142\AG-473-15	AC
Wetlands and Water Quality	WQWM-115\EBAE 166-93	BE
Engineered Stormwater Controls --- **Sorry out-of-date**	WQWM-117\AG-473-9	BE
Fertilizer Recommendations & Techniques to Maintain Landscapes and Protect Water Quality	WQWM-127\AG-508-5	AR
Erosion and Sedimentation Control in North Carolina	WQWM-130\AG-473-20	AC
Engineered Stormwater Controls	WQWM-139\AG-473-9	AC
Watershed Management: Planning and Managing a Successful Nonpoint Source Pollution Control Project	WQWM-140	AC

Small Water System Waivers for Monitoring of Pesticides, Synthetic Organic Chemicals and PCB's--- **Sorry out-of-date**	AREP 95-1	ARE
Agriculture and the Coastal Nonpoint Pollution Control Program --- **Sorry out-of-date**	AREP 94-10	ARE
Wetland Regulations in North Carolina--- **Sorry out-of-date**	AREP 94-3	ARE
North Carolina's Basinwide Approach to Water Quality Management --- **Sorry out-of-date**	AREP 93-2	ARE
The Tar-Pamlico River Basin Nutrient Trading Program --- **Sorry out-of-date**	AREP 94-1	ARE

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North Carolina Cooperative Extension Service

Water Quality & Waste Management

Watershed Management: Planning and Managing a Successful Project To Control Nonpoint Source Pollution

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While significant progress has been made in reducing water pollution caused by point sources since the Clean Water Act was passed over 20 years ago, much work remains to be done to reduce nonpoint source pollutants that impair the quality of streams, rivers, lakes, ground water, and other bodies of water throughout the country.

Many local government officials, as well as citizens, are becoming increasingly interested in taking action to address local water quality problems caused primarily by nonpoint source pollutants. These groups recognize that water-quality problems do not occur in isolation, but that many activities within a watershed can degrade water resources downstream. Surface and ground waters are directly connected, so management strategies aimed at protecting water quality must often be designed to address the impacts of human activities on watersheds (surface water) as well as aquifer-recharge areas (ground water).

This publication is designed to provide assistance to local and state government officials and staff, concerned citizens, educational and technical assistance agencies, farmers, and other people who are interested in protecting or restoring the quality of a local water resource.

Causes of Water Quality Problems

Most watersheds encompass many land uses (farms, homes, industries, forests, mines). Each land use has an impact on water quality. Even in uninhabited watersheds, natural sources of pollution exist. These include sediment from stream-bank erosion, bacteria and nutrients from wildlife, and chemicals deposited by rainfall.

Water pollution caused by human activities results from either *point sources or nonpoint sources*. These terms indicate how pollutants are released to surface water or ground water.

A *point source* is a single, identifiable source of pollution, such as a pipe through which factories or treatment plants release water and pollutants into a river. Point source pollution is often controlled through water-quality standards and permitting programs, which establish limits on the kind or amount of pollutants each point source may discharge into a body of water.

A *nonpoint source* is an activity that takes place over a broad area and results in the release of pollutants from many different locations. Agriculture, forestry, residential, and urban development are examples of nonpoint sources of pollutants. Common pollutants from these activities include:

- sediment from cropland, lawns and gardens, forestry activities, roadways, construction sites, and stream-bank erosion;
- nutrients from cropland, lawns and gardens, livestock operations, wildlife, septic systems, and land receiving waste application;
- bacteria from livestock, wildlife, septic systems, land receiving waste application, and urban runoff; and
- man-made chemicals, including pesticides, from roadways, mining operations, cropland, lawns and gardens, and forestry.

Watersheds and Ground-Water Recharge Areas

Wherever you are, you are in a watershed. Every stream, reservoir, lake, and estuary has one. Some of the water that falls on the land as rain, sleet, and snow evaporates. The rest drains into streams, rivers, and lakes, or soaks into the ground. A watershed is the land that contributes water to a particular body of water, such as a lake or stream. Ridges of higher ground generally separate one watershed from another. Rain falling on one side of the ridge flows toward the low point of one watershed, while rain on the other side flows toward the low point of a different watershed.

Ground water lies under the surface of the land in aquifers--underground areas that hold large quantities of water in the spaces between rocks and particles of soil. The source of ground water in each aquifer is the rain (or sleet or snow) that falls in the recharge area of the aquifer, or centuries-old stored water. If recharge occurs, the recharge area is the land area through which water percolates into an aquifer.

Since underground recharge areas and watershed areas do not always coincide, the hydrogeological area for a project must be defined for either the surface water (watershed) or the ground water (recharge area) resource, or both, depending on the objectives of the project.

Steps to a Successful Voluntary Project

1. Choose a Viable Project

The first step in a successful nonpoint source pollution control project is to identify a water resource whose water quality needs restoration or protection. Focus on a water resource that is valued by the community and on a problem that is neither too complex nor too difficult to solve. Talk to or formally survey community members who live and work near the water resource. Find out whether the impairment of the water body is of concern to them. For example, does it impair their recreational use (such as fishing, swimming, or boating) or aesthetic enjoyment of the water?

If the source of the water-quality problem is not clear and well-documented, or if the source is one that cannot be affected by changes in project participants' behavior (for example, if the source is a point source versus agricultural runoff), there is likely to be dissention about what is causing the problem and how to resolve it. If people do not agree that a problem exists, if the source of the problem is not clear, or if agencies cannot work effectively together, a project is unlikely to be successful. In such cases, limited resources for addressing water-quality problems may well be better spent on another project or program.

If project funds are restricted to one source of nonpoint source pollutants, such as agricultural sources, avoid choosing a watershed that contains major point sources. Pollutants from point sources often mask water-quality changes associated with best management practices (BMPs) installed to address nonpoint source pollution, thus making it difficult to document the benefits of a nonpoint source pollution control project. Other approaches, such as total watershed management, that seek to reduce both point and nonpoint sources of pollution, can be effective if adequate technical and financial resources are available.

Select a watershed of a size that matches the level of available funding for the project; if funds for installing BMPs are limited, treating a small watershed will be likely to result in greater water-quality improvements than treating a small land area in a large watershed.

2. Identify and Document the Water Quality Problem

Clearly identify and document the water-quality problem or impairment, and the source or sources of the problem. For example, a popular swimming beach at the community lake may have algal blooms (rapid growth of algae) at certain times of year. The results are color changes, odor, and fish kills all of which impair swimming and other uses of the water resource for recreation. In order to plan an effective approach to this problem, the specific pollutants causing the blooms must be identified and their sources determined. Which nutrient is causing the problem? Is there too much nitrogen or too much phosphorus?

After identifying the pollutant, find out where it originates. Possible sources of nitrogen or phosphorus include runoff from animal operations, over-application of commercial fertilizers on farms or lawns, leakage from septic tanks, or discharges from a sewage treatment plant or industry. It is critical to first identify the source of the problem, so that targeting those activities which are actually affecting water quality. Taking action to address a problem whose source is not clearly understood can often waste time and money.

Request water-quality data and other relevant information from agencies listed under "Information Resources for Environmental Data" in this publication. If adequate information about the problem and its sources has not already been collected, find assistance in securing the technical and financial resources necessary to design and implement a water-quality monitoring program for the water body and its tributaries. (Relevant state and federal programs are discussed in the section entitled "Secure Funding." Expertise in interpreting the significance of existing water-quality data may be available from the North Carolina Division of Environmental Management's regional or state offices, local health or planning departments, or county centers of the North Carolina Cooperative Extension Service.

To identify the exact nature of the problem and its sources implement a monitoring program lasting from six to 18 months. Monitor sites suspected of contributing pollutants during both base flow (normal flow) and storm conditions, especially during the seasons when the highest amount of the pollutant enters the water and during the season when water-quality problems have been noticed. For example, in North Carolina, during winter and spring there is often a great deal of runoff carrying nutrients, sediment, and other pollutants.

Before initiating a project, write a problem statement that (1) states what the impaired water use is, (2) identifies the location of the problem, (3) specifies the pollutant or pollutants, and (4) identifies the major sources or suspected sources of each pollutant. The process of writing a problem statement often helps clarify the problem in the minds of project staff, documents the problem for reference in the future, and clearly states the problem and its sources for participants and other community members, thereby contributing to consensus.

3. Define Project Goals

Well-defined goals clearly convey the purpose of the project to potential participants and the public. Goals also provide a basis for evaluating progress during the course of a project. Goals need to be quantitative--or measurable. For example, progress toward the goal "reduce the phosphorus load to Blue Reservoir by 45 percent" can be measured, while the achievement of a goal such as "reduce pollution in the reservoir" is very difficult to evaluate.

Set specific goals at the beginning of a project. Be sure to include local agencies, project participants, and representatives from the community in this process.

4. Involve Potential Participants and Community Members

Public support and sufficient participation are essential for project success. A high rate of participation is key in voluntary projects because nonpoint sources of pollution are widespread. The following are suggestions for increasing participation:

- Educate potential participants and the community about the water quality problem. They need to agree that there is a problem, that it is important to solve it, and that the right approach has been chosen to address the problem.

- Encourage potential participants to accept responsibility for the effects of their activities. However, awareness of the impacts of human activities on water quality does not necessarily translate into ownership of the problem and a willingness to change patterns of behavior. On-going education of project's participants about the impacts of their land uses on water quality is necessary.

- Involve potential participants early in the planning to help foster a feeling of ownership, which often results in a higher rate of participation in the project.

- Find out if federal, state, or local funds are available to project participants. Financial assistance, such as cost-share funds, is necessary for many potential participants to be able to afford to implement BMPs designed to reduce nonpoint source pollution. (See also the section "Secure Funds.")

- Recommend the lowest-cost BMPs that can effectively reduce nonpoint source pollution. Poor economic conditions and high costs of recommended BMPs can decrease participation in voluntary programs.

- One-to-one contact between project personnel and potential participants is much more effective than mass media for educating and gaining their cooperation in a project. Because of their importance as a means of encouraging producers to participate, initiate information and education efforts well in advance of BMP installation.

- Provide technical assistance seen by participants as valuable, such as soil testing and assistance in designing affordable site-specific BMPs.

- Ask project participants to talk with their neighbors about the project and why they decided to become involved.

- Where relevant, make potential participants aware that regulation may be considered if voluntary implementation of BMPs does not improve water quality. This can provide incentive for them to become involved in a nonpoint source pollution control project.

5. Secure Funding

Funds to support each aspect of the project must be obtained. Cost-share funds that can be used to assist participants in installing BMPs are often critical to the success or failure of a voluntary nonpoint source project. Monitoring water quality and BMP implementation are also important before, during, and after the project, as are educational activities. It may be necessary to tap different resources for each of these essential project components.

Cost-share funds from the North Carolina Agriculture Cost Share Program are allocated to counties based on water-quality protection needs and severity of nonpoint source problems. The program is administered by the state Soil and Water Conservation Commission and implemented by local Soil and Water Conservation Districts. For information, contact: Division of Soil and Water Conservation, North Carolina Department of Environment, Health, and Natural Resources, 512 N. Salisbury St., P.O. Box

27687, Raleigh, NC 27611 (919-733-2302).

Cost-share assistance for implementation of forestry BMPs may be available through the state Forestry Stewardship Program. For information, contact the Division of Forest Resources, North Carolina Department of Environment, Health, and Natural Resources, 512 N. Salisbury St., P.O. Box 27687, Raleigh, NC 27611 (919-733-2162).

For watershed programs addressing agricultural or forestry nonpoint sources of pollution, information about federal cost-share programs can be obtained from county U.S. Department of Agriculture Agricultural Stabilization and Conservation Service offices.

Project funds for water quality and land treatment monitoring may be available from the Nonpoint Source Branch, Water Quality Section, North Carolina Division of Environmental Management (919-733-5083) through Section 319 funds given to each state by the U.S. Environmental Protection Agency (EPA).

A U.S. Environmental Agency publication, "State and Local Funding of Nonpoint Source Control Programs," may be of assistance to local project planners (EPA 841-R-92-003, available from Nonpoint Source Control Branch, WH-553, Office of Water, U.S. EPA, Washington, D.C. 20460, (202) 260-7085 or 7107. The report includes case studies of how states and local governments are funding nonpoint source pollution-control programs.

6. Clarify Agency Roles and Responsibilities and Administer the Project Effectively

Inter-agency cooperation and coordination is essential. Potential participants within the project area need to receive clear messages about the project, its purpose, and its value. Conflicting messages from local, state, or federal agencies participating in a project can result in low rates of participation. Clearly define each agency's role and how agencies will interact with each other to avoid confusion, duplication of efforts, or competition. Urge agency administrators to express support for the project and emphasize the need for inter-agency communication and cooperation. When key agencies are unable to agree on the value of a proposed project, or when turf battles seem unresolvable, consider choosing another project.

Designate a project manager to coordinate the project as a whole and assess progress. Ideally, the project manager should have a background in water resources and project management.

Establish a local coordinating committee consisting of project participants, agency personnel, and community leaders to support the project. The committee should set direction, establish objectives and goals, assure adequate public involvement, enlist agency assistance, oversee information and education, and determine priorities for water quality monitoring. The committee should also develop plans for selecting the critical area, choosing BMP systems, and linking land-treatment and water-quality data.

7. Define the Critical Area

Apply BMP systems to the areas where land treatment will have the greatest effect. Where available, pre-project water-quality monitoring and modeling can be used to identify or refine the critical area--the land area that contributes the most to the water-quality problem. In the absence of such resources, the critical area can be roughly outlined based on distance to the water body and its tributaries, or other obvious location or land-use characteristics Within the critical area, significant pollutant sources (such as animal operations, farm fields, forestry operations, and residential neighborhoods) can be assigned a priority for BMP installation based on the expected impact of the source on the impaired water resources.

Land Treatment and BMP Systems

Water-quality best management practices (BMPs) are designed to control the delivery of pollutants from land-use activities to water resources. BMPs can be either structural (for example, waste lagoons or storage tanks, terraces, sediment basins, or fencing) or managerial (for example, rotational grazing, fertilizer or pesticide management, or conservation tillage).

Any two or more BMPs used together to control a pollutant from the same source constitute a BMP system. A BMP system can be tailored for a specific pollutant, source, geographical location, as well as to a project participant's economic situation.

Systems of BMPs control nonpoint source pollution more effectively than do individual BMPs because systems can minimize the impact of the pollutant at several points: at the source, during transport from the source to the water body, and at the water body.

Systems of BMPs, however, are just part of a land treatment strategy to reduce nonpoint source pollution. In addition to selection of a BMP system that will effectively address the primary pollutants, project managers must be sure that BMPs are placed in the correct locations in the watershed (critical areas contributing the most pollutants) and that a sufficient amount of land treatment is implemented to achieve the desired water-quality improvement.

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8. Choose a Land Treatment Approach

Encourage participants to implement systems of best management practices. Systems of practices are often more effective in controlling a nonpoint source pollutant from the critical area than is a single BMP. Resources for assistance in identifying BMP systems that will effectively address a particular water quality problem and source include county agents of the North Carolina Cooperative Extension

Service, and personnel from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service and from Soil and Water Conservation Districts.

9. Design a Monitoring and Evaluation Plan

Monitoring and evaluating water quality and land treatment can be important tools for conducting an effective project. Monitoring and data analysis document water-quality changes due to land-treatment practices. Reporting conveys the results to participants, funding agencies, and the general public. However, not all nonpoint source projects can afford water-quality monitoring, and few rely on local funds for such monitoring.

When little or no funding is available for monitoring the effectiveness of BMPs installed as the result of a project, visual observations of changes such as fewer algal blooms, clearer water, or increased recreational use can be helpful in assessing the effectiveness of the project. If citizens monitor a few key factors (such as dissolved oxygen, turbidity, or chlorophyll a) Monthly, they can contribute significantly to a project.

For projects that do have funds specifically earmarked for more extensive water-quality monitoring, essential tasks and elements include:

- Develop a monitoring plan based on clearly stated water quality monitoring objectives.
- Include in the monitoring plan the monitoring design, agency roles, laboratory procedures, quality assurance and quality control, data storage, reporting requirements, personnel needed, and costs.
- Collect sufficient pre-project, during-project, and post-project water-quality data to detect and document water-quality changes. In large watersheds with lakes, water-quality changes often occur gradually. As a result, monitoring for five to 10 years, or longer, may be required to confirm real, consistent changes that can be linked to land treatment. Short-term monitoring is seldom effective because climatic and hydrologic variability can mask water quality changes. However, for small watersheds affected by only a few relatively large pollutant sources, the monitoring period may be shorter.
- To detect long-term trends, collect samples at regular intervals using a predetermined time schedule. Focus on collecting samples at a relatively high frequency, and measure only pollutants that the project is trying to reduce through land treatment.

Assessing the Effectiveness of Your Project

Evaluate the data collected, keeping with project goals clearly in mind. A consistently improving trend in water quality may provide evidence needed to attribute water quality improvements to land treatment using a BMP system..

Where appropriate, interview or survey project participants as well as people who were eligible to participate but chose not to become involved in the project. This information can provide helpful feedback on the effectiveness of information and education programs, and may be of value to future projects.

It is frequently useful to assess public perceptions of water quality before and after a project. One way to evaluate the effectiveness of a project is to determine if people perceive that water quality has improved. Surveys or focus groups conducted before and after a project can document changes in public perceptions of water quality.

Report successes and failures to provide feedback to project participants and participating agencies on the results of their efforts. Making results available to the community enhances public education and provides information that can contribute to the more-effective management of water-quality problems in the future.

Checklist for a Successful Project

- Choose a viable project. Identify a water resource that needs restoration or protection. Choose a water resource that is valued by members of the community.
- Identify and document the water-quality problem and its source.
- Define objectives and goals and use them to guide the project.
- Involve potential participants and community members early in the planning.
- Secure funding for all aspects of the project, including incentives for participation.
- Clarify agency roles and responsibilities and administer the project effectively. Designate a project manager. Organize a local coordinating committee.
- Define the critical area contributing the greatest amount of the primary pollutants.
- Choose a land-treatment approach that will address the water-quality problem. Encourage participants to implement systems of two or more BMPs designed to reduce a particular pollutant.

- Design a water quality and land treatment monitoring and evaluation plan program when possible, to document the effects of BMPs installed.
- Evaluate Project Effectiveness. Report project results to the public and to project participants.

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Jacobson, E. M., L. E. Danielson, L. S. Smutko, V. Cox, and G. D. Jennings. 1993. *Environmental Assessments*. North Carolina Cooperative Extension Service, North Carolina State University, Raleigh, NC. AREP93-1. 8p.

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Information Resources for Environmental Data

The following list provides starting points for officials and citizens searching for information about the quality of a local water resource and about factors that may affect the water quality.

Water-Quality Data

North Carolina Division of Environmental Management
Ground Water Section: 919-733-3221
Water Quality Section: 919-733-5083
EPA STORET User Assistance Group: 800-424-9067
U. S. Geological Survey: 919-571-4000

Soils, Climate, Hydrogeology

North Carolina Division of Environmental Management
Ground Water Section: 919-733-3221
U. S. Geological Survey: 919-571-4000
Soil and Water Conservation District (local offices)

Land Use

County Planning Departments
Soil and Water Conservation Districts (local offices)

Public Water Supplies

North Carolina Division of Environmental Health, Public Supply Section: 919-733-2321
County Health Department

Private Wells

County Health Department

Hazardous Waste Facilities

North Carolina Division of Waste Management, Hazardous Waste Section: 919-733-2178

Pollution Incident Management Data Base

North Carolina Division of Environmental Management, Ground Water Section: 919-733-8488

Solid Waste Facilities

North Carolina Division of Waste Management, Solid Waste Section: 919-733-4996

Septic Systems

North Carolina Division of Waste Management, Solid Waste Section: 919-733-0692

Underground Storage Tanks

North Carolina Division of Environmental Management, Ground Water Section: 919-733-3221

Mining Operations

North Carolina Division of Land Resources, Land Quality Section: 919-733-4574

Pesticides

North Carolina Department of Agriculture: 919-733-3556

Animal Waste Storage and Application

North Carolina Division of Soil and Water Conservation: 919-733-2302
Soil and Water Conservation Districts (local offices)
U. S. Department of Agriculture, Natural Resource Conservation Service: 919-790-2888 (or county offices)
U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service: 919-790-2957 (or county offices)
North Carolina Cooperative Extension Service (county centers)

National Pollutant Elimination System (NPDES) Permits

North Carolina Division of Environmental Management, Water Quality Section, Permits and Engineering Department: 919-733-7015

Non-Discharge Permits

North Carolina Division of Environmental Management, Water Quality Section: 919-733-5083

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