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What's In My Water?

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That water you're drinking — or sprinkling onto your flowers, or using to irrigate your crops, or providing to your livestock — what's in it? Is it safe? Does it taste good? Is it beneficial for people, plants and animals? If not, what can be done to improve it?

One way to learn about the contents of your water is to send a sample to a laboratory to be analyzed. The lab will test the water and send you a report about its contents. Water analysis is conducted by governmental agencies and by private companies.

But sometimes it is difficult to understand the reports that labs send to consumers. What do the results mean? What characteristics of your water can cause problems? And what can be done to make it safer, tastier or more usable?

To help you understand the lab analysis of your water, on the following pages are tables of common components and properties measured in water. The tables include the sources of water contaminants, problems that can be caused by those contaminants, suggestions for how to correct them and the safe levels of each in water for household use, for irrigation and for livestock. After the tables are explanations of commonly used terms and water treatment methods.

The U.S. Environmental Protection Agency (EPA) has set safety standards for drinking water. The **EPA Primary Drinking Water Standard** is a legally enforceable standard that applies to public water systems. Such systems must meet this EPA standard.

The **EPA Secondary Drinking Water Standard** is a nonenforceable guideline regulating contaminates that may affect the appearance or taste of your drinking water. Public water systems do not have to meet this standard.

Most U.S. public water sources are safe. But problems have been found in some areas, and in many cases they can be alleviated. If you have questions about your water, contact your local health department.

What's inside:

- Common water contaminants
- The problems they cause
- Treatment methods
- Water terms
- Hardness ratings
- Salinity limits
- Where to get more information

Common Components and Properties of Water

Element/ Property	Source	Issues	Treatment/Practices	Maximum Concentrations
Alkalinity (expressed as $CaCO_3$)	Caused by bicarbonates and carbonates, but it is calculated using the concentration of calcium and magnesium.	Water with low alkalinity is more likely to be corrosive and cause plumbing to deteriorate.	Acidifying the water will reduce actual alkalinity. The only way to reduce the calculated alkalinity is to reduce the calcium and magnesium levels through water softening or distillation.	***Household water:*** No EPA[1] drinking water standard has been set; see TDS[2] section on page 10. ***Irrigation:*** Current limit not established, see TDS section on page 10. ***Livestock:*** Levels above 500 ppm may pose problems for dairy cattle.
Aluminum (Al)	May be found in surface water from industrial waste or from the wash water of drinking water treatment plants.	Aluminum may cause discoloration of water or buildup of scales or sediments.	Reverse osmosis, distillation or electrodialysis.	***Household water:*** 0.05-0.2 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** 5 ppm for long-term use; 20 ppm for short-term use. ***Livestock:*** Recommended upper limit of 5 ppm.
Ammonia (NH_3)	By-product of drinking water disinfection; produced by bacteria in the soil, animal wastes and decaying plants and animals.	Inadequate or no evidence that it causes cancer in people or animals.	Aeration.	***Household water:*** 30 ppm, EPA Lifetime Health Advisory. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established.
Antimony (Sb)	A metal found in natural deposits as ores containing other elements. Found in drinking water as an industrial pollutant from petroleum refineries or from fire retardants, ceramics, electronics or solder.	Potential health effects include increased risk of cancer, increase in cholesterol or decrease in blood sugar.	Coagulation/filtration, submicron filtration, reverse osmosis, ultrafiltration or distillation.	***Household water:*** 0.006 ppm, EPA Primary Drinking Standard. ***Irrigation:*** Current limit not established. ***Livestock:*** Recommend upper limit of 5 ppm.
Arsenic (As)	May be found naturally in groundwater and in surface water as an industrial pollutant or as a product of agricultural runoff from previously used pesticides.	Arsenic is highly toxic. Over time, it builds up in the body. The symptoms range from fatigue to coma and death. Potential health effects include skin damage, problems with the circulatory system and possible increased risk of cancer.	The best way to reduce arsenic levels is by reverse osmosis.	***Household water:*** 0.05 ppm, EPA Primary Drinking Water Standard. May change to 0.01 ppm. ***Irrigation:*** 0.10 ppm for long-term use; 2.0 ppm for short-term use. ***Livestock:*** Reported problems with dairy cows at levels of more than 0.2 ppm; CAST[3] has established level of 0.5 ppm.
Barium (Ba)	May be found naturally in groundwater or in surface water as an industrial pollutant often related to oil and gas.	Barium may have a toxic effect on the heart, blood vessels, nerves and kidneys.	Reverse osmosis is considered the best overall treatment method.	***Household water:*** 2.0 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** Drinking water standard, 2.0 ppm. ***Livestock:*** Some health issues with dairy cattle have been reported at levels of more than 10 ppm; CAST has not established limits.
Beryllium (Be)	A metal found in natural deposits as ores containing other elements and in some precious stones such as emeralds and aquamarine. Found in drink-drinking water as a pollutant from discharges from metal refineries and coal-burning factories, nuclear reactors, petroleum refineries, and electrical, aerospace and defense industries.	Potential health effects from ingestion of water are intestinal lesions, increased risk of cancer and damage to bones and lungs.	Coagulation/filtration, submicron filtration, activated charcoal, activated alumina, cation exchange, reverse osmosis, distillation or electrodialysis.	***Household water:*** 0.004 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** 0.10 ppm for long-term use; 0.5 ppm for short-term use. ***Livestock:*** Current limit not established. Guideline: 0.10 ppm.

[1]EPA — Environmental Protection Agency
[2]TDS — Total Dissolved Salts
[3]CAST — Council for Agricultural Science and Technology
[4]NAS — National Academy of Science

(continued)

Common Components and Properties of Water

Element/ Property	*Source*	*Issues*	*Treatment/Practices*	*Maximum Concentrations*
Bicarbonate and Carbonate (HCO_{3-} and CO_32-)	Dissolved limestone, dolomite, and atmospheric carbon dioxide.	Lime deposits may form in plumbing and irrigation systems with high bicarbonate and carbonate levels in the water when calcium and magnesium are also present.	Lower the pH through acid injection.	***Household water:*** No standard has been set; see TDS section on page 10. ***Irrigation:*** Calcium carbonate may form on equipment or plants. Levels of 180-600 ppm can be severely hazardous. See Alkalinity section. ***Livestock:*** Current limit not established; see TDS section below.
Boron (B)	May be found naturally in groundwater, in surface water as an industrial pollutant or as a product of agricultural runoff and decaying plant materials. Generally, toxic boron concentrations in the soil are found only in arid regions of Texas.	Boron can be toxic to some plants when the levels are too high. Sensitive crops may be affected at 0.33 ppm; semitolerant crops may be affected at 0.33-0.67 ppm; tolerant crops may be affected at 0.67 ppm or above. **Note:** If there is more than 1 ppm of boron in your water, boron levels may increase in your soil. Clay soils accumulate boron faster than do sandy soils.	Reverse osmosis and distillation.	***Household water:*** No EPA drinking water standard set, see TDS section on page 10. ***Irrigation:*** Toxicity to many sensitive plants may occur at 1 ppm. Most perennial grasses are relatively tolerant at 210 ppm. Because crops vary in tolerance to boron, water that is marginal for sensitive plants may still be used for more tolerant crops. ***Livestock:*** CAST levels established at 5.0 ppm.
Bromate (BrO_3)	By-product of drinking water disinfection	Increased risk of cancer.	Reverse osmosis.	***Household water:*** 0.01 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established.
Cadmium (Cd)	Primarily found in surface water as a pollutant from industries such as electroplating.	Potential damage includes anemia, retarded growth and increased hypertension.	Reverse osmosis.	***Household water:*** 0.05 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** 0.01 ppm for long-term use; 0.5 for short-term use. ***Livestock:*** 0.05 ppm — limit recommended by NAS; CAST established limits at 0.5 ppm.
Calcium (Ca)	Dissolved rock, limestone gypsum, salts and soil.	A component of water hardness, calcium can combine with bicarbonate and carbonates and cause "lime deposits," scale, extremely hard water and salinity (see Hardness).	Add water softeners or use similar ion exchange methods.	***Household water:*** No EPA drinking water standard has been set; see the TDS section on page 10. ***Irrigation:*** Current limit not established, see the TDS section on page 10. ***Livestock:*** Current limit not established; see TDS section; potential problems with dairy cattle >500 ppm.
Chloride (Cl)	In nature, chloride comes from dissolving minerals. May be found in large amounts in oilfield brine, sea water and industrial brine. In surface water, may be from road salt, fertilizers, industrial wastes or sewage.	When combined with sodium, chloride makes drinking water taste salty and may make the water more corrosive. May also blacken or pit stainless steel.	Reverse osmosis.	***Household water:*** More than 250 ppm may cause the water to taste salty (EPA Secondary Drinking Water Standard). ***Irrigation:*** More than 900 ppm is considered unsuitable for all agronomic crops. ***Livestock:*** Current limit not established, see TDS section on page 10. Recommended maximum concentration 15,000 ppm.

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Chlorine (Cl_2)	Water additive used to control microbes.	Eye/nose irritation; stomach discomfort.	Charcoal filtration.	***Household water:*** 4.0 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** <70 ppm safe for all plants; 70-140 ppm sensitive plants show injury; 140-350 ppm, moderately tolerant plants show injury; >350 ppm can cause severe injury. ***Livestock:*** Current limit not established.
Chromium (Cr)	May be found naturally in groundwater and in surface water as an Industrial pollutant commonly from the plating industry.	Chromium can be toxic to humans. Can produce irritations if it touches the skin. May damage liver and kidneys if ingested.	Reverse osmosis.	***Household water:*** 0.10 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** 0.1 ppm for long-term use; 1.0 for short-term use. ***Livestock:*** 1.00 ppm established by CAST.
Cobalt (Co)	Cobalt occurs in nature in many chemical forms. Cobalt enters the environment from natural sources, burning coal and oil, and the exhaust of cars and trucks.	Cobalt has both beneficial and harmful effects on human health. It has been used as a treatment for anemia. Exposures to high levels in the air may cause asthma, pneumonia or wheezing. It is listed as a possible cancer-causing agent in humans.	Reverse osmosis.	***Household water:*** There are currently no EPA Primary or Secondary Drinking Water Standards. ***Irrigation:*** 0.05 ppm for long-term use; 5.0 ppm for short-term use. ***Livestock:*** NAS and CAST levels established at 1.0 ppm.
Color	Dissolved organic matter; inorganic contaminants such as aluminum, iron and manganese.	Color has no impact on health, but may affect the aesthetic qualities of the water.	Activated charcoal, distillation, reverse osmosis or dialysis.	***Household water:*** 15 color units, EPA Secondary Drinking Water Standards. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established.
Conductivity	An indicator of salinity, which often originates from the earth's crust. Fertilizers and organic matter may also contribute salts. The salts in water are not just table salt, but are often a combination of sodium, calcium, potassium and magnesium, with chloride, nitrate, sulfate, bicarbonate, and carbonate.	High conductivity is an indication of (TDS) total dissolved salts. Use this value only as an initial screening parameter. When conductivity levels are high, evaluate other individual characteristics of the water.	Steam distillation, ion exchange (H+ and OH saturated resin only) and reverse osmosis are common treatment methods for reducing TDS and conductivity levels.	***Household water:*** Current limit not established, see TDS section on page 10. ***Irrigation:*** Concern over soil salinity is greatest when irrigating with water high in salts, where soils are poorly drained and allow for too much water to evaporate from the surface, or where soils are naturally high in salts because very little salt leaches out of the soil and the water table is shallow. Some plants can tolerate high soil salinity better than others. Permissable limits for classes of irrigation water are listed in Table 3. ***Livestock:*** Current limit not established, see TDS section on page 10.
Copper (Cu)	Sometimes caused by contamination from mining operations, acid waters and corrosion in copper plumbing.	Copper poisoning symptoms include jaundice and anemia. High levels may cause staining, bad tastes and corrosion.	Increase pH by using soda ash (sodium carbonate). Prevent corrosion created by high dissolved oxygen or total salts by using a polyphosphate feeder system.	***Household water:*** 1.3 ppm, EPA Primary Drinking Water Standard; 1.0 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** 0.2 ppm (See Other Terms section). ***Livestock:*** 0.5 ppm level established by CAST.
Corrosivity	Results from a low or high pH water and/or high salt content.	Corrosivity has no impact on health, but may affect the use of the water because of its effects on equipment, pipes, etc.	To lower pH: add acid. To raise pH: add soda ash. To lower salts: steam distillation, ion exchange or reverse osmosis.	***Household water:*** noncorrosive, EPA Secondary Drinking Water Standard. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established.

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Cyanide (as free cyanide)	Found in drinking water as a result of discharges from sheet metal, plastic or fertilizer factories.	Potential health effects from ingestion of water are nerve damage or thyroid problems.	Ion exchange, reverse osmosis or addition of chlorine.	***Household water:*** 0.2 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** Current limit not established. ***Livestock:*** 103 ppm fatal to cows and ducks.
Fluoride (F)	May be found naturally by dissolving small amounts of rock and soil in the water. Some water utilities also add fluoride to drinking water.	Fluoride concentrations of 1 ppm in drinking water protect against dental cavities. However, excessive levels may cause brownish discoloration of the teeth. Elevated levels may cause skeletal damage, bone disease. The maximum recommended levels fluoride concentration depends on the amount of water consumed and temperature average per year: **°F** — **ppm** 63.9 - 70.6 — 1.8 70.7 - 79.2 — 1.6 79.3 - 90.5 — 1.4	Reverse osmosis.	***Household water:*** 4.0 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** 1.0 for long-term use; 15.0 for short-term use. ***Livestock:*** NAS recommended limit: 2.0 ppm; CAST limit: 3.0 ppm.
Hardness (expressed as $CaCO_3$)	Total hardness is caused by the presence of calcium and magnesium in the water.	Hard water consumes soap before lather can form and interferes with almost every cleaning and cooking task. It deposits film on surfaces, causing spots and dingy clothes. It creates scale in boilers, water heaters and pipes. It forms white flakes in ice that are visible after the ice melts. See Table 2 to evaluate the relative hardness of your water.	Add water softeners or use distillation methods.	***Household water:*** No EPA standard has been set for drinking water; see sections on Alkalinity and TDS. ***Irrigation:*** See alkalinity, calcium and magnesium sections. ***Livestock:*** Current limit not established, see TDS section on page 10.
Iron (Fe)	May be dissolved from rock and soil. May also come from iron pipes, pumps and other equipment if low pH water is present.	On exposure to air, iron in groundwater oxidizes to reddish brown (or rust) water that may stain laundry and utensils. Large quantites can cause unpleasant taste and encourage the growth of iron bacteria. Laundry practices: Avoid using chlorine bleach. Iron reacts with bleach in water to cause permanent stains. To remove rust discoloration from white and colorfast washable fabric, use a commercial rust remover. Follow product directions. Do not use the rust remover in the washing machine.	1) Continuous chlorination followed by sediment filter and carbon filter. 2) Aerate water in a storage tank or use a potassium permanganate ($KMnO_4$) feeder, then sediment filter. 3) Use a sediment filter and water softener. 4) Adjust the pH to 7.0 or more, then treat with manganese oxidizing green sand filter. 5) Trickle the water over a crushed limestone bed.	***Household water:*** 0.3 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** 5 ppm. High iron (greater than 5 ppm) may significantly reduce photosynthesis as films form on leaf surfaces. ***Livestock:*** Levels above 0.3 ppm may reduce consumption quantities because of taste issues

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Lead (Pb)	Normally found in surface water from industrial pollution, but some Texas groundwater naturally contains elevated levels.	Symptoms range from gastrointestinal disturbances to inflammation of the brain and spinal cord. Brain damage is common in children exposed to high levels of lead. Short-term effects include interference with red blood cell chemistry, delays in normal mental and physical development in babies and young children; slight deficits in attention span, hearing and learning abilities of children; and slight increases in blood pressure of some adults. Long-term effects include stroke, kidney disease and cancer.	Reverse osmosis is considered the best overall method to reduce lead concentrations. Some point source precipitation filters are currently on the market.	***Household water:*** 0.015 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** 5.0 ppm for long-term use; 10.0 for short-term use. Elevated levels may corrode plumbing ***Livestock:*** 0.10 ppm established by NAS and CAST.
Magnesium (Mg)	Dissolved from rock, dolomite, salts and soil.	Magnesium is a component of water hardness and can combine with bicarbonate and carbonates resulting in "lime deposits," scale, extremely hard water and salinity (see Hardness).	Add water softeners or similar ion exchange methods.	***Household water:*** No EPA drinking water standard set, see TDS section on page 10. ***Irrigation:*** Current limit not established, see TDS section on page 10. ***Livestock:*** Current limit not established, see TDS section on page 10. Potential problems occur with dairy cattle if the concentration is higher than 125 ppm.
Manganese (Mn)	Dissolved from shale, sandstone or river basin material, May be found in surface water in swampy areas.	Excessive manganese gives water a grayish/black appearance and may stain plumbing fixtures and laundry. Manganese can also make water taste bad.	1) Use oxidizing treatments to convert reduced manganese to oxidized manganese, then use precipitate filtration (air spray system and $KMnO_4$ feeders). 2) For low levels, use ion exchange water softeners.	***Household water:*** 0.05 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** 0.2 ppm. High concentrations can reduce photosynthesis by coating leaf surfaces, thus limiting sunlight adsorption by chlorophyll. ***Livestock:*** Levels above 0.05 ppm may cause taste issues, reducing livestock consumption; 0.1 ppm has been established by CAST.
Mercury (Hg)	Found in drinking water from the erosion of natural deposits, discharge from refineries or runoff from landfills and croplands.	Potential health effects from ingestion of water are kidney and nervous system disorders.	Hg^{+2} : Submicron filtration/activated charcoal, cation exchange, reverse osmosis, distillation or electrodialysis. $HgCl_3^-$: Anion exchange, reverse osmosis, distillation or electrodialysis. Organic mercury compounds: Activated charcoal.	***Household water:*** 0.002 ppm, EPA Primary Drinking Water Standard for Hg^{+2}. No EPA Primary or Secondary Drinking Water Standards have been set for other forms of mercury ($HgCl_3^-$ or organic mercury complexes). ***Irrigation:*** Current limit not established. ***Livestock:*** NAS and CAST levels established at 0.01 ppm.

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Molybdenum (Mo)	Occurs naturally as the mineral molybdenite. Molybdenum enters the environment from natural sources or as an industrial pollutant from the manufacture of steel, alloys, electrodes and pigments.	Inhalation or contact with dust or fumes can irritate the eyes, nose, throat and respiratory tract. Molybdenum and its compounds are considered to be of low toxicity.	Cation exchange resins or coagulation.	***Household water:*** 0.08 ppm — 1-day and 10-day EPA Health Advisories; 0.04 ppm lifetime EPA Health Advisory. The British Columbia Ministry of Water, Land and Air Protection has listed a maximum level of .025 ppm. The World Health Organization lists a guideline value of 0.07 ppm. ***Irrigation:*** 0.01 ppm for long-term use; 0.05 ppm for short-term use. It can be toxic to plants and normal concentrations found in soil and water. ***Livestock:*** The British Columbia Ministry of Water, Land and Air Protection has listed a maximul level of 0.08 ppm (consuming forages not irrigated or if no fertilizers containing molybdenum are applied) or 0.05 ppm (all other cases).
Nickel (Ni)	May be found naturally in groundwater or in surface water as a mining or an industrial pollutant.	Chronic exposure may decrease body weight, damage the heart and liver, and cause dermatitis problems.	Reverse osmosis.	***Household water:*** 0.1 ppm former EPA Primary Drinking Water Standard. No current standard. ***Irrigation:*** 0.2 ppm for long-term use; 2.0 for short-term use. ***Livestock:*** NAS established recommended limit of 1.0 ppm.
Nitrate (NO_3-N)	Decaying organic matter, sewage, fertilizers, manures and nitrates in the soil result in soluble nitrates.	Water with high nitrate content may cause methemoglobinemia (bluebaby syndrome) and should not be used by pregnant women or to feed babies. High concentrations in rivers, streams and lakes encourage the growth of algae and other organisms that may produce undesirable tastes and odors in water.	Reverse osmosis is considered the best overall method for nitrate reduction.	***Household water:*** Less than 10 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** Levels of more than 40 ppm may be very limiting for some plants; only 10-20 ppm may be limiting for others. ***Livestock:*** Less than 100 ppm (NAS), 300 ppm (CAST).
Nitrite (NO_2-N)	Runoff from fertilizer use; leaching from septic tank sewage; erosion from natural deposits.	Shortness of breath and blue-baby syndrome in infants under 6 months old.	Reverse osmosis.	***Household water:*** 1.0 ppm, EPA Primary Drinking Water Standard. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established. <10 ppm recommended.

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pH	pH is lowered by acids, acid generating salts, and free carbon dioxide. pH is raised by carbonates,bicarbonates, hydroxides, phosphates, silicates and borates.	Equipment can be corroded if the water has exceedingly low (< 5.5) or high (> 8.5) pH. High pH values (> 8.5) indicate alkalinity and may pose a hazard of excess sodium). Water with high acidity may dissolve iron from pumping facilities and mains and produce a "red water" problem. Fabrics may be stained from the action of acid water on plumbing and appliances. Detergents do not perform as well in acidic water as in neutral or alkaline water. **Rating** — **pH Range** High Acidity — < 6.5 Moderate Acidity — 6.5 - 7.0 Moderate Alkalinity — 7.0 - 8 .5 High Alkalinity — > 8.5	To lower pH, use acid feeders. To raise pH, use soda ash feeders. To remove rust-colored stains from white or colorfast fabrics, use a commercial rust remover. Follow the product directions, but avoid using it in the washing machine.	***Household water:*** 6.5-8.5 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** pH can greatly affect the solubility/availability of many trace elements in the soil. ***Livestock:*** 5.5-8.5 Levels outside this range may cause problems for dairy cattle.
Phosphorus (P)	May be found naturally in ground water and in surface water from landscape runoff or discharges from sewage treatment facilities.	Elevated phosphorus in surface water can lead to algal blooms and lower dissolved oxygen content, thereby reducing desired aquatic life and creating water taste issues.	Reverse osmosis.	***Household water:*** No EPA drinking water standard has been set; see TDS section on page 10. Levels above 0.1 ppm in still water may encourage growth of algae. I***rrigation:*** Current limit not established, see TDS section on page 10. ***Livestock:*** Current limit not established, see TDS section on page 10.
Potassium (K)	Dissolved from rock, fertilizer, salt and soil.	High levels in irrigation water may significantly increase potassium concentrations in forage grasses and may create concerns for lactating livestock.	Consider distillation, reverse osmosis or ion exchange methods.	***Household water:*** No EPA drinking water standard set, see TDS section on page 10. I***rrigation:*** Current limit not established, see TDS section on page 10. ***Livestock:*** Current limit not established, see TDS section on page 10.
Selenium	Found in drinking water from the erosion of natural deposits, combustion of petroleum and coal fuels or during the smelting and refining of other metals.	Selenium is an essential nutrient at low levels, but may cause hair or fingernail damage to the peripheral nervous system, fatigue or irritability upon ingestion.	Se^{+4}: Coagulation/filtration, activated charcoal, anion exchange, activated alumina, reverse osmosis, distillation or electrodialysis. Se^{+6}: Anion exchange, activated alumina, reverse osmosis, distillation or electrodialysis.	***Household water:*** 0.05 ppm, EPA Primary Drinking Standard for total selenium. No EPA Primary or Secondary Drinking Water Standards have been set for the individual forms of selenium (Se^{+4} or Se^{+6}). ***Irrigation:*** 0.02 ppm for long-term use; 0.05 ppm for short-term use. ***Livestock:*** EPA recommends upper limit of 0.05 ppm.

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Silver (Ag)	Trace amounts found naturally in drinking water. Water contamination can be caused by industrial waste, including waste from metal plating and photographic processing industries.	Noticeable effects of ingestion above 0.1 ppm include skin discoloration and graying of the whites of the eyes.	Distillation, reverse osmosis or electrodialysis.	***Household water:*** 0.10 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** Current limit not established ***Livestock:*** Current limit not established.
Sodium (Na)	Dissolved from rock, salts, and soil. Also found in oilfield brine, sea water, industrial brine and reclaimed effluent water, etc.	Moderate amounts of sodium have little effect on the usefulness of water; however, people on low-sodium diets should consult their physicians for levels above 20 ppm. (See section on Sodium Adsorption Ratio below for information on sodium's role in water and soil quality). High levels may contribute to corrosion of copper plumbing and metal fixtures. High levels in irrigation water may cause it to build up in soils, resulting in poor soil structure.	Reverse osmosis treatment is considered the only economical way to remove sodium for household uses. Because of its cost, reverse osmosis is more often used just for drinking water rather than for the whole household.	***Household water:*** 20 ppm, EPA Secondary WaterStandard. People on restricted sodium diets may be limited to 20 ppm. ***Irrigation:*** Water with more than 400 ppm may burn the foliage significantly. ***Livestock:*** Current limit not established, see TDS section on page 10.
Sodium Adsorption Ratio (SAR)	A measure of the sodium concentration in relation to the calcium and magnesium charge concentrations in meq/L or eq/L.	Less than 10 SAR: No sodium hazard. May be used on all sensitive crops. 10-18: Medium sodium hazard. Gypsum and leaching needed. 18-26: High sodium hazard. Generally unsuitable for continued use. More than 26: Very high sodium hazard. Generally unsuitable for use.	See Extension publication E60, Managing Soil Salinity.	***Household water:*** No EPA drinking water standard, refer to salinity section. ***Irrigation:*** Current limit not established, see TDS section on page 10. ***Livestock:*** Current limit not established, see TDS section on page 10.
Strontium	Found in natural deposits as ores. May be found in surface water as an industrial pollutant from the manufacture of color television picture tubes, magnets or fireworks, or from the refining of zinc.	Inadequate or no evidence that it causes cancer in people or animals.	Cation exchange, reverse osmosis.	***Household water:*** 25.0 ppm 1-day and 10-day HAs; 4.0 ppm lifetime HA. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established.

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Sulfate (SO_4)	Dissolved from rock and soil containing gypsum, iron sulfides, and other sulfur compounds. May be found in surface water as an industrial pollutant from coal mining, industrial wastes and sewage, and streams draining from coal or metalsulfide mines.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfates can result in bitter, medicinal tastes, laxative effects or "rotten egg" odor from hydrogen sulfide gas formation (see Extension publication L-5312, *Hydrogen Sulfide in Drinking Water*).	Reverse osmosis.	***Household water:*** More than 250 ppm can cause diarrhea, EPA Secondary Drinking Water Standard. ***Irrigation:*** Moderate concentration of sulfate can reduce growth or cause specific injury. Refer to the section on salinity. ***Livestock:*** More than 2,000 ppm can cause diarrhea in most livestock.
Thallium (Tl)	In drinking water, found primarily from the leaching of ore-processing plants or discharges fromelectronics, glass or drug factories.	Potential health effects from ingestion include hair loss, changes in the blood and damage to the kidney, liver or intestine.	Cation exchange, activate alumina or distillation.	***Household water:*** 0.002 ppm EPA Primary Drinking Water Standard. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established.
Total Dissolved Salts (TDS)	Determined by adding together all measured ions (cations and anions).	In clear, non-turbid waters, total dissolved salts may be used interchangeably with total dissolved solids. See sections on conductivity and SAR.	Reverse osmosis.	***Household water:*** 500 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** See section on conductivity regarding classification of waters based on TDS. ***Livestock:*** Avoid levels above 3,000 ppm for lactating animals; levels above 7,000 ppm may pose significant risks for many animals. See Extension publication L-2374, Water Quality: Its Relationship to Livestock.
Vanadium (Va)	Enters the environment mainly from natural sources or from the burning of fossil fuels.	No data available on potential health effects from ingestion.	Reverse osmosis.	***Household water:*** No current EPA Primary or Secondary Drinking Water Standards. The California Department of Health Services has set an action level of 0.05 ppm. ***Irrigation:*** Current limit not established. ***Livestock:*** Current limit not established. Colorado State University Cooperative Extension recommends upper limit of 0.10 ppm.
Zinc (Zn)	Occurs naturally, but may also result from industrial pollution. Also, low water pH can cause zinc to be released in plumbing systems made of copper-zinc alloys.	Can produce a chalky appearance in water and produce a disagreeable taste.	Treatment practices depend on the source of zinc. For water naturally high in zinc, use ion exchange, reverse osmosis and distillation. For elevated zinc levels because of contact by low pH water with metal alloys, use soda ash feeder.	***Household water:*** 5.0 ppm, EPA Secondary Drinking Water Standard. ***Irrigation:*** 2.0 ppm. ***Livestock:*** 25 ppm established by CAST.

[1]EPA — Environmental Protection Agency
[2]TDS — Total Dissolved Salts
[3]CAST — Council for Agricultural Science and Technology
[4]NAS — National Academy of Science

Water Terms and Abbreviations

10^{-4} cancer risk: the concentration of a contaminant in drinking water indicating an estimated lifetime cancer risk of 1 in 10,000.

Acid feeder: a system that dispenses a preset concentration of acid (usually sulfuric acid) into the water stream to reduce pH and to eliminate calcium and magnesium carbonate deposits. Most acid feeders are used in irrigation systems, greenhouses or other non-household/drinking water systems. Acid feeders are often available only to professional installers or specialty supply stores.

Activated alumina: aluminum oxide that is highly porous and has a large surface area. It is used to adsorb impurities such as beryllium, selenium or thallium from water.

Aeration: a process in which air is bubbled or otherwise mixed into water to oxidize specific reduced contaminants such as iron and manganese. This process may be used in ponds or tanks, where much nonpotable (not for drinking) water is to be treated, or in semi-enclosed spray chambers. The efficiency of aeration depends on the amount of oxygen absorbed into the water and the amount of time allowed0 for the precipitation of contaminants.

Most aeration systems require sediment filters to remove the particulates generated during oxidation. Spray systems are often available only to professional installers or in specialty supply stores.

AL (action level): the trigger point at which remedial measures are to take place.

Anion: an ion or group of ions with a negative charge because they have gained one or more electrons.

Cation: an ion or group of ions with a positive charge because they have lost one or more electrons.

Charge balance: a calculation of the ratio of negative charges (anions) to positive charges (cations). Ideally, water will have a charge balance of 100, which indicates that it has an equal number of anions and cations. This number can differ significantly from 100 if sediment, organics or other substances are present.

Chlorination: a process by which reduced chlorine (includes chlorine gas and hypochlorite, the active ingredient in chlorine bleach) is injected into water to oxidize inorganic (iron, manganese, etc.) or organic (microorganisms) constituents. The equipment required for this process generally requires professional installation.

Coagulation/filtration: the act of collecting like dissolved, suspended and non-settleable particles from water into a mass through chemical treatment and the subsequent removal of the mass through filtration.

Contaminant: any physical, chemical, biological or radiological substance or matter in water.

Corrositivity: the reaction between water and metal surfaces. Corrosive water can increase the levels of copper, lead and zinc in the water; deteriorate household plumbing; and stain laundry, basins and drains. Also, the deterioration of metallic plumbing fixtures often makes the water taste bitter or metallic.

Deionization: a process to treat water using resins saturated with various anions and cations. As water passes across the resin, the ions "exchange." The ions in the water are replaced by those on the resin. There are two major groups of ion exchange systems: mixed-bed units and water softeners (explained below). Most mixed-bed exchange units reduce the salt content of the water.

Because of the high costs of resins or consumables required to regenerate the resins, deionization is typically reserved for a final polishing of previously treated water. Deionized water is normally used for laboratories or saltwater aquariums.

DHA (draft health advisory): a draft version of a health advisory.

Distillation (steam): a process in which water is heated to its vapor point and steam is then the collected. Salts and other nonwater substances with higher vapor points (208 to 215 °F) remain in the heating chamber or are flushed from the heating element in wastewater. Some organics with vapor points similar to or lower than water may be concentrated in the final product.

Because of the energy costs and low recovery of water, distillation is often limited to laboratory use. The equip-

Most U.S. public water sources are safe. But problems have been found in some areas. If you have questions about your water, contact your local health department.

Corrosive water can stain laundry and damage household pipes.

ment for large-scale production is generally not available to the general public. However, small-volume (1-gallon) tabletop models are available.

DWEL (drinking water equivalent level): the concentration of a contaminant in drinking water at which a lifetime of exposure to it will not cause adverse, carcinogenic health effects, assuming that all the exposure to the contaminant is from drinking water.

Electrodialysis: the passage of anions or cations through a permeable membrane under the influence of an electrical gradient.

HA (health advisory): the estimated concentration of a substance below which there will likely be no observable health effects.

- **One-day HA:** The concentration of a chemical in drinking water that is not expected to cause adverse noncarcinogenic effects for up to 1 day of exposure, based on a 10-kg (22- pound) child.
- **Ten-day HA:** The concentration of a chemical in drinking water that is not expected to cause adverse noncarcinogenic effects for up to 10 days of exposure, based on a 10-kg (22-pound) child.
- **Lifetime HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure.

LED_{10} (lower limit on effective dose$_{10}$): the dose of a chemical needed to produce an adverse effect in 10 percent of those exposed to the chemical, compared to a control group of people not exposed.

MCL (maximum contaminant level): the highest amount of a specific contaminant allowed in the water delivered to any customer of a public water supply. MCLs are based on the levels of contaminants that cause adverse health effects.

MCLG (maximum contaminant level goal): the concentration of a contaminant that experts believe a person can safely drink over his or her lifetime. Although the EPA does not enforce the MCLG, it is used to set the enforceable drinking water standards.

Micrograms per liter (µg/L): 0.001 mg/L or parts per billion (ppb) concentration of a substance in water.

Milligrams per liter (mg/L): parts per million (ppm) concentration of a substance in water.

Millirems per year (mrem/yr): an equivalent unit of radiation a body or organ receives (0.001 rem, where rem is roentgen equivalent man).

(N)PDWR [(National) Primary Drinking Water Regulations)]: legally enforceable standards that apply to public drinking water systems.

(N)SDWR [(National) Secondary Drinking Water Regulations)]: nonenforceable guidelines regulating contaminants that may cause cosmetic effects such as skin or tooth discoloration; aesthetic effects such as taste, odor or color in drinking water; or technical effects such as damage to equipment or reduced effectiveness for treatment of other contaminants. The EPA recommends but does not require that public water systems comply with secondary standards. Individual states may elect to adopt them as enforceable standards.

Oxidation: a process in which oxygen or another element or compound (poor in electrons) reacts with a reduced element or compound (rich in electrons) and acquires one or more electrons. Normally, this reaction converts the reduced material to a more treatable/management form. The best example of this process is the aeration of water to convert iron to a more easily treated form. The oxidizing agents used to treat water include chlorine, hypochlorite and potassium pemanganate. Homeowners should consult with a reputable water treatment professional on system design and installation because chemical oxidation systems are complex and spray systems can introduce biological contaminants into the water.

Picocuries per liter (pCi/L): a common unit used to measure radioactivity.

Polyphosphate feeders: a system that introduces a polyphosphate solution into a water system to protect the plumbing from corrosive or other metal-related problems. The polyphosphate coats the plumbing, forming a protective barrier against dissolved oxygen

and other corrosive materials. Because these systems are expensive and require considerable design expertise, they should be installed by water treatment professionals.

ppm: parts per million.

Public water system: any system that provides water to the public for human consumption.

Radionuclides: radioactive particles that occur naturally in areas where there are uranium and radium deposits.

Reverse osmosis (RO): a procedure in which water is forced through a semi-permeable membrane with openings that are about the size of water molecules. The membrane allows the water to pass through but rejects the contaminants in it.

Reverse osmosis can remove salts, bacteria, sugars and other particles whose molecules are bigger than those of water. Contaminants that are collected on the membrane are back flushed and washed out of the system as waste.

Because dissolved iron and manganese can significantly reduce the life of a membrane life, they should be removed through other treatment procedures before the water is entered into an RO system. Similarly, water with more than 20 ppm of calcium and magnesium should be softened to reduce the formation of lime scale on the membrane. Also, it is vital that particulates be removed to maintain and extend the life of the membrane.

Most RO units sold in retail stores operate on household water pressure and contain RO membranes that are sensitive to chlorine or other oxidizing agents. These oxidizers are commonly removed, along with dissolved organics, by activated charcoal.

Waters high in salt often require higher pressure "pump" systems. This type of unit is often available only to specialty distributors and/or professional installers.

Rfd (Reference dose): the estimate of the daily dose of a substance that a person can ingest over a lifetime and suffer no adverse health effects. This estimate, formerly called the acceptable daily intake (ADI), includes a conservative safety margin.

Salt: an organic or inorganic compound that is subject to dissociation when water is added, resulting in a distinct increase in specific anions and cations.

Sediment/precipitate filter: a filter that removes suspended solids by trapping particles between media pores. The filter may be made of numerous materials, including sand, pleated paper, porous disks, porous aggregates, spun paper and other fibers. The effectiveness of each filter depends on the average particle retention size and the estimated amount of water that can be filtered. In turn, these sizes and estimates depend greatly on the initial water quality, water pressure and length of time since the last filter change.

Many user-installable filter cartridges are available from home centers and hardware stores. Sand filters and other non-cartridge systems are normally available only through professional installers, as they can introduce disease-causing agents if introduced improperly.

SOC (synthetic organic compound): a man-made compound that contains carbon (and is hence called organic) and that is *nonvolatile.* Regulated SOCs include atrazine, chlordane, 2,4-D, lindane, and glyphosate.

Soda ash feeder: a system in which sodium carbonate is fed into water to raise water pH. Typically, these systems are placed near the water source and treat all the water used by the home. Soda ash feeders are often available only to professional installers or specialty supply stores.

Submicron filtration: the process of removing particles from a solution that are less than 1 millionth of a meter by passing the solution through a porous medium.

SWDA (Safe Drinking Water Act): the law authorizing the EPA to establish a cooperative program among local, state and federal agencies for drinking water. The federal government's primary role under this act was to develop national drinking water standards to protect public health and welfare.

TT (treatment technique): the mandatory minimum technique with

You can have your water analyzed by a government agency or a private company.

which public water systems must be treated.

Ultrafiltration: the process of removing particles from a solution under pressure by passing it through a porous medium that has larger pore sizes than submicron or RO filtration systems.

URTH (unreasonable risk to health): the level above which long-term exposure to a substance may present significant health risks.

VOC (volatile organic compound): a man-made compound that contains carbon (and is hence called organic) and that readily evaporates or votilizes. Regulated VOCs include benzene, vinyl chloride, toluene and xylene.

Water ratings:

- **Acceptable** — Under normal management, the water should not pose any long-term problem for the intended use.
- **Limiting** — A higher than normal level of management or treatment is needed to use the water for a given application.
- **Very limiting** — The water needs such significant management or treatment that it may not be economically or technically feasible for the intended use.

Water softener: a system that uses cation exchange resin to remove calcium, magnesium, iron and manganese from water. Such systems typically use a sodium chloride salt brine to saturate the resin with sodium. As the water is treated, calcium and magnesium are exchanged for sodium. The result is simply a trade of cations, not a reduction of salt.

The size of the water softener should accommodate the water hardness and daily water usage to minimize the number of resin regeneration cycles required per week. Some systems are designed to use potassium instead of sodium, thus providing softened water without raising sodium levels. Water softeners are commonly available in home centers as well as from professional installers.

Water hardness rating scale

Rating	Grains per Gallon	Total Hardness (ppm)
Very Soft Soft	0 - 1	0.0 - 17.17
Slightly Hard	1 - 3.5	17.18 - 60
Moderately Hard	3.5 - 7	61 - 120
Hard	7.1 - 10.5	121 - 180
Very Hard	> 10.5	> 180

Permissible limits of salinity for various classes of irrigation water

Classes of Water	EC, dSM-1 mmho cm-1*	TDS, ppm	Comments
Class 1, Excellent	0 - 0.250	175	No damage is expected; no additional management is needed.
Class 2, Good	0.250 - 0.750	175 - 525	Sensitive plants will be damaged; you may need to use low salinity water periodically.
Class 3, Permissible	0.750 - 2.0	525 -1,400	Plants with low salinity tolerance are likely to be damaged. To improve plant growth and quality, irrigate more water will than is needed for the plants, which helphelp leach the salts from the soil, and/or periodically use low-salinity water.
Class 4, Doubtful	2.0 - 3.0	1,400 - 2,100	Plants with high tolerance to salinity may be damaged. To use this water successfully for irrigation, you must have salt-tolerant plants, good soil drainage, excess irrigation for leaching, and/or periodic use of low salinity water.
Class 5, Unsuitable	> 3,0	> 2,100	Same as above.

*To convert to umhos cm^{-1} multiply by 1,000.

For more information

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http://soiltesting.tamu.edu

Texas A&M University Department of Soil and Crop Sciences
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