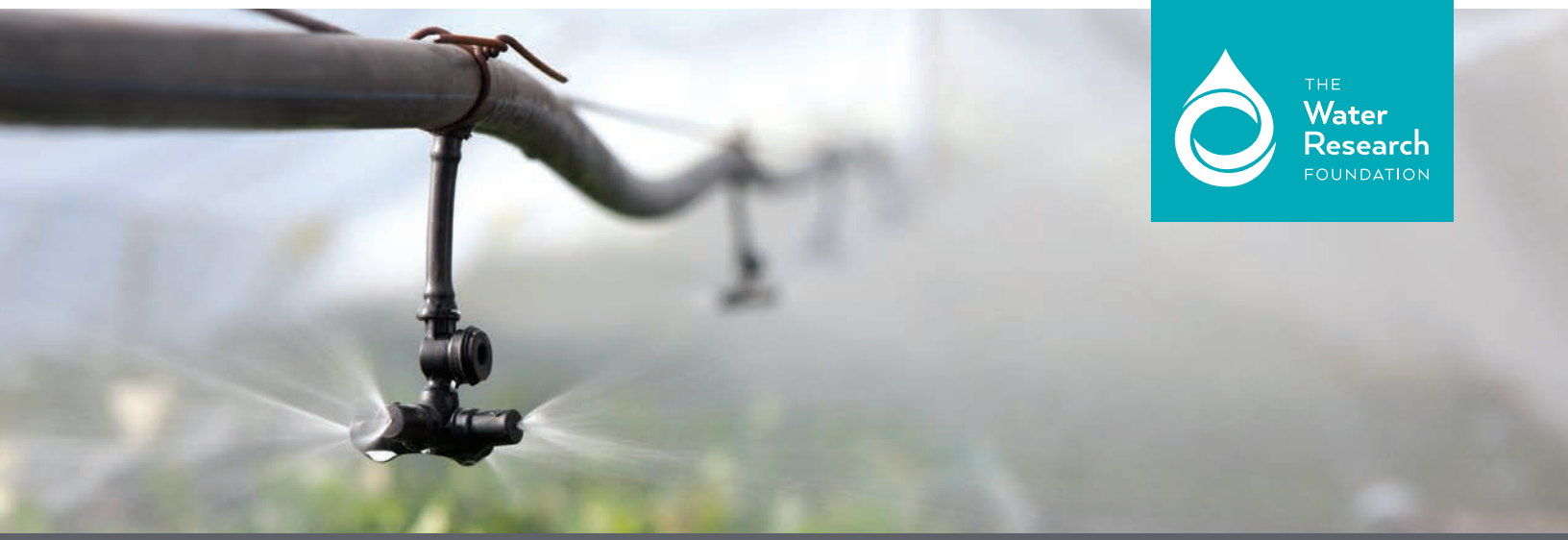


THE Water Research FOUNDATION

Non-Potable Reuse

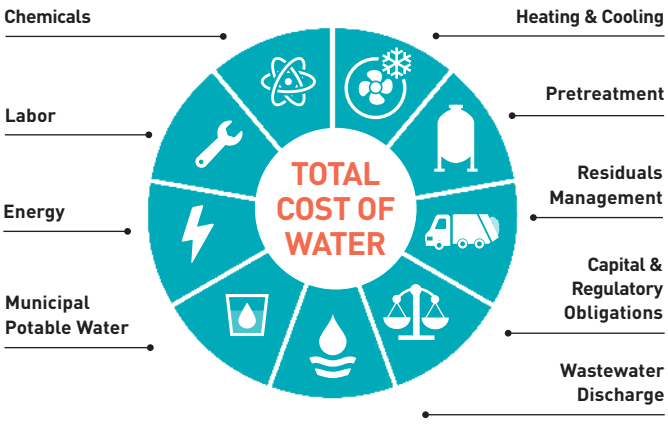
THE CHALLENGE

One of the biggest challenges today's communities face is the ability to provide safe, sustainable sources of water—not only for drinking, but for an assortment of other everyday uses that don't require water treated to drinking water standards. With a growing number of pressures straining our water sources, many utilities are relying on non-potable water reuse to keep up with demand—recycling municipal wastewater and water from impaired sources for activities that don't involve human consumption, such as landscape and crop irrigation, industrial processes, and other uses. Depending on the purpose and the risk of human exposure, different types of wastewater can be treated to meet specific quality standards. By treating water to match its intended use, utilities can avoid the high costs associated with over treatment—producing a product that relieves the demand on drinking water resources and offers a host of environmental benefits, including lower energy consumption, decreased diversion of water from sensitive ecosystems, and decreased discharges of nutrients and other pollutants.

While non-potable reuse systems have the potential to extend drinking water supplies and may require less treatment than potable reuse operations, these systems can be difficult to develop and maintain due to regulatory uncertainty. Challenges like the cost of maintaining separate "purple-pipe" distribution systems and long-held public perceptions on water reuse also increase this challenge.

THE RESEARCH

Starting in the mid-1990s, WRF was among the first organizations to explore the long-term viability of water reuse, charting its path as a sustainable resource. As the need for alternative water sources continued to grow, WRF stepped up these efforts, making this area a critical focus in the early 2000s. Since that time, WRF has launched more than 150 projects, leveraging over $100M in applied research to advance the science of water reuse, including roughly $1M each year in non-potable reuse. This research works to



As industries weigh the cost of using reclaimed water against traditional water sources, they must factor in all of the expenses that go into treating and transporting water.

help develop the most cost-effective processes and technologies to support water quality standards, protect public health, and preserve the environment—as well to more effectively integrate these systems into current operations.

Through strategic partnerships with state, federal, and international agencies, WRF has explored a range of community, utility, and regulatory issues to help develop sustainable water reuse systems. Key collaborations include efforts with the California State Water Resources Control Board, the Pentair Foundation, and the Metropolitan Water District of Southern California, as well as a nearly two-decades long collaboration with the Bureau of Reclamation to advance water reuse and accelerate the adoption of transformative technologies. This joint effort resulted in 124 research projects valued at $53M.

In 2018, the California State Water Board expanded their work with WRF, providing a $4.5M grant to identify and execute key research needed to bolster the production and use of recycled water in California. A substantial amount of this funding will go directly toward non-potable studies, which will drill into issues such as agricultural reuse, industrial reuse, and the energy-water nexus.

Agricultural Reuse

Because agriculture accounts for 80% of total water use in the United States, increasing water reuse practices in this area has the potential to have a big impact—making it a top priority for WRF. Agricultural reuse for food crops is currently practiced in many states, including California, Florida, and Colorado. To help supplement these efforts, in 2012, WRF began to strategically partner with agricultural organizations to better understand cross-sector issues, such as sources and impacts of nutrients, as well as to aid in moving agricultural reuse forward.

The 2019 WRF project *Agricultural Use of Recycled Water: Impediments and Incentives* (Reuse-15-08/4775) takes stock of some of the top challenges involved with switching from traditional water sources to recycled water for agricultural irrigation—looking at causes of setbacks and potential challenges and offering strategic solutions. Through interviews with both utilities and growers, a spatial assessment of irrigated farmlands, case studies of successful projects around the world, and a collaborative workshop, the findings highlight the largely untapped potential for agricultural reuse and serve as a springboard for other research efforts—including a follow-up study that is weighing the environmental, economic, and social costs and benefits of this agricultural water source.

This research also helped launch several WRF workshops and cross-sector events focused on finding collective solutions for overcoming challenges associated with agricultural reuse. The 2018 Agricultural Water Reuse Workshop took an important collaborative step, bringing together the agricultural community, water utilities, regulatory agencies, and consultants to work toward the common goal of making water reuse more feasible for growers and utilities. The workshop, which attracted over 100 attendees, included presentations by WRF agricultural reuse researchers and an expert panel session to identify potential collaboration areas across sectors and future research gaps.

Another 2019 study also made strides in agricultural reuse, this time with a focus on groundwater recharge—which has the potential to restore more than 300,000 acre-feet of sustainable groundwater each year in California alone. *Groundwater Replenishment with Recycled Water on Agricultural Land* (Reuse-16-03/4782) documents how agricultural areas with a need for reliable water supplies, due to a lack of access to surface water or reduced availability of groundwater, could benefit from combining agricultural reuse with groundwater recharge, resulting in substantial cost savings. The research also covers top concerns, including pathogens, nutrients, salinity, crop risks, and regulations, and offers approaches to address these issues.

Industrial Reuse

Because industrial facilities rely on water for a variety of uses beyond drinking, there is a significant opportunity to use recycled water. And because these facilities can also generate large amounts of wastewater, they have the option of capturing, treating, and reusing their own wastewater for industrial processes or other uses such as landscape irrigation. This means less reliance on outside water sources, which can translate into cost savings and improve community relations. But, because reuse in industrial settings is different than in municipal settings, there are often questions about how to design, construct, and operate these systems. WRF research is targeting these issues, offering guidance and resources to effectively implement industrial reuse projects—with a focus on the unique organizational, regulatory, and motivational issues involved with industrial reuse to help ensure projects align with business strategies.

The 2016 study, *Drivers, Successes, Challenges, and Opportunities for Onsite Industrial Reuse* (Reuse-13-04/1701),

highlights industrial water reuse practices, homing in on the best opportunities based on various industrial sectors, including the food and beverage, oil and gas, and manufacturing sectors, and explains how water reuse can help improve their bottom line. This work was expanded on in the WRF research project *Framework for the Successful Implementation of Onsite Industrial Water Reuse* (Reuse-14-04/1709). Released in 2017, the research identifies elements necessary for developing successful onsite industrial reuse programs and how to achieve a favorable return on investment—an key piece in the project approval process.

More recently, WRF research has also explored how industrial reuse can prove mutually beneficial to both the power industry and wastewater treatment facilities. Particularly in the United States, where up to 80% of power plants are within 10 miles of a wastewater treatment facility, there is a large opportunity to collaborate. Findings from WRF's 2019 report, *Multipurpose Reuse of Reclaimed Water at an Electric Utility and for Wetlands Rehydration in Florida* (Reuse-15-12/4778), provides an overview of tangible benefits to both wastewater and power utilities, barriers that limit joint efforts, and potential risks to both operations. The report evaluates the ability of current treatment technologies to meet water quality requirements for applications, such as cooling towers and boilers, and includes cost estimates for individual treatment process trains.

Onsite Non-Potable Systems

Although there is an increased interest in onsite non-potable reuse, the lack of water-quality or monitoring standards for these systems can make implementing these projects difficult. To help expand the use of onsite non-potable systems, WRF joined forces with the U.S. Water Alliance to establish the National Blue Ribbon Commission for Onsite Non-Potable Water Systems. The commission, which works to advance best practices for non-potable reuse within individual buildings or on local scales, has already released more than a dozen resources.

To further help fill the void, in 2017 WRF released the guidebook *Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems* (SIWM10C15/4632), which lays out a flexible process for developing systems that are reliable, efficient, affordable, and protective of public health. The framework, the result of collaborative efforts between public health and utility leaders, offers a fit-for-purpose approach, looking at site-specific conditions and targeting human health-based goals, which could help inform regulatory conversations.

Potential potable water offset by using non-potable water for toilet and urinal flushing:

25% **Residential Buildings**

75% **Commercial Buildings**

WRF and the U.S. Water Alliance are also moving forward on another newly launched collaborative project, *Onsite Non-Potable Water System: Guidance Manual and Training Modules* (4909). This project is in the process of developing a manual and training program for engineers and operators for design, operations, and monitoring of onsite non-potable water systems. The manual will also be of use to regulators permitting these systems and utilities working with communities to implement them.

Water Reuse Diversification

As water demands shift, many communities are turning to water reuse as an alternate source to keep pace with growing and moving populations. Although water reuse has already found a place in many industries—including agriculture, landscaping, energy production, and industrial and manufacturing processing—WRF research is helping to open up new opportunities. Research is laying the foundation for water reuse to become a bigger piece in a balanced water portfolio through non-traditional applications.

Recycled Water Use in Zoo and Wildlife Facility Settings (Reuse-07-06/1641), released in 2013, chronicles water reuse practices at two-dozen zoos and wildlife facilities in the United States and abroad. The research offers the water sector its first glimpse at the current state of recycled water

use in these settings, which typically operate using large amounts of water. It looks at water quality, treatment technology, current regulations and guidelines, and possible animal health effects. The study outlines potential water quality criteria to support long-term animal health, and helps assess the suitability of recycled water for potential uses at zoos—a first step toward the development of a standard sustainability program that encourages the use of recycled water at these facilities.

Assessing and Communicating Risk

As the use of the recycled water continues to gain momentum, receiving more recognition as a viable and beneficial practice, risk to public health remains a top priority. WRF research has been leading the way in accurately measuring potential risks, as well as helping to communicate results to the public—which is key to expanding these efforts.

To investigate the presence of residual chemicals in recycled water, in 2012 WRF undertook an effort to understand the health effects of these substances, considering factors like exposure pathways and concentrations. *Risk Assessment Study of PPCPs in Non-Potable Recycled Water to Support Public Review* (Reuse-09-07/1665), measures the risk of common pharmaceuticals and personal care products (PPCPs)—starting with a small group of substances like ibuprofen, caffeine, and DEET, as well as some of the top exposure scenarios, such as a golfer playing on a course that uses recycled water. Results showed that risks from PPCPs in water reuse are comparable to risks from the same substances in drinking water, and much less than the levels of these chemicals most people experience through daily exposure. These findings were broken down in a series of easy-to-understand communications pieces, including a video, talking points, and answers to frequently asked questions, which could aid in overcoming negative public perceptions and generating reuse project support.

Along the same lines of research, *Attenuation of PPCPs through Golf Courses Using Recycled Water* (Reuse-08-02/1802) explores the fate and transport of PPCPs in the environment, looking at how these substances behave when applied to turf grass. The multi-year, collaborative project assessed the presence of 15 PPCPs, demonstrating the ability of turf grass to remove up to 98% of PPCPs under most conditions and underscoring the viability of recycled water for irrigation purposes. It also called out key factors that impact how much reclaimed water should be applied, including soil type, turf type, and evapotranspiration rate, providing guidance for turf managers going forward.

LIFT

The Leaders Innovation Forum for Technology (LIFT) is an initiative that helps move water technology to the field quickly and efficiently. Because innovative technologies and processes will play a critical role in making water reuse a sustainable practice, WRF launched the LIFT Water Reuse Focus Group. The group is currently investigating more efficient membranes and other novel treatment processes to decrease energy use and treatment costs, real-time monitoring of contaminants using advanced sensors, and technologies aimed at making water reuse more widespread.

WHAT'S NEXT?

As shifting environmental conditions and other changes raise our reliance on alternate water sources, WRF will continue to provide sound science to support the role non-potable reuse will play in a balanced water portfolio. Although growers have been increasingly turning toward water reuse to meet their irrigation needs, there is still much to learn about agricultural reuse. WRF is helping to fill knowledge gaps with newly launched research like *SAR-Soil Structure Interactions to Provide Management Options for Recycled Water Use in Agriculture* (4963), which hopes to shed light on specific plant-soil interactions after irrigation with recycled water. Another new project, *Assessing the State of Knowledge and Impacts of Recycled Water Irrigation on Agricultural Crops* (4964) is working to develop guidance on growing crops for farmers using recycled water.

As it becomes more important for industries to improve their water management practices, the use of municipal reclaimed water and onsite reuse of industrial wastewater will likely play a larger part. WRF research will remain focused on this critical area, as well as explore the viability—and ensure the safety—of new industrial uses. One ongoing project is studying the emerging area of reusing oil-field produced wastewater for applications such as irrigation. WRF will also look to extend work on onsite reuse in buildings and other applications, continuing to invest in other ways this valuable resource can be used.

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