The corrosion of steel or galvanized metal will cause a rusty stain in fixtures, give the water a metallic taste, and may produce cloudy water on occasion. In addition to damaging the water system, corrosive water can also interfere with other water treatment. Iron and manganese cannot be easily removed from acidic water. In this case, the acidity must be neutralized prior to the iron removal treatment.

**TREATMENTS:**

1. **pH Adjustment:** This method uses a small metering pump and mixing tank. The metering pump adds small amounts of a mixture of soda ash and water to the well water whenever the well pump is running. The soda ash (sodium carbonate) raises the pH and the alkalinity of the well water, chemically neutralizing the acidity. The use of soda ash will not increase the hardness of the water. However, this method can be used with almost any pH level.

2. **Neutralizing Filters:** These are essentially a pressurized tank containing a filter bed of calcium carbonate or calcite. As the acidic water passes through the filter, the carbonic acid and carbon dioxide combine with the calcium carbonate neutralizing the acidity. Because the filter bed is composed of a calcium compound, neutralizing filters will increase the hardness of the water, as well as increase the pH and alkalinity. Neutralizing filters work best at a pH between 6 and 7.

   If the pH is between 5 and 6, a magnesium oxide must be added to the filter bed to adequately neutralize the acidity. They should not be used with a pH below 5. Neutralizing filters must be backwashed periodically to remove sediments trapped within the filter bed. Most manufacturers offer both a manually operated and an automatic backwash cycle.

3. **Polyphosphates (Micromet, Shan-No-Coor, etc.):** These compounds deposit a protective layer on exposed metal surfaces. They do not change the acidity of the water. Polyphosphates work best within a pH range of 6.8 to 7.4. It may take as long as eight weeks for the protective coating to form.

---

**Fluoride**

Fluorine is the 13th most common element in the earth’s crust. In the form of fluoride, it is found in varying amounts in all natural waters. High fluoride concentrations are not usually found in surface waters, such as lakes and streams. However, they can occur in groundwater supplies. In many communities, fluoride is added to water to help prevent dental cavities.

The U.S. Environmental Protection Agency has established a twofold limit for fluoride in drinking water: A limit of 2.0 milligrams per liter to avoid the dental fluorosis associated with long term exposure to excessive fluoride; and a maximum allowable level of 4.0 mg/l. While the EPA does regulate the amount of fluoride in drinking water, it also strongly supports water fluoridation at optimum levels to aid in preventing dental cavities.

**CAUSE:**

Fluoride is dissolved into water from fluoride bearing minerals that occur naturally in the earth. In the United States, these minerals occur only in a few regions of the country. In South Carolina, fluoride is more common toward the coastal region.
EFFECTS:
Fluoride is a normal part of the human diet. At an optimum concentration of 1.0 mg/l in drinking water, fluoride produces no ill effects. Children who have received optimally fluoridated water from birth have shown as much as a 65 percent reduction in the occurrence of cavities when compared to areas with little or no fluoride. The beneficial effect of fluoride diminishes greatly as the fluoride concentrations decrease below 0.7 mg/l.

Children exposed to excessive amounts of fluoride while their teeth are developing can develop dental fluorosis. Dental fluorosis appears as whitish or brown spots on the teeth. The occurrence of dental fluorosis increases as the fluoride concentration increases. At fluoride levels below 2.0 mg/l, dental fluorosis is rare. At 3.0 mg/l, brown stains can be found in a small percentage of the population. In the United States, dental fluorosis is the only adverse health effect observed from long term exposure to excessive fluoride in drinking water.

TREATMENT:
Excessive fluoride is a concern only in the small amount of water used for cooking and drinking. Other household uses of the water are not affected by excessive amounts of fluoride. Removal of fluoride from the entire household water supply is expensive and generally unnecessary. For the small amount of water used in cooking and drinking, point-of-use treatment devices are a more reasonable solution.

Point-of-use devices are small treatment units that produce up to 15 gallons of water per day for drinking and cooking. The device is usually located near the kitchen sink. All of the methods described below are available as point-of-use devices.

1. **Reverse Osmosis (RO):** RO units remove dissolved minerals by forcing the water, under pressure, through a synthetic membrane. The membrane contains microscopic pores that will allow only molecules of a certain size to pass through. Since the molecules of dissolved minerals are large in comparison to water molecules, the water will squeeze through the membrane leaving the minerals behind. A properly operated RO unit is capable of removing about 90 percent of the dissolved minerals from a water supply.

2. **Distillation:** Distillation units are better known as “stills.” They are made of either heat-resistant glass or stainless steel. Stills work by heating small amounts (less than 2 gallons) of water to produce steam. The steam is then collected and condensed back into water. The dissolved minerals will not vaporize and are left behind in the heating chamber.

   Stills require frequent, rigorous cleaning to remove the baked-on mineral salts. The “flat” taste from boiling the water can be reduced by pouring the water back and forth between two containers to aerate it.

3. **Deionization (DI):** Deionization units are available as small, wall-mounted cartridges containing ion exchange resins. When water passes through the cartridge, the dissolved minerals are retained in the resin, producing a mineral-free water. The DI cartridges usually show a color change in the resin to indicate when they should be replaced.

4. **Combination point-of-Use Devices:** These are multi-step systems which use a pre-
filter, RO membrane or DI cartridge, and a carbon polishing filter. They treat up to 15 gallons of water per day. The treated water is stored in a small pressure tank and piped to a special faucet on the kitchen sink.

Where treatment is not desirable or practical, bottled water may be used as an alternative source of drinking water. A chemical analysis of the water (including fluoride) will sometimes be listed on the label.

Hard water is one of the most common water quality problems in the United States. In the past, hardness was measured by the amount of soap that had to be added to water to produce a lather. It is now measured as the concentration of dissolved calcium and magnesium compounds (expressed as calcium carbonate).

There is no firm dividing line between hard and soft water. However, for most household uses, a hardness of between 50 and 150 milligrams per liter (mg/l) is acceptable. Hardness may sometimes be expressed as grains per gallon (gpg) instead of mg/l. 1 gpg is equal to 17.1 mg/l.

**CAUSE:**

The amount of naturally occurring calcium and magnesium compounds dissolved by the water as it filters through the earth will determine its hardness. Hardness varies with location and the types of minerals and rocks in the earth.

**EFFECTS:**

Despite all of the problems it causes, hard water is not considered to be a health hazard. Moderate amounts of hardness are desirable because of the protective coating it produces on exposed metal surfaces. Excessively hard water, however, will cause a hard, chalky scale (boiler scale) to form when the water is heated. Water heaters are especially affected by hardness. The boiler scale will accumulate on the heating elements, reducing their heating capacity, and eventually causing them to burn-out.

Hard water will form a white, powdery residue on plumbing fixtures, and will cause spots on dishes. Because calcium and magnesium compounds are not very soluble in cold water, ice made from hard water may contain white particles. Vegetables cooked in hard water may be tough. More soap must be added to a hard water to produce a lather. With very hard water, soap will form a sticky “curd,” which is difficult to remove from fabrics and containers. Laundry washed in hard water will be stiff and dingy. Hair becomes dull and limp when washed in hard water.

**TREATMENT:**

The minerals that cause water hardness can be removed by a water softener. Water softeners use an ion exchange process to replace the calcium and magnesium that cause hardness with an equivalent amount of sodium, which does not contribute to water hardness.

With use, all of the sodium in a softener will eventually be replaced by calcium and magnesium. When this occurs, the softener must be regenerated to maintain its softening ability. In regeneration, the softener is filled with a concentrated salt solution. The sodium in the salt solution replaces the calcium and magnesium in the softener, restoring it to its