Tech Brief

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Dual Water Systems

By **Zane Satterfield, P. E.**, NESC Engineering Scientist

Summary

Dual water systems feature two separate distribution systems that supply potable water through one distribution network and non-potable water through another. The two systems work independently of each other within the same service area. Using dual systems can boost public water supplies because they lessen the burden on drinking water systems because they do not have to provide water treated to drinking water standards for activities such as toilet flushing, firefighting, street cleaning, and irrigating ornamental gardens or lawns. In addition, dual water systems have the potential to save communities money because water can be used for more than one purpose thus reducing consumption of potable water. This *Tech Brief* discusses the dual-system concept.

What is a dual water system?

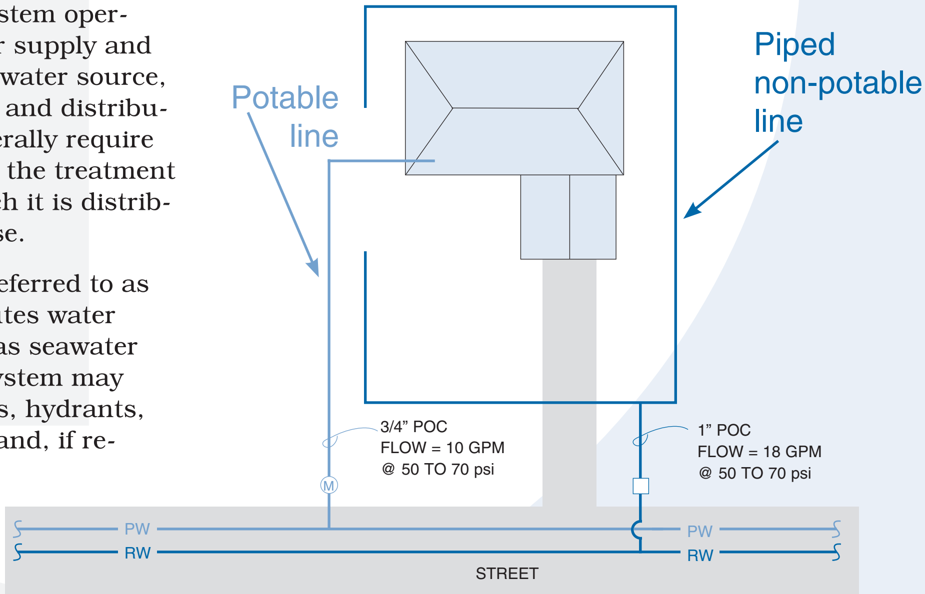
Two separate, underground, piped water systems that serve a parcel of land or lot characterize dual water systems. The potable water system conveys drinking water (i.e., water treated to meet U.S. Environmental Protection Agency Safe Drinking Water Act requirements) for household use while the non-potable system conveys water for landscape irrigation and other purposes (Figure 1). Note that the non-potable water is still treated, just not to drinking water standards.

The potable-water or primary system operates like any other potable-water supply and distribution system, requiring a water source, treatment plant, storage facility, and distribution system. These systems generally require pumps to lift potable water from the treatment plant to storage tanks from which it is distributed by gravity to the point of use.

The non-potable water is often referred to as a secondary system and distributes water from non-potable sources such as seawater or household gray water. This system may include distribution pipes, valves, hydrants, standpipes, a pumping system, and, if required, treatment and storage.

The main differences are the potable system has no fire hydrants and in most cases will use smaller-size distribution lines, smaller, high-service pumps, and require less storage. The non-potable water system is used for firefighting, which requires six-inch diameter lines or larger, and storage that can provide pressurized water at 250-gallons per minute for at least two hours. The other big difference is a non-potable system uses less treatment. A fine screen or strainer is used to keep particulates out.

Figure 1



The non-potable system also may need pH adjustment, depending on the raw water source and what kind of pipe material has been used to minimize corrosion or scaling of the distribution system. For unrestricted use in urban areas, disinfection for microorganisms and more filtration to reduce turbidity would be necessary. Pipes in either system can be made of PVC, ductile iron, or high-density polyethylene.

Cross connections of these systems may be a concern, but installers can minimize potentially dangerous connections if they use proper installation procedures, such as color-coded pipe and point-of-connection identifiers or a lower supply pressure gradient for the untreated system.

Why consider dual systems?

Simply put: We are treating more water to drinking water standards than we need to treat. Water used for toilet flushing, landscaping, irrigation, and numerous other applications, does not need to be treated to drinking water quality. Using drinking water for outdoor landscape needs is a waste of money for the water supplier and to the end user, especially in areas prone to drought.

A pressurized secondary water supply may help to reduce the cost of providing treated water by reducing the need to develop drinking water treatment facilities to provide for both indoor and outdoor water needs. In many instances, water for outdoor use may comprise more than 50 percent of annual water demand. Substituting a pressurized secondary water supply to meet this outdoor demand would greatly reduce the demand on existing water treatment systems.

Many small communities provide drinking water treatment through reverse osmosis, which is an expensive, high energy, and high maintenance method. For many of these communities, non-potable water can be substituted for drinking water that is currently being applied to residential, public, and commercial landscapes. This may be accomplished in a way that lowers the cost of water to users, while at the same time benefiting agricultural water distribution systems and reducing drought risk for both agriculture and cities in the process.

Water distribution systems are typically designed to include fire protection in addition to providing drinking water. However, water for fire fighting does not need to be treated to a level that would be considered safe for drinking. In addition, fire protection requires pipes and storage tanks to be larger, resulting in longer residence times that can cause degradation of drinking water quality.

The good news is that conventional systems offer modern water systems the foundation for a dual water system that can: shorten detention times, produce higher-quality water, reduce trihalomethanes and haloacetic acids, minimize “red water” calls and odor problems, save energy, save money, and conserve potable water.

Dual systems also can address urban growth around irrigated areas, while maintaining, for at least the near future, irrigated agricultural infrastructure. While some claim that dual systems promote urban sprawl onto agricultural lands, land-use policies are more likely the culprit than any kind of reclaimed water provided by dual systems for outlying subdivisions, golf courses, and recreational facilities.

Small communities that face water shortages should consider dual water systems. During droughts—when groundwater levels drop and small streams slow to a trickle—small systems are usually the first to be without water. Seeking water from a distant source is hardly ever a feasible solution. Often these sources are not available, or they are so far away that they are too expensive to consider. Dual distribution systems can reclaim a community’s wastewater and reuse it for non-potable purposes. In addition, dual systems can make money from the sale of reclaimed water to residential and agricultural users.

There are many uses for non-potable water and their importance varies with different areas of the country. Here are some uses for non-potable water:

- Golf course, sports field, landscape, and agricultural irrigation;
- Car washes;
- Fire protection;
- Street cleaning;
- Building washing;
- Industrial processes such as cooling tower and boiler feed makeup water;
- Commercial, industrial, and industrial air conditioning;
- Toilet flushing especially for bigger facilities such as schools, and high rises;
- Construction projects such as concrete mixing and dust control;
- Environmental enhancements such as fountains and landscape ponds.

Landscape irrigation is a major non-potable water use in the U.S. An additional benefit of irrigating with reclaimed water is that it is rich in dissolved nutrients, such as nitrogen and phosphorus, which

What does it mean?

Drinking water or potable water is water of sufficiently high quality that it can be consumed or used without risk of immediate or long-term harm to pubic health.

Non-potable water is water that is not of drinking water quality, but which may still be used for many other purposes, depending on its quality, such as fire protection or irrigation.

Reclaimed water, sometimes called recycled water, is wastewater that has been treated to remove solids and certain impurities. In most locations, it is only used for non-potable purposes, such as irrigation, dust control, and fire suppression, and there is controversy about possible health and environmental effects for those uses.

Water recycling or reuse is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a groundwater basin (referred to as groundwater recharge).

perform better and at far less cost than commercial fertilizers. In many locations, if the wastewater is not reclaimed, communities are obliged, according to National Pollution Discharge Elimination System permits, to remove the nutrients before it is discharged into a receiving stream.

Communities with Dual Systems

Seawater-based systems have been used in Castries, Saint Lucia, for fire-fighting purposes and in Charlotte Amalie, U.S. Virgin Islands. U.S. Navy bases have installed and operated similar systems in the past.

Two agricultural entities with pressurized secondary systems serving residential areas are the Davis and Weber Counties Canal Company in Sunset, Utah, and the Nampa-Meridian Irrigation District in Nampa, Idaho. These two irrigation systems were originally agricultural in nature. They gradually entered into secondary water service as people moved into the area.

Today, the Davis and Weber Counties Canal Company (D&W) is made up of two operations that are carefully integrated. One is the traditional system of open ditches serving agricultural area production, while the second system is pressurized to serve more than 8,000 residential houses in the area. Ordinances, along with a special water-rate structure for the secondary system, and a policy that ensures that D&W is in full control of secondary system development, make it possible for the D&W stockholders to realize the many benefits of providing secondary water service.

The Nampa-Meridian Irrigation District (NMID), although originally developed to provide irrigation water to cropland, is now almost 90 percent residential. This has brought about a gradual transfer of open ditch deliveries to pressurized raw water deliveries for residential lots. NMID now has about 40,000 individual water accounts, most of which are residential water users.

Meanwhile, NMID has developed a wide range of ordinances, covenants, contracts, and agreements that protect their irrigation facilities from construction activities associated with residential subdivision development. NMID operates very much like a conventional utility company, with its own dedicated rights-of-way, water billing, growth management planning capabilities and professional staff.

Dual systems are increasingly found in highly urbanized areas. Since 2004, Toronto, Canada, began receiving a new water supply from Lake Ontario for drinking water and building cooling. The project established a fresh drinking water system thermally interfaced with a closed-loop, 52,000-ton capacity district cooling system capable of serving 20 million square feet of downtown office space. The system consists of three, three-mile-long, 63-inch diameter, high-density polyethylene (HDPE) intake pipes that bring 39° F fresh water from nearly 275 feet down in Lake Ontario to an upgraded water filtration plant on Toronto Island. After treatment, the water continues through a $97^1/_2$-inch-diameter tunnel in bedrock under the Toronto harbor to the energy transfer facility in a downtown pumping station. There, heat exchangers are used to transfer the cooler lake temperatures to the closed water loop used for cooling.

Water in the cooling system is returned to 40 degrees F while water from the lake is heated to about 55 degrees F and then pumped into the city's distribution system. Each system remains completely separated throughout the energy transfer process. Separation is also ensured by creating a pressure differential of 25 pounds per square inch (psi) between the drinking water and cooling water systems. The deep lake water cooling system has benefited the city by providing a clear, cool, and clean source of water, as well as a 75 percent reduction in energy use compared with conventional chillers.

Considerations

There are several points that need to be addressed before considering a dual system, including: (1) water quality, (2) water rights issues, and (3) state and local regulations.

Water Quality

The main difference between potable and non-potable water quality is that no effort is made to remove trace organic chemical contaminants (such as benzene, chlordane, toluene, and vinyl chloride) in the reclaimed water. Also, it is not necessary to perform costly monitoring to assure that they are absent. These contaminants are a health risk only when ingested over long periods of time. For non-restricted use in urban areas the reclaimed water should be—and in most cases must be—free of microorganisms that, if ingested inadvertently, cause infectious disease.

The quality standards for reclaimed water for unrestricted non-potable reuse, as recommended in the U.S. Environmental Protection Agency guidelines, are:

Fecal Coliform

- Absent per 100 milliliters (ml)
- Monitored daily

Chlorine residual

- Minimum; 1 milligram per liter (mg/L) in the system
- Monitored continuously

Turbidity

- 2.0 nephelometric turbidity units average (NTU); 5 maximum
- Monitored continuously

If chlorine disinfection is used, the water may well be high in chlorination byproducts, which need to be tightly controlled in drinking water, but are of little significance in non-potable water that is not to be ingested.

Legal Issues

Water rights in some areas may limit the ways that reclaimed water may be used, including whether water can be used for irrigation, the amount of water that can be used, the place where the water can be used, and the time of year during which the water can be used.

The provider of a secondary system may be subject to liability if people or animals become sick from drinking the water. As the provider of a potentially hazardous product, the water company should be aware that it may have certain legal obligations and must notify its customers of the potential hazards of the water it supplies.

Rules and Regulations

You must address state policy on secondary (non-potable) systems through your state public services commission or utility commission and the regulatory agency, which may be different from the state primacy agency for drinking water. Check with your state officials about different rules and regulations before considering a dual system.

With water resources stretched to the limit—especially considering the prolonged drought conditions in many parts of the country—having a dual system can be a viable option and well worth considering.

References

Colorado State University. 2003. "The Benefits and Cost of Pressurized Dual Water Systems in Colorado and the Potential Role of Canal Companies and Irrigation Districts in Providing the Pressured Irrigation Water Supply Portion of Dual Systems." Sociology Water Lab and The Colorado Institute for Irrigation Management.

Okun, Daniel A. 2002, "Running Out of Water;" *On Tap* (Summer). National Environmental Services Center.

Rolan, Terry. 2008. "An Innovation Concept for Dual Water System in Older Cities." McKim & Creed. Accessed at *www.ncsu.edu/wrri/conference/2008ac/speakers/abstracts/Rolan.pdf*

United Nations Environment Program. *Source Book of Alternative Technologies for Freshwater Augmentation in Latin America and the Caribbean*. International Environmental Technology Centre. Accessed at *www.oas.org/dsd/publications/unit/oea59e/ch30.htm*

Warne, Keith. 2005. "Building A Dual-Purpose Water System, Toronto Reaches out 3 Miles for Drinking and Cooling Water," *Public Works Magazine* (March).

NESC Engineering Scientist **Zane Satterfield** is a licensed professional engineer and water operator who previously worked for the West Virginia Bureau of Public Health, Environmental Engineering Division.

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