Potable Reuse 101

An innovative and sustainable water supply solution

American Water Works Association

Dedicated to the World's Most Important Resource®

Introduction

Both the quality and quantity of conventional water supplies are increasingly affected by population growth, urbanization, prolonged and severe droughts, and climate change. Consequently, finding the opportunities to develop new groundwater or surface water sources is becoming more challenging. With an increased pressure on water systems, a diversified portfolio of water sources is required to meet future water demands, ensure public health, and provide economic and environmental sustainability. Many communities are working to increase water conservation and seek new strategies to develop sustainable water supplies for the future. For that reason, there is a clear need to use our existing local water resources effectively to produce and provide reliable, high-quality water. One viable approach to address existing and anticipated water shortages is to implement water reuse in which used water from homes and businesses is highly treated and used to augment public water supplies.

What is water reuse?

Water reuse involves using water more than once to expand a community's available water supply. The practice of water reuse occurs in various forms throughout the world. The latest advances in water technology allows for communities to reuse water for beneficial purposes including drinking, irrigation, and industrial processes. The following terms are commonly used to describe the types and purposes of water reuse:

- **Recycled or reclaimed water** indicates water that has been used more than once.
- **De facto reuse** occurs when downstream communities use surface water as a drinking water source that has been subjected to upstream wastewater discharges (Figure 1).
- **Nonpotable reuse** refers to recycled or reclaimed water that is not used for drinking but is safe to use for irrigation or industrial processes.
- **Potable reuse** refers to recycled or reclaimed water that is safe for drinking.

Advanced purification processes are proven technologies that transform treated wastewater into high-quality water—or purified water—for potable reuse. Purified water surpasses state and federal drinking water standards as well as additional water quality objectives. In general, nonpotable reuse does not involve treatment to drinking water standards, and water quality objectives may vary depending on the end use and risk for human exposure. Both potable and nonpotable reuse are practiced in the United States, and de facto reuse is relatively common.

Figure 1: Flow schematic of de facto reuse

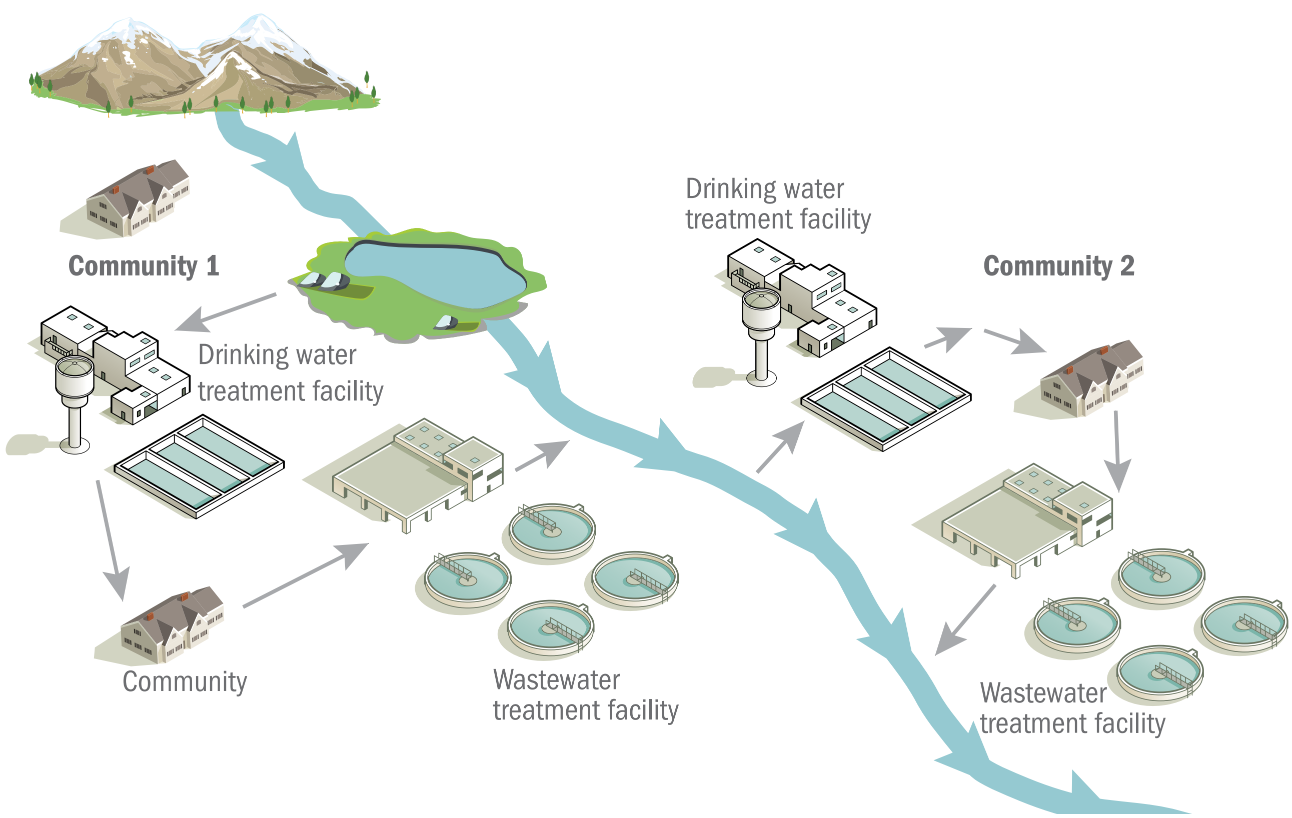
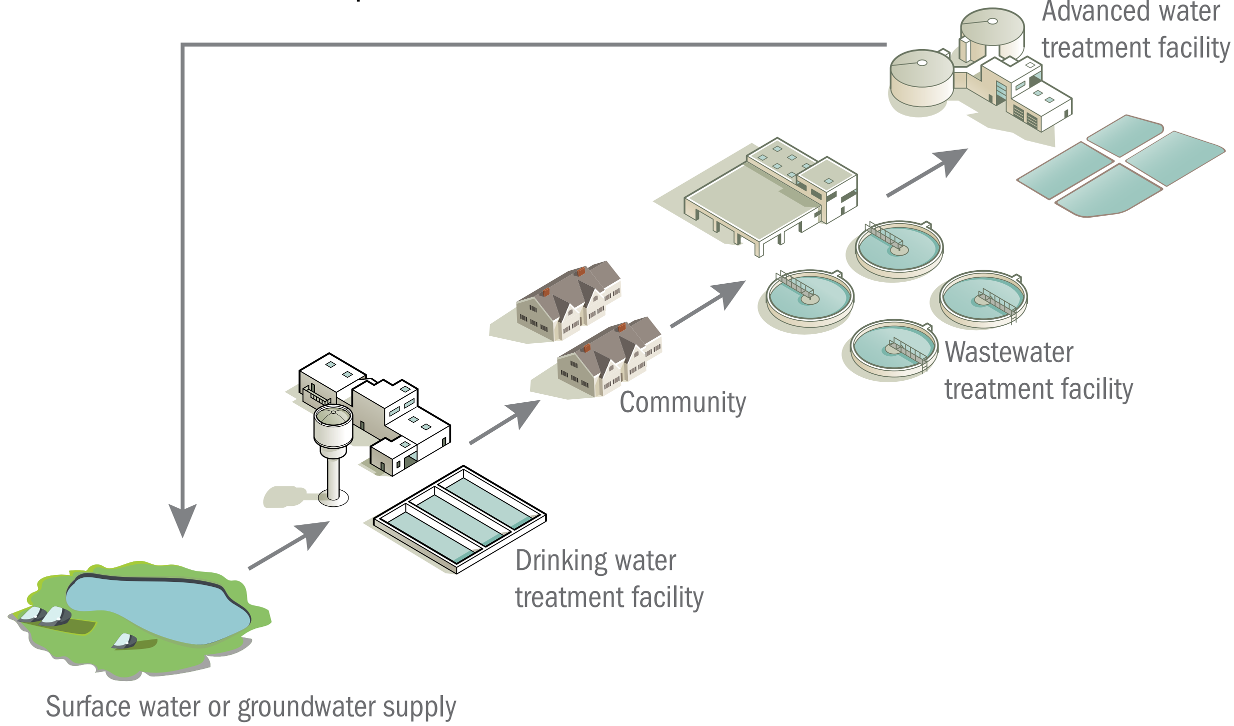


Figure 2: Flow schematic of indirect potable reuse



Direct vs. Indirect Potable Reuse

In general, there are two forms of potable reuse:

- **Indirect potable reuse (IPR)** introduces purified water into an environmental buffer (e.g., a groundwater aquifer or a surface water reservoir, lake, or river) before the blended water is introduced into a water supply system (Figure 2).
- **Direct potable reuse (DPR)** introduces purified water directly into an existing water supply system (Figure 3).

Many IPR projects have been established in the United States (Figure 4), and generally, they involve using reclaimed water to recharge groundwater aquifers and augment surface water reservoirs that are used as drinking water supplies. There are two different approaches to implementing DPR. Both apply additional advanced treatment to the used water; however, the two differ in the location of blending. In one approach the purified water is blended with the raw water supplies (e.g., surface water or groundwater) before undergoing additional treatment process in a drinking water plant; the other approach involves blending the purified water directly into the potable water distribution system downstream of the drinking water plant (i.e., pipe-to-pipe or direct-to-distribution DPR). Although both DPR and IPR provide significant additions to local water supplies, neither can meet all potable water demands.

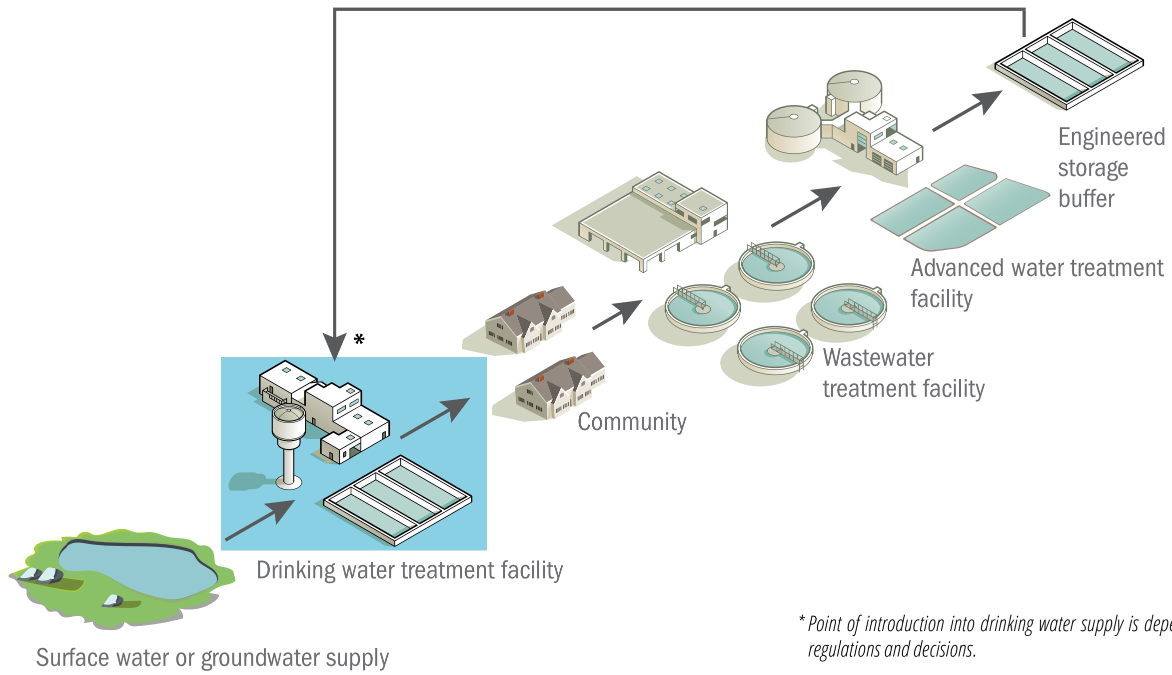
Water Resources Planning

To maximize resources, water managers often consider a diverse portfolio of water sources in their long-term strategy. Public water supplies in North America come from various sources including surface water, groundwater, desalinated seawater and brackish groundwater, and reused water. Planning and managing water resources becomes increasingly complex as surface water and groundwater supplies in many regions are stressed. Additionally, desalination of seawater or brackish groundwater is not always economically feasible. Importing water from other communities has a high price tag as well. As a result, many communities are incorporating potable reuse into their integrated water resources plan as a practical solution to ensure reliable water sources for the future. Potable reuse offers many benefits in addition to playing an integral role in a water portfolio.

What are the benefits of potable reuse?

Because potable reuse provides especially high-quality water, the end-uses are more diverse than for other types of reclaimed water. For example, in addition to drinking water, applications include agricultural and landscape irrigation, industrial processes, and other municipal uses. Environmentally, potable reuse is a more sustainable water supply, making more efficient use of existing water supplies by recycling a resource that would otherwise be discharged. Accordingly, potable reuse may decrease the

Figure 3: Flow schematic of direct potable reuse



** Point of introduction into drinking water supply is dependent on local regulations and decisions.*

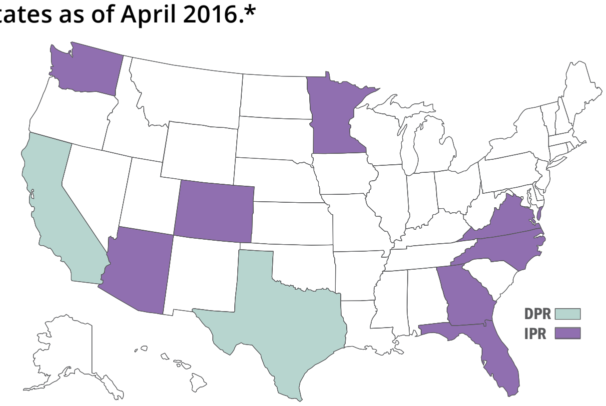
amount of water imported to urban areas (in many cases, from long distances), reduce groundwater extraction, and minimize wastewater discharges to the environment. In turn, energy costs are lowered, groundwater overdrafts are limited, and the health of aquatic ecosystems that receive wastewater effluent is improved. Finally, potable reuse utilizes a local resource that is accessible for many water systems throughout the country, unlike sources such as seawater and brackish groundwater, which may not be available depending on geography and geology.

Is potable reuse regulated?

Federal potable reuse regulations have not been developed in the United States. Thus, state and local agencies are responsible for setting potable reuse standards. The majority of states have established regulations or guidelines for water reuse (Figure 5. **www.awwa.org/reuse**), and state regulations are expected to be regularly updated and developed as states gain experience and confidence in water reuse. Although few states have established regulations or guidelines specifically for potable reuse, most will still consider potable reuse projects on a case-by-case basis. A summary of each state's water reuse requirements (not specific to potable reuse) is provided in the US Environmental Protection Agency (USEPA) document Guidelines for Water Reuse (2012), along with recommendations for water reuse opportunities, technical guidance, and key considerations for implementing reuse projects. Additionally, in a collaborative effort, the WateReuse Research Foundation, the American Water Works Association, Water Environment Federation, and National Water Research Institute developed a framework for DPR. This framework document provides information about the value of DPR as a water supply option and the fundamental components to implementing a DPR program (Figure 6).

Regardless of the source, all potable water distributed to communities meets drinking water quality standards derived from the Safe Drinking Water Act (SDWA). Established in 1974, the SDWA provides the framework for USEPA to set the minimum quality standards for drinking water and requires all public water suppliers to comply with those standards. However, source water for potable reuse is also regulated further upstream. The Clean Water Act (CWA), established in 1972, regulates pollutant discharges and allows USEPA to set quality standards for surface waters in the United States. The CWA was integral for protecting and improving the quality of source waters throughout the nation, thereby mak-

Figure 4: Current DPR and IPR projects in the United States as of April 2016.*



** Canada and Mexico do not currently have any DPR or IPR projects in place.*

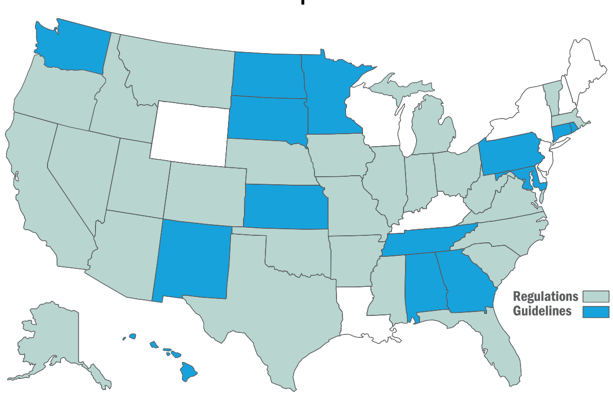
ing potable water reuse attainable. Building on these two critical pieces of legislation, the water industry can utilize potable reuse to augment public water supplies in a manner that is protective of public health.

Potable reuse is also growing in popularity in both Canada and Mexico, although specific potable reuse regulations have not been developed in either country. However, potable reuse projects are considered on a case-by-case basis where appropriate.

Public Health Protection

Public health protection is at the forefront of potable reuse. Considering the multitude of people who rely on public drinking water supplies, ensuring public health and safety is of utmost importance to water professionals. A wide range of established treatment options and process combinations are available to ensure that potable reuse produces the best water quality that protects against adverse health effects from contaminant exposure. Public health concerns are a driving force to advance research efforts, develop new regulations, enhance treatment technologies, and train skilled water operators.

Figure 5: Current water reuse regulations and guidelines in the United States as of April 2016.*



** Canada and Mexico do not currently have water reuse regulation or guidelines.*

Potable Reuse Treatment

There are as many as four different treatment points associated with potable reuse. First, all wastewater is treated prior to discharge using one or more of the following steps:

- **Preliminary Treatment**—Removal of suspended and floating particles that may cause operational or maintenance problems with subsequent treatment processes
- **Primary Treatment**—Removal of a portion of the suspended solids and organic matter
- **Secondary Treatment**—Removal of most of the suspended solids and organic matter
- **Tertiary Treatment**—Removal of targeted dissolved solids and finer suspended materials

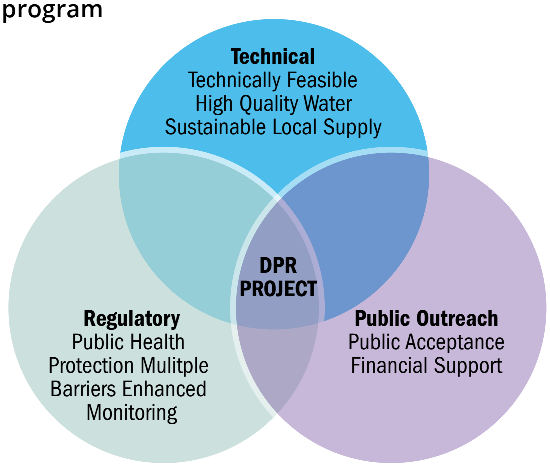
This treated wastewater becomes the source of supply for potable reuse, which uses a combination of advanced processes in a second point of treatment. A comprehensive summary of advanced treatment options is provided in the Framework for DPR (2015), including the following:

- **Biological Treatment**—The use of bacteria and other microorganisms to consume and remove organic materials and nutrients in the water; examples include biologically active media filters and anaerobic denitrifying filters (specifically for the removal of nitrate and nitrite).
- **Membrane Filtration**—Processes that use a membrane barrier with microscopic pores to remove suspended particles and pathogenic microorganisms; examples include microfiltration (MF) and ultrafiltration (UF).
- **Membrane Desalination**—Processes that use a non-porous, semipermeable membrane barrier to remove salts, pharmaceuticals, and other dissolved contaminants; examples include reverse osmosis (RO) and nanofiltration (NF).
- **Ozone**—A powerful oxidant used for disinfection and/or breaking down organic contaminants, including pharmaceuticals.
- **Advanced Oxidation**—Processes used to achieve significant pathogen disinfection and break down organic contaminants, including pharmaceuticals; examples include ozone (O_3) or ultraviolet (UV) light in combination with hydrogen peroxide.

An advanced treatment plant for potable reuse will include many of these processes in combination to not only achieve water quality goals, but also provide resilient, redundant, and robust treatment in a multiple barrier approach to contaminant removal.

In addition to the wastewater and advanced potable reuse treatment described above, IPR also uses an environmental buffer either before or after advanced treatment as a third point of treatment. The environmental buffer may be a groundwater aquifer, surface water reservoir, or even natural or constructed wetlands, providing storage, hydraulic transport, and/or an additional barrier for the protection of public health. Although DPR does not include an environmental barrier, it does use an engineered storage buffer. If the DPR approach involves blending the purified water with the raw water supplies prior to a subsequent drinking water plant, the engineered storage buffer occurs between the advanced and drinking water treatment plants. For pipe-to-pipe DPR, the engineered storage buffer occurs between the advanced treatment plant and potable water distribution system.

Figure 6: Inter-relationship of the Key Components of a DPR program



Source: *Framework for Direct Potable Reuse (2015)*

Public Education and Outreach

Pubic engagement is critical to the success of potable reuse projects. As water stressors continue to grow and potable reuse expands, it is necessary to provide transparent communication, build consumer confidence, and address public concerns, all of which require a comprehensive program of public and political involvement and education. First, it is essential to inform communities in a proactive manner, addressing key questions: Where does your water come from? Why do we need alternative water sources? Answering these questions for consumers will improve public understanding of water supply and treatment, which is crucial to informed decision making. It's also important to make the natural water cycle a part of the conversation. All water on Earth is used and reused, over and over. Water reuse happens daily all over the world. When a community's treated used water is discharged into rivers and streams, downstream users clean and reuse that water.

Collaborative and cooperative outreach with a uniform message and consistent terminology are needed for public acceptance of potable reuse projects. Accordingly, it is beneficial to initiate community and media outreach several years before construction of potable reuse treatment facilities is scheduled to begin. Project success requires sufficient time to create rapport, build trust, and establish effective communication strategies with the public and media. The successful implementation and ongoing success of potable reuse projects relies on educating and encouraging local communities in order to gain support.

What is the future of potable reuse?

Water is both a precious and limited resource that we must use more efficiently, as it is imperative that supplies remain available and preserved for future generations. Potable reuse is a viable and environmentally friendly strategy for achieving improved efficiency, and further, will undoubtedly play a significant role in utilities' overall water supply portfolio in the future. To implement and expand potable reuse projects, guidance and standards must be continually enhanced, process control must be refined as treatment technologies and strategies evolve, and customized operator training and certification must be developed. Additionally, as more municipalities and water agencies embrace the benefits of potable reuse, it is increasingly critical to mitigate concerns and promote public confidence about potable reuse. By working together to address these challenges, potable reuse can help us to more sustainably manage and locally expand vital water resources.

AWWA Policy Statement: Reclaimed Water for Public Water Supply Purposes

AWWA recognizes the need for sustainable water supply resources in light of drought, competition with other users, population growth, climate change impacts, ecological needs, and limited natural availability. Wastewater reclamation produced through appropriate treatment, monitoring, and control can be a tool to increase the water supply portfolio for many utilities faced with these constraints.

AWWA recognizes the value of high-quality reclaimed wastewater—properly treated to appropriate standards—as a sustainable supplement to a region's water supply portfolio. Reclaiming water from wastewater systems to augment supplies used for irrigation, industrial, ecological, and municipal uses within a public drinking water supplier's service area has been successful in many places and may hold promise for others. In addition, reclaiming water from wastewater effluent, for indirect potable uses, such as replenishing drinking water sources, maintaining aquifer levels, increasing stream flow or as a direct potable use may be a viable option with the appropriate level of treatment, reliability, and safeguards to protect public health.

AWWA encourages continued research to assess potential public health and safety impacts, improve treatment technology, refine monitoring techniques, expand applications, and further develop health-based standards that ensure the increased and safe use of reclaimed water for the public.

Revised by the Board of Directors on January 19, 2014.

Additional Reuse Resources:

- AWWA's International Symposium on Potable Reuse Post Show Report
- AWWA Manual M24: Planning for the Distribution of Reclaimed Water, third edition (2009)
- AWWA's Reuse Resource Community: **www.awwa.org/reuse**
- Framework for Direct Potable Reuse (2015): **www.awwa.org/resources-tools/water-knowledge/reuse.aspx**
- "Helping People Understand Potable Reuse" (2015) WateReuse Research Foundation: **www.datainstincts.com/white_papers.htm**
- U.S. EPA Guidelines for Water Reuse (2012): **www3.epa.gov/region9/water/recycling**
- WateReuse Research Foundation: **www.watereuse.org**

AWWA Reuse Articles:

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Katz, S.M., Tennyson, P.A., Public Outreach for Potable Reuse: Bringing the Public to a New Level of Acceptance. 2015. *Journal AWWA,* 107:11:46.

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Miller, G.W., Direct Potable Reuse: Its Time Has Come. 2015. *Journal AWWA,* 107:5:14.

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Rice, J., Via, S. H., Westerhoff, P., Extent and Impacts of Unplanned Wastewater Reuse in US Rivers. 2015. *Journal AWWA,* 107:11:E571.

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Via, S. H., Tchobanoglous, G., Introducing the Framework for Direct Potable Reuse. In press. *Journal AWWA,* 108:7.

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All links last accessed April 2016.

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