

Potable Water Reuse: Balancing Health and Sustainability

By Kelly A. Reynolds, MSPH, PhD

Reuse of wastewater supplies can augment a quarter of the drinking water needs in some communities. Advanced technologies provide higher levels of treatment to ensure safe and consistent quality. Today, reuse water treatment options have evolved along with public acceptance, in part due to the lack of evidence for substantial health effects following decades of application. Concerns of uncertain regulatory needs, potential treatment failures and emerging contaminants with unknown health risks continue to be barriers to consumer acceptance, however.

Sustainable solutions

Reuse of water supplies is necessary for many communities to meet future drinking-water needs as conditions of drought and increased demand continue to worsen. According to a 2012 report by the National Academies of Sciences, *Engineering and Medicine*, water reuse could substantially and sustainably offset predicted water shortages.¹ The report further states that of the nation's 32 billion gallons (121 billion liters) of municipal wastewater discharged per day, nearly a third is released to oceans or estuaries. Approximately eight percent of wastewater is reclaimed. While reuse of inland supplies may have the unintended consequence of affecting dependent ecosystems or downstream users, reusing coastal discharges alone could save an estimated 27 percent of the public water supply.

Recognizing the sustainable benefits of water reuse, California (and specifically the Los Angeles County Sanitation District) became a progressive initiator of augmented water supplies more than 50 years ago. Since the early 60s, acceptance of non-potable wastewater reuse for irrigation of parks, golf courses and cooling towers spread over time, but reluctance remained relative to using these resources for drinking water, despite growing development of more effective advanced treatment options.

Similar to municipal water sources, potable reuse waters require a multi-barrier approach to disinfection but the latter utilizes additional treatment steps, such as microfiltration, RO, advanced oxidation and UV-light disinfection. These technologies provide additional barriers for unregulated, emerging contaminants of concern, including endocrine disrupting compounds, 1,4-dioxane and NDMA. Increased monitoring for a wider variety of contaminants may also mean a problem is likely to be detected if present. Thus, the risk of drinking reuse water supplies may be lower than that from existing municipal supplies.¹

A 2012 survey found that 80 percent of American respondents strongly supported non-potable water reuse but only 30 percent supported drinking it (i.e., potable reuse).² According to a more recent 2018 US EPA report, consumer confidence is shifting.

Surveys in southern California indicate the public understands that treated reclaimed water is potentially of higher quality than current sources.³ Concern for future generations, the environment and water sustainability, as well as increased stakeholder information on the safety of advanced treated drinking-water supplies, have contributed to improved public opinion.

Water reuse options

The term potable reuse includes both direct or indirect use of highly treated wastewater as a municipal drinking-water supply. The reuse water is often blended with other waters and passed through the standard drinking-water treatment system where still more treatment measures are employed.

Indirect water reuse involves the use of an environmental reservoir where the water is stored or mixed with existing supplies for subsequent drinking-water sources. The reservoir may be a groundwater aquifer, stream, lake or river. In the arid southwest region of Tucson, AZ, treated wastewater effluent is discharged into dry riverbeds (or washes) where the reuse water naturally recharges groundwater aquifers supplying drinking water to the community.

Direct potable-water reuse indicates the lack of an environmental buffer. Contaminated source-water supplies are therefore treated with engineered controls. In 1968, Windhoek, Namibia was the first city to initiate direct potable reuse throughout the community. The augmented supply routinely saved up to 35 percent of the potable water supply. Epidemiological studies of the Namibia population have found no evidence of increased stomach ailments, jaundice or mortality. Additional studies in multiple international regions have also found no substantial evidence of increased cancer, death or infectious disease incidence. Other studies reported no differences in estrogenic, genotoxic or mutagenic effects in animal and cell bioassays. To the contrary, one study found that those drinking reclaimed water had slightly lower diarrheal disease than those consuming the conventional water supply.³

One problem with current study designs is that long-term, chronic effects were not fully tracked. Many health effects typical of some of the chemical contaminants in reuse water would take years to appear. Other limitations of previous study designs include small or poorly matched test and control populations and inability to detect low incidence of disease or milder health outcomes. More long-term research is needed but very costly to conduct. New applications of quantitative microbial risk assessment (QMRA) modeling approaches are being utilized to simulate scenarios of public health benchmark values to predict anticipated health outcomes and treatment efficacy needs. QMRA

methods can predict health outcomes much more rapidly than epidemiological field studies but are also limited by the need for more data to accurately assess scenario assumptions.

Challenges and concerns

A multitude of microbial pathogens are present in higher numbers in wastewater supplies, including viruses, bacteria, protozoa and helminths capable of causing human disease. In addition, a wide variety of chemical contaminants can be found in wastewater from industrial and domestic sources. Endocrine-disrupting compounds and pharmaceutically active compounds are two examples of emerging contaminants found in potable-reuse water sources that are not routinely removed via conventional wastewater treatment. In addition, treatment of wastewater adds additional contaminants of concern, such as DBPs.

Challenges include advanced treatment needs for diverse incoming water quality. As the source-water quality changes over time, the treatment train must also adjust to ensure any contaminants of concern are appropriately removed. More research is needed to determine the frequency of these events and the successful mitigation of changing needs. In addition, more research is needed to evaluate what level of protection for public health is afforded by regulatory standards for water reuse. Currently, no consistent federal standard exists across states specific to water reuse, although drinking water supplied to consumer taps is required to meet limits defined under the *Safe Drinking Water Act (SDWA)*. (Contaminant-specific SDWA standards were developed based on anticipated levels in source waters and required treatment-technology efficacy to achieve a defined acceptable risk limit and may differ relative to reuse water quality.)

The multi-barrier treatment approach provides successive safety nets to mitigate a wide range of harmful drinking water

contaminants, regardless of source. Systems can fail, however. Information on the frequency of failures in reuse treatment systems is limited and thus accurate assessments of risks over time are difficult to determine. Potable-reuse water sources promise to provide a more sustainable (and possibly safer) drinking-water supply compared to conventional sources. The use of a final barrier (i.e., POU treatment device), however, continues to be needed for minimizing exposure to the variety of contaminants that may escape the municipal treatment train, be introduced in the distribution system or grow in the premise plumbing.

References

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