

# Land & Water

## Conserving Natural Resources in Illinois

University of Illinois Extension • College of Agricultural, Consumer and Environmental Sciences

### Water-Treatment Systems—Part 1

#### Treatment Time

Taste. Odor. Hardness. Contamination. These are four of the most common reasons why people install water-treatment systems in their homes.

Those who receive their water from municipal supplies usually turn to water-treatment systems because of taste or odor problems (often caused by chlorine) or water hardness. Those who receive their water from a private well may also have additional reasons for installing a water-treatment system, such as bacterial contamination.

The following guide gives you a general idea of available technology. Part 1 focuses on the three most common water-treatment systems, while Part 2 deals with less popular systems. Just remember, each system does not work with equal efficiency on all of the contaminants listed.

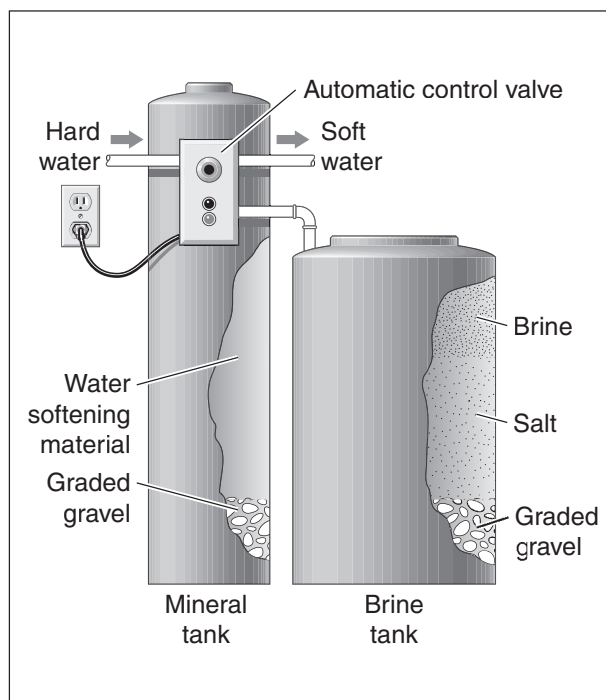
#### Cation Exchange (Water Softener)

**What it removes:** Dissolved iron and manganese (when they are present in low concentrations), barium, and radium.

**How it works:** As hard water passes through resin beads, magnesium and calcium ions attach to the beads. They are removed from water and replaced by sodium, which softens the water (Figure 2).

**Limitations:** People with hypertension or high blood pressure should consult their doc-

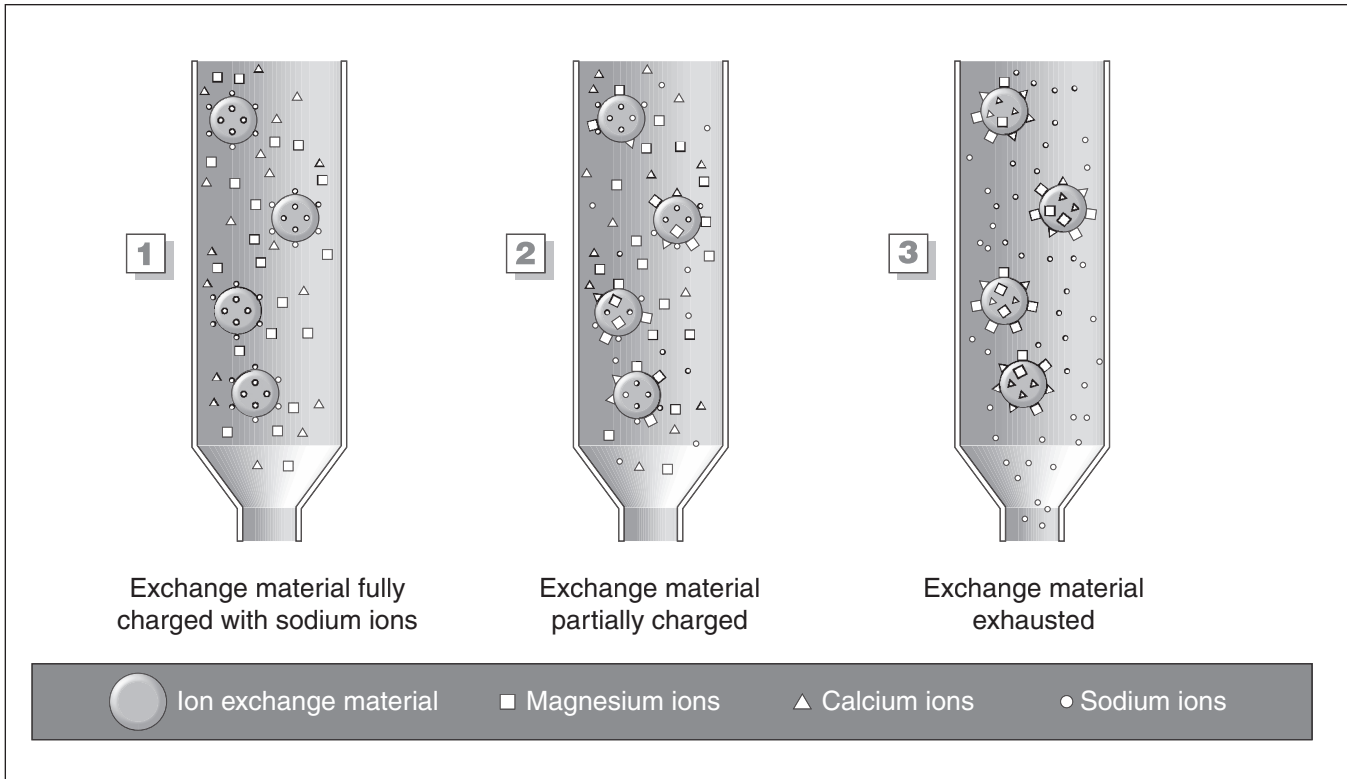
Figure 1. Ion Exchange Water Softener



Hard water enters the mineral tank, which is filled with water-softening material—synthetic resin beads. The ion exchange process, depicted in Figure 2, takes place inside the mineral tank. Salt water in the brine tank recharges the synthetic resin beads when they become exhausted of sodium ions.

tor about personal health risks associated with drinking softened water. Sodium is normally added to water during the softening process and can cause health problems for those prone to hypertension.

**Figure 2. The Water-Softening Process**



When hard water passes through the ion exchange column, magnesium and calcium ions exchange places with the sodium ions on the resin beads. As the magnesium and calcium ions are removed, the water is softened. The resin beads will continue to lose sodium ions until they eventually become exhausted. To recharge the beads with sodium ions, salt water from the accompanying tank—the brine tank—flows through the resin material. Sodium ions in the salt water exchange places with the calcium and magnesium ions on the resin. As a result, the resin is recharged with sodium ions. The brine water, now containing the magnesium and calcium ions, drains away.

### Activated Carbon Filter

**What it removes:** Many volatile organic chemicals, some pesticides, radon gas, hydrogen sulfide, and mercury. It also reduces odor, color, and taste problems (such as residual chlorine).

**How it works:** Water is filtered through carbon granules. Contaminants attach to the carbon and are trapped (Figure 3).

**Limitations:** If the filter is not replaced regularly, it will lose its ability to filter contaminants. As a result, contaminants may reenter water in amounts that are even more concentrated than before. Infrequently maintained filters can also serve as breeding grounds for bacteria.

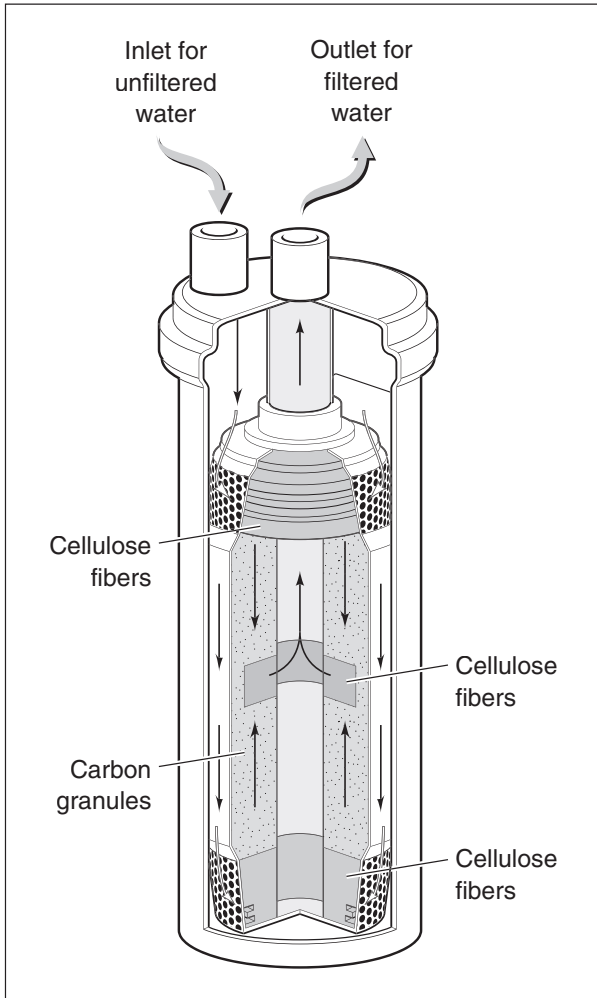
### Reverse Osmosis

**What it removes:** Inorganic minerals such as radium, sulfate, calcium, magnesium, potassium, nitrate, fluoride, boron, and phosphorus. It also helps to remove salts, certain detergents, volatile organic contaminants, some pesticides, and taste- and odor-producing chemicals.

**How it works:** Water is filtered through a membrane. Membrane passages are smaller than the contaminant molecules (Figure 4).

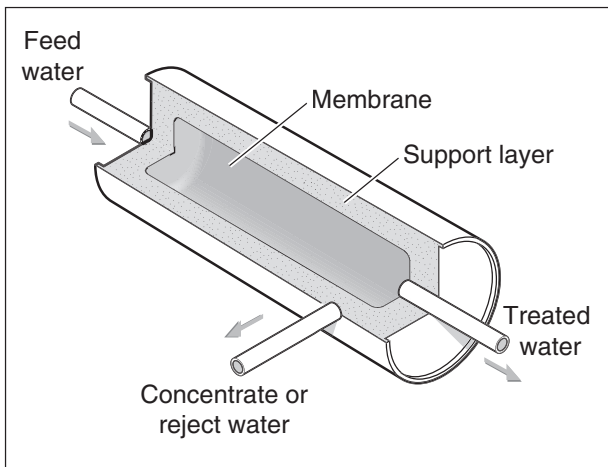
**Limitations:** Under-the-sink installations are costly and take up a lot of space. Filter replacement is also costly, and the system is slow and wasteful of water. Some microorganisms may be small enough to pass through the reverse osmosis membrane and colonize the holding tank.

**Figure 3. Activated Carbon Filter**



Water enters the top of an activated carbon filter. As water passes through carbon granules, certain contaminants attach to the surface of the material and are removed from the water. Water then moves up through cellulose filters to the outlet.

**Figure 4. Reverse Osmosis Membrane**



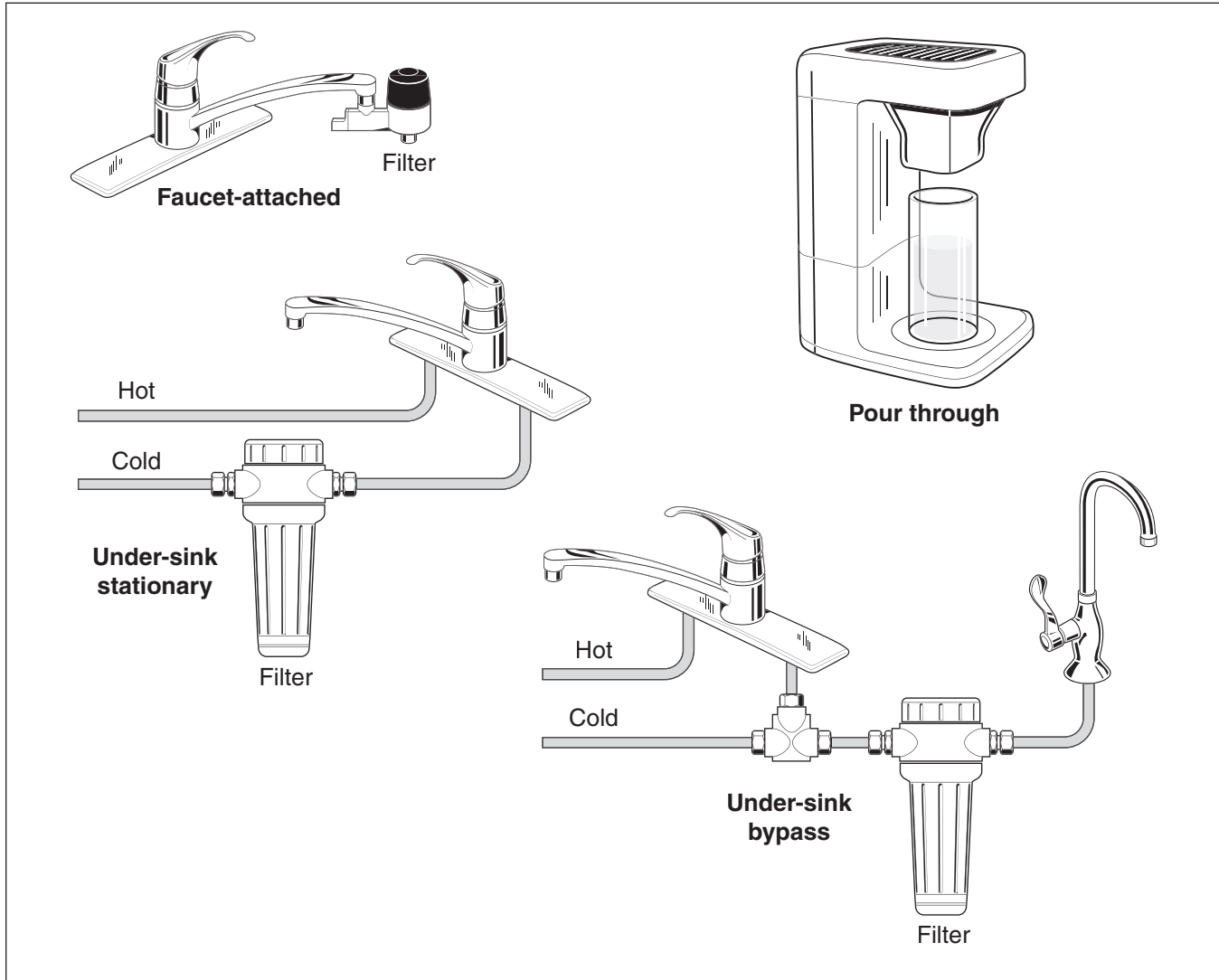
**Table 1. Treatment Methods**

Contaminants	Treatment methods		
	Activated carbon filters	Cation exchange/ water softener	Reverse osmosis <sup>4</sup>
Chlorine	✗		
Color	✗		
Hydrogen sulfide	✗		
Inorganics, minerals, and heavy metals (lead, mercury, arsenic, cadmium, barium)	✗ <sup>1</sup>	✗ <sup>2</sup>	✗
Iron/manganese – dissolved		✗ <sup>3</sup>	
Nitrate			✗
Odor and off-taste	✗		✗
Pesticides (some)	✗		✗
Radium		✗	✗
Radon gas	✗		
Salt			✗
Volatile organic chemicals	✗		✗
Water hardness		✗	

1. Mercury only.
2. Barium only.
3. When present in low concentrations.
4. While reverse osmosis works for many contaminants it may not be the treatment of choice due to cost and maintenance requirements.

The illustration to the left shows that only a portion of the water passes through the membrane of a reverse osmosis unit. With smaller devices, about 5 to 15 percent of the water is treated. With larger units, about 25 to 35 percent of the water is treated. The rest is reject water.

**Figure 5. Activated Carbon Filter Styles**



You can attach some activated carbon filters directly to the water faucet, while some sit on the countertop. You pour water through a countertop unit. Under-the-sink stationary filters and under-the-sink bypass filters are similar. However, stationary filters treat all of the water coming to the faucet; a bypass unit treats only the water flowing through an alternate faucet. Treated water in the alternate faucet is used for cooking and drinking, while untreated water in the main faucet can be used for cleaning. Carbon filters can also be used to treat water for appliances like ice makers and water coolers.



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**Land & Water**

November 2007 • Number 17

**Sources**

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