Finished Drinking Water and Treatment Fundamentals

By the Water Quality & Health Council

Drinking water has been called the 2nd most essential human need (after the air we breathe). Every day, over 50,000 community drinking water systems serve over 300 million Americans, with just 3 percent of these systems serving almost 80 percent of the US population.[1,2] Regulated by the Safe Drinking Water Act, and supported by the work of federal, state, tribal and local governments and utilities, the US drinking water system has been recognized as one of the nation's most significant advances in public health.[3]

Raw and Finished Drinking Water

About two-thirds of Americans served by community drinking water systems obtain their raw (i.e., untreated) water from surface water sources, such as rivers, lakes and reservoirs.[4] The remaining third are served by municipal groundwater systems using wells, while some systems use both sources. In addition to source water protection, transforming raw surface water or groundwater into safe and clean (finished) drinking water requires appropriate treatment and ensuring its safe distribution to consumers' taps through on-site premise plumbing. Without adequate treatment, drinking water consumers are at risk of contracting diseases caused by viruses, bacteria, and protozoan parasites, as well as the risk of harm from toxic substances.
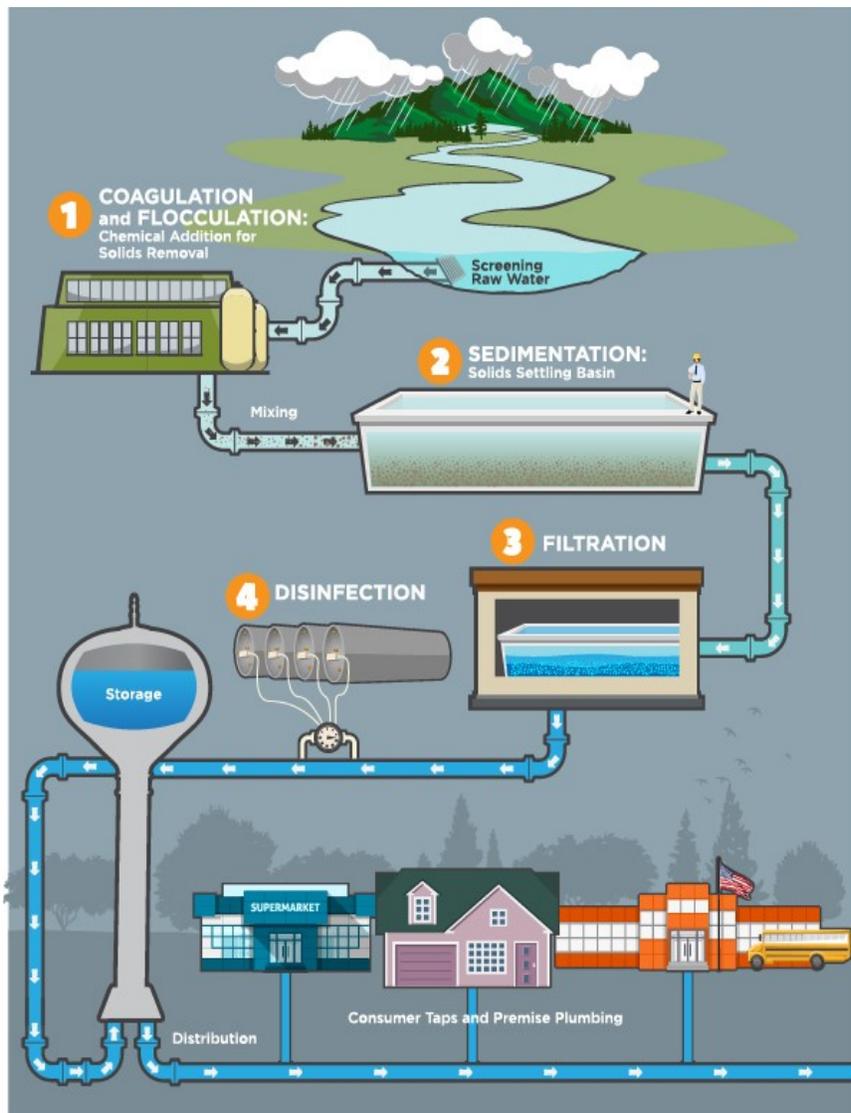
Drinking Water Treatment Fundamentals

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[1] President's Council of Advisors on Science and Technology (2016). REPORT TO THE PRESIDENT: Science and Technology to Ensure the Safety of the Nation's Drinking Water. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_drinking_water_final_report_20161221.pdf.

[2] Roughly 15 percent of Americans, almost 45 million people, get all or part of their water from private wells and are responsible for monitoring and maintaining the safety of their drinking water.

[3] National Bureau of Economic Research (2004). The Role of Public Health Improvements in Health Advances: The 20th Century United States. http://www.nber.org/papers/w10511.

[4] The USGS Water Science School: Public-Supply Water Use. https://water.usgs.gov/edu/wups.html.

Conventional water treatment transforms raw surface and groundwater into finished drinking water that is biologically (*disinfected*) and chemically safe; other treatment objectives include low or no taste or odor, low levels of color and turbidity (cloudiness) and chemical stability (non-scaling and non-corrosive). The critical failure to provide adequate corrosion control was at the core of the highly publicized lead in drinking water problems plaguing Flint, Michigan. Generally, surface water presents a greater treatment challenge than groundwater, which is usually filtered naturally as it percolates through the earth and geological strata. Individual systems customize treatment to address the particular water quality and contamination characteristics of their raw water supply.

Although practices vary from facility to facility, there are four basic processes—as well as finished water distribution and storage—included in conventional surface water treatment and as illustrated in the figure.[5]

1. Coagulation and Flocculation help remove dirt and other particles through the addition of *alum* (or other metal salts) to form coagulated masses called *floc* that attract other particles.

2. Sedimentation of coagulated, heavy particles through gravity to the bottom of a basin.

3. Filtration of water after sedimentation is accomplished by channeling water through sand, gravel, coal, activated carbon, or membranes to remove smaller solid particles not already removed.

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[5] Source: Drinking Water Chlorination: A Review of U.S. Disinfection Practices and Issues (2016).
https://chlorine.americanchemistry.com/Chlorine-Benefits/Safe-Water/Disinfection-Practices.pdf.

4. Disinfection by the addition of chlorine destroys or inactivates microorganisms. Additional chlorine may be applied to ensure an adequate residual during storage or transportation throughout the community.

US Drinking Water System Challenges

Although America's drinking water remains among the safest in the world, it faces a growing array of increasingly costly challenges—particularly those related to aging infrastructure, including pipe system rehabilitation and drinking water treatment plant upgrades and expansion. Tackling these systemic problems will require realistic priorities and unprecedented collaboration among all levels of government, utilities and the private sector.

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