Public Water Systems

Public Water Systems (PWSs) come in all shapes and sizes, and no two are exactly the same. They may be publicly or privately owned and maintained. While their design may vary, they all share the same goal – providing safe, reliable drinking water to the communities they serve. To do this, most water systems must treat their water. The types of treatment provided by a specific PWS vary depending on the size of the system, whether they use ground water or surface water, and the quality of the source water.

Tapping a Source of Water

Large-scale water supply systems tend to rely on surface water sources, while smaller systems tend to rely on ground water. Around 35 percent of the population served by community water systems (CWSs) drink water that originates as ground water. Ground water is usually pumped from wells ranging from shallow to deep (50 to 1,000 feet). The remaining 65 percent of the population served by CWSs receive water taken primarily from surface water sources like rivers, lakes, and reservoirs.

Treating Raw Water

The amount and type of treatment applied by a PWS varies with the source type and quality. Many ground water systems can satisfy all Federal requirements without applying any treatment, while others need to add chlorine or additional treatment. USEPA is developing a ground water rule that will specify the appropriate use of disinfection and will address other components of ground water systems to assure public health protection. Because surface water systems are exposed to direct wet weather runoff and to the atmosphere and are therefore more easily contaminated, federal and state regulations require that these systems treat their water. Applicable Federal Regulations include the Surface Water Treatment Rule, the Interim Enhanced Surface Water Treatment Rule, and the Stage I Disinfectants/Disinfection Byproducts Rule.

Water suppliers use a variety of treatment processes to remove contaminants from drinking water. These individual processes may be arranged in a “treatment train” (a series of processes applied in sequence). The most commonly used processes include filtration, flocculation and sedimentation, and disinfection for surface water. Some treatment trains also include ion exchange and adsorption. Water utilities select a combination of treatment processes most appropriate to treat the contaminants found in the raw water used by the system.

Types of Treatment

Flocculation/Sedimentation

Flocculation refers to water treatment processes that combine or “coagulate” small particles into larger particles, which settle out of the water as
sediment. Alum and iron salts or synthetic organic polymers (used alone or in combination with metal salts) are generally used to promote coagulation. Settling or sedimentation occurs naturally as floculated particles settle out of the water.

**Filtration**
Many water treatment facilities use filtration to remove all particles from the water. Those particles include clays and silts, natural organic matter, precipitates from other treatment processes in the facility, iron and manganese, and microorganisms. Filtration clarifies water and enhances the effectiveness of disinfection.

**Ion Exchange**
Ion exchange processes are used to remove inorganic contaminants if they cannot be removed adequately by filtration or sedimentation. Ion exchange can be used to treat hard water. It can also be used to remove arsenic, chromium, excess fluoride, nitrates, radium, and uranium.

**Adsorption**
Organic contaminants, unwanted coloring, and taste-and-odor-causing compounds can stick to the surface of granular or powder activated carbon and are thus removed from the drinking water.

**Disinfection (chlorination/ozoneation)**
Water is often disinfected before it enters the distribution system to ensure that potentially dangerous microbes are killed. Chlorine, chloramines, or chlorine dioxide are most often used because they are very effective disinfectants, not only at the treatment plant but also in the pipes that distribute water to our homes and businesses. Ozone is a powerful disinfectant, and ultraviolet radiation is an effective disinfectant and treatment for relatively clean source waters, but neither of these are effective in controlling biological contaminants in the distribution pipes.

**Distribution to Customers**
An underground network of pipes typically delivers drinking water to the homes and businesses served by the water system. Small systems serving just a handful of households may be relatively simple. Large metropolitan water systems can be extremely complex—sometimes with thousands of miles of piping serving millions of people. Although water may be safe when leaving the water treatment plant it is important to ensure that this water does not become contaminated in the distribution system because of such things as water main breaks, pressure problems, or growth of microorganisms. Much of the existing drinking water infrastructure was built many years ago. The USEPA Infrastructure Needs Survey, released in 1997, estimated that drinking water systems will need to invest $138.4 billion over a 20 year period to ensure the continued source development, storage, treatment, and distribution of safe drinking water. Many agree this is a very conservative low estimate.

**The Water Cycle**
Drinking water can come from both surface water and ground water. The water cycle begins with rainwater and snow melt that gathers in lakes and rivers which interact with ground water.
Water Treatment Plant

Follow a drop of water from the source through the treatment process. Water may be treated differently in different communities depending on the quality of the water which enters the plant. Groundwater is located underground and typically requires less treatment than water from lakes, rivers, and streams.

Coagulation removes dirt and other particles suspended in water. Alum and other chemicals are added to water to form tiny sticky particles called "floc" which attract the dirt particles. The combined weight of the dirt and the alum (floc) become heavy enough to sink to the bottom during sedimentation.

Sedimentation: The heavy particles (floc) settle to the bottom and the clear water moves to filtration.

Disinfection: A small amount of chlorine is added or some other disinfection method is used to kill any bacteria or microorganisms that may be in the water.

Filtration: The water passes through filters, some made of layers of sand, gravel, and charcoal that help remove even smaller particles.

Storage: Water is placed in a closed tank or reservoir for disinfection to take place. The water then flows through pipes to homes and businesses in the community.

Source: AWWA Drinking Water Week Blue Thumb Kit