# Can water reuse save the Colorado?

## *An analysis of wastewater recycling in the Colorado River Basin states*


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**Additional Research: Danielle Sonobe, Emily Tieu, Katherine Mathews, and Julia Wu**



UCLA Institute of the Environment & Sustainability

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Horseshoe bend on the Colorado River (photo credit: Zack Gold).

# Executive Summary

The impacts of climate change and prolonged drought on water scarcity in the Western United States have accelerated since the end of the 20th century. The Colorado River has been strained by a history of excessive withdrawals and long-term drought. Increasingly less water is available across the seven Colorado River Basin states—Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming—for natural ecosystems and the 40 million people that rely, in part or in whole, on its diverted flows to cities and farms. Faced with this challenge, the importance of recycled water at a large scale has never been greater. Water recycling of treated municipal wastewater is a cost-effective source of reliable, sustainable water supply; people shower, flush toilets, and wash clothes and dishes on a regular basis even in times of fluctuating water availability, and these waste flows go to publicly owned treatment works (POTWs) in urban areas.

To assess the current state of water recycling across the Colorado River Basin and its affected states, UCLA Institute of the Environment and Sustainability, in partnership with Natural Resources Defense Council, has investigated water recycling progress and policy development across the seven states in the basin. We analyzed the amount of water entering municipal wastewater treatment plants treating an average of greater than 1 million gallons per day across the 2022 calendar year, the amount these plants reclaim or reuse, and the amount they discharge back into the environment. Our analysis demonstrates that while individual treatment facilities, cities, or even regions may be making substantial progress toward water sustainability, most basin states are falling well short of their potential to reuse wastewater. Overall, the Colorado River Basin states are missing opportunities to ensure a safe, sustainable, climate-resilient supply of water in a hotter, drier future.

While across the Colorado River Basin, an average of 26% of municipal wastewater from POTWs was recycled, there are striking differences between states that are prioritizing reuse and those that are falling behind. Arizona (reusing 52% of treated wastewater) and Nevada (as much as 85%) deserve accolades for their efforts to develop the recycled water supply. California, which produces by far the largest volume of wastewater, only recycled 22% of its treated wastewater in 2022. Of the remaining four states, New Mexico recycles a similarly modest 18%, and Colorado (3.6%), Utah (less than 1%), and Wyoming (3.4%), for a variety of state-specific reasons, have made little to no progress to date on reusing meaningful volumes of treated wastewater. Further and distinct breaks appear to exist between efforts and progress made by states in the lower Colorado River Basin (Arizona, California, and Nevada) and those of the upper basin (Colorado, New Mexico, Utah, and Wyoming).[1] In 2022, the upper basin states as a whole recycled less than 5% of their assessed influent, as compared to more than 30% for the lower basin. (See Figure EX-1 for state-by-state results of our analysis.)

1 The division of the Colorado River is roughly marked by Lees Ferry just below Glen Canyon Dam near the Arizona-Utah border.

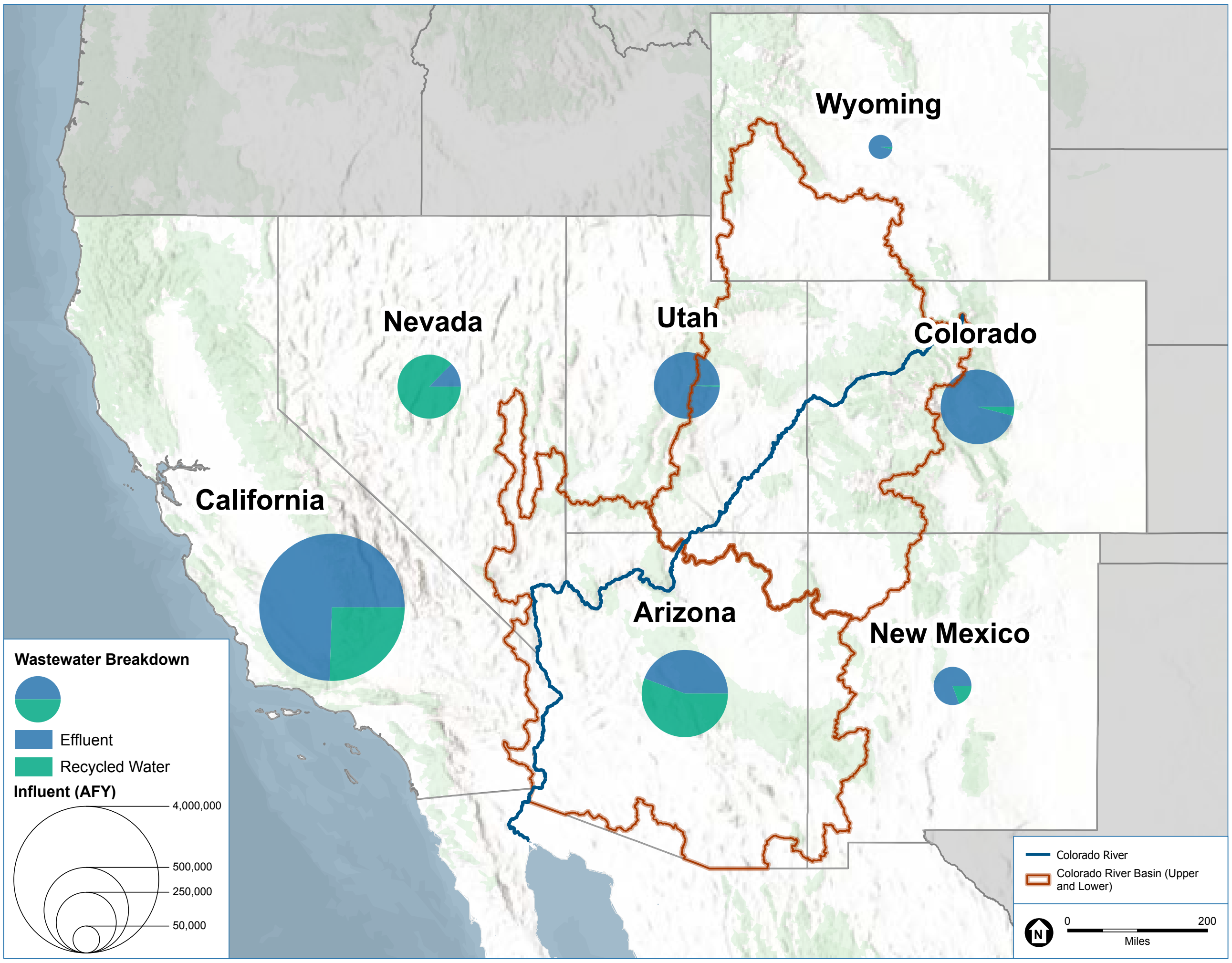


Figure EX-1. Volume of municipal wastewater effluent vs. current reuse by state across the Colorado River Basin for 2022. Totals include figures for the whole state, not only for wastewater generated in the Colorado River watershed.

In addition to the lack of progress on wastewater reuse, the overall lack of data on wastewater recycling, including volume, level of treatment, and end use of the recycled water is also glaring. California maintains the most comprehensive database of recycled water, including its end uses, through the California Open Data Portal (see SWRCB, 2022). While we were able to gather data directly from individual wastewater treatment facilities in other states, determining how much water is being recycled was a significant challenge, and determining how much recycled water is ultimately directed to municipal, agricultural, or industrial users was often limited to qualitative description, if information was available at all.

All of the state results have been achieved in the absence of strong federal recycled water policy or any federal regulation. The lack of federal support for or consistency among state programs has hampered efforts and stands as a significant impediment to further growth of recycled water use. Promoting consistent and growing national water reuse will require action at both the federal and state level.

To this end, through our investigation we have developed a set of recommendations for the U.S. Environmental Protection Agency (EPA) and other federal and state partners and stakeholders. Additional detail and guidance for these recommendations is presented in the main report body and conclusions. These recommendations include the following:

- Within two years, EPA, working with state partners, water agencies, and nongovernmental organizations, should develop a model state program and ordinance for recycling of municipal wastewater with minimum elements.
- EPA should improve data acquisition and management, including developing guidance for standardized facility-level reporting and state data sharing, to ensure availability of information and comparability of data between states.
- EPA should further develop and disseminate the latest science and technical information on treatment processes and pathogen risk assessment for different sources of water and reuse applications.
- In partnership with the states, EPA should develop wastewater reuse goals and timelines.
- EPA—working with other federal agencies including the Bureau of Reclamation and the Departments of Agriculture, Energy, and Defense—should develop and implement funding strategies beyond those already in existence, including furthering the Pilot Program for Alternative Water Source grants.

In addition, our analysis uncovered that, across the Colorado Basin states, inconsistency between programs and overall lack of state-level oversight or even awareness of wastewater recycling efforts in several states is alarming.[2] Recommended improvements needed at the state level for those states without these programs include:

- Work with EPA to establish numeric targets for wastewater reuse for each state, with timelines and interim goals. Figure EX-2 provides a breakdown of the total water supply that would be made available for each state with targeted goals of 30%, 40% or 50% reuse by 2040, a number already exceeded by two of the basin states.
- Work with local water reclamation or reuse agencies to develop funding strategies to meet targets for 30%, 40%, or 50% goals.

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2 The Western States Water Council produced a report, “Water Reuse in the West,” providing an overview of state-level governance of wastewater reuse and state programs in 2021 (Reimer & Bushman, 2021).

- Improve data acquisition and management, as well as reporting requirements where applicable, for wastewater treatment facilities and wastewater reuse operations.

- Conduct assessments of current state legal and regulatory requirements to identify barriers to wastewater reuse and develop formal state policies for overcoming those barriers.

Overall, substantial action needs to be taken to achieve sustainable water management across the Colorado River Basin. Better use of climate modeling, water pricing that does not encourage waste and unreasonable use, stronger water conservation and efficiency programs and requirements for agricultural and urban users, enhanced stormwater capture, greater and longer-term cutbacks in Colorado River water withdrawals, and, critically, a substantial increase in water reuse all must be embraced as climate resiliency solutions.

| State (Current Reuse %) | Treated Wastewater (AFY, 2022) | 30% (AFY) | 40% (AFY) | 50% (AFY) |
|---|---|---|---|---|
| Arizona (52%) | 505,639 | Achieved | Achieved | Achieved |
| California (22%) | 3,311,030 | 993,309 | 1,324,412 | 1,655,515 |
| Colorado (3.6%) | 368,915 | 110,674 | 147,566 | 184,457 |
| Nevada (85%) | 272,586 | Achieved | Achieved | Achieved |
| New Mexico (18%) | 97,222 | 29,167 | 38,889 | 48,611 |
| Utah (<1%) | 294,790 | 88,200 | 117,916 | 147,395 |
| Wyoming (3.3%) | 38,533 | 11,559 | 15,413 | 19,267 |
| Net Water Supply Gain Across States | | 453,776 | 864,866 | 1,275,955 |

Figure EX-2. Recycled water volume created for each state at targeted reuse percentage of 30%, 40%, and 50% of the state's total wastewater influent, with net increase in overall potential available water supply.

As shown in Figure EX-2, if the Colorado Basin states other than Arizona and Nevada were to increase wastewater reuse to even 40% of treated influent it could increase current recycled water availability by nearly 900,000 acre-feet per year (AFY) over current efforts. Reuse of 50% of influent would increase water availability by nearly 1.3 million AFY. This represent a significant percentage of the projected shortfall on the Colorado River, and a solution that should be pursued aggressively to ensure sustainable management of the river.

Hoover Dam and Lake Mead (photo credit: Ryan Thorpe on Unsplash).

# Introduction

On June 14, 2022, the U.S. Bureau of Reclamation (USBR) ordered the seven Colorado River Compact states[3], which share the rapidly dwindling supply of water flowing in the Colorado River, to develop a plan to cut water use in the river basin by between 2 and 4 million acre-feet per year (MAFY). The target, which accounts for about as much as one-third of the river's current annual flow, represents enough water to meet the supply needs of 30 million people annually. The drastic measures followed the federal government declaring a water shortage for Lake Mead in 2021 for the first time ever. Water levels in the lake had dropped more than 150 feet—to less than 40% of the reservoir's capacity—over the two preceding decades. By early 2023, Lake Mead had dropped even further, to just over 28% of capacity. The record low levels followed a century of declining flow in the Colorado River and two decades of drought gripping the southwest U.S. that was the worst in more than 1,200 years (Williams et al., 2022).

Water levels have rebounded somewhat since. Due to a wet winter and well-above-average snowpack across the Colorado River watershed in 2022-2023, water levels in both Lake Mead and Lake Powell, the two largest reservoirs and sources of water in the basin, have begun to climb back up again. After the reservoirs reached record lows in early 2023 (Lake Mead at 1,040 feet of elevation and 28% of capacity, and Lake Powell at 3,521 feet of ele-

3 The Colorado Basin states include Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming.

vation and 22% of capacity), increased snowmelt has been welcome news. November 2024 surface water elevation levels were approximately 1,061 feet above sea level in Lake Mead (32% capacity) and 3,575 feet in Lake Powell (37%).

However, it would take many years of well-above-average snows, coupled with a significant paring back of water withdrawals, for the two reservoirs to fully recover. Current climate projections and increasing volatility do not support assumptions that this will happen (see, e.g., Bass et al., 2023). The long-term climate change outlook suggests that water availability for the Colorado River and states that rely on it is in a severe crisis (Werdann, 2023; SNWA, n.d.). Increasingly less water is available across the seven Colorado Basin states for natural ecosystems and the 40 million people that rely, in part or in whole, on diverted flows to cities and farms.

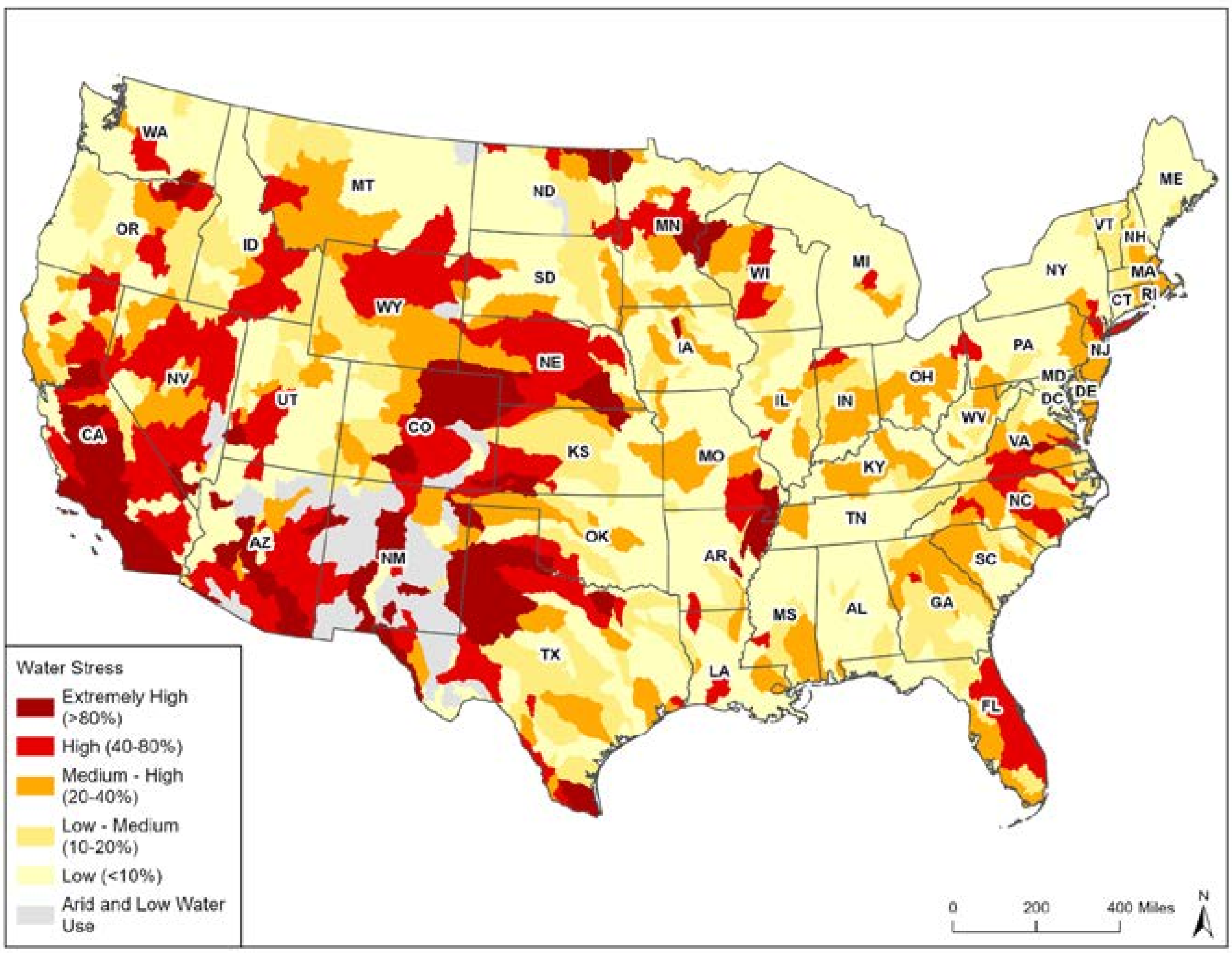



Figure 1. Map of overall water stress for the United States, which "measures the ratio of total water demand to available renewable surface and groundwater supplies." The Colorado River Basin is among the most water stressed regions in the world. (Adapted from Kuzma et al., 2023.)

In early 2024, the USBR approved a supplemental environmental impact statement (SEIS) that functionally adopted a proposal by the lower Colorado River Basin states (California, Arizona, and Nevada) for an average annual reduction of 750,000 acre-feet in withdrawals and a total reduction of 3 MAFY from the Colorado River by the end of 2026, on top of the previously adopted 2007 interim guidelines for Colorado River operations and the 2019 Drought Contingency Plan (see USBR, 2024a). This modest reduction will provide the time needed to develop a post-2026 Colorado River operations plan without additional substantial cuts in the short term. However, the USBR's efforts to work with states, tribes, and Mexico to develop and implement such a plan will determine whether water shortages and environmental harm to the Colorado River will continue to worsen or finally move toward a path of sustainable water management and aquatic resource conservation.

There is currently a deadlock between the upper and lower basin states on needed reductions of Colorado River diversions. Although both the lower and upper basin states agree that up to 3.9 MAFY of reductions in Colorado River diversions are needed to sustainably manage the river and the reservoirs, the basins disagree on how to get there. The lower basin states are offering to cut 1.5 MAFY from their 7.5 MAFY annual allocations, but they want remaining reductions of over 1.5 MAFY to be equitably distributed between the basins. The upper basin states (Colorado, New Mexico, Utah, and Wyoming), averaging 4.5 MAFY of diversions, have stated that they want the lower basin states to provide all flow-diversion reductions. Recently, the USBR announced that it will analyze four alternatives, and the "no action" alternative for the draft final environmental impact statement is expected to be released in spring 2025.

Current approaches to post-2026 Colorado River system management have not focused enough on the need to permanently reduce water demand from the river. The federal focus has been on funding individual projects that provide both temporary and permanent conservation benefits. There has not been a concerted focus on systematic approaches to reduce waste and unreasonable use of Colorado River water supplies. But state and federal water reuse investments at a larger scale could reduce Colorado River consumption by 1 MAFY or more on a permanent basis. Long-term sustainable management of the river will require all parties to embrace multiple strategies, including water reuse, as solutions for Colorado River system operations.

## The Role of Water Reuse

The importance of recycled water at a large scale as a means of addressing this challenge has never been greater. Water recycling, particularly of treated municipal wastewater, is a cost-effective source of reliable, sustainable water supply; people shower, flush toilets and wash clothes and dishes on a regular basis even in times of fluctuating water availability. As California Governor Gavin Newsom's 2020 Water Resilience Portfolio highlighted, "Recycled water is a sustainable, nearly drought-proof supply when used efficiently" (Newsom, 2019). This is particularly compelling to address the loss of freshwater resources that occurs in coastal areas—primarily in California, where wastewater discharge is lost to the ocean—but also for the other four basin states that currently recycle 0 to 18% of their wastewater influent, as allocations from the Colorado River will necessarily be reduced in the years ahead as part of post-2026 operations.

But a lack of consistency and of comprehensive tracking or data collection of wastewater reuse at both the state and federal level pose a serious challenge for assessing how much wastewater is currently being reused by the Colorado Basin states and what purposes it is being reused for. Assessing the potential to reuse water across the basin states poses additional challenges[4].

Based on our review, however, two of the basin states are already reusing more than 50% of the treated municipal wastewater. And states in other parts of the country are achieving similar levels of success. For example, even a decade ago, Florida was reusing approximately 45% of its treated domestic wastewater. Each Colorado Basin state, in collaboration with U.S. Environmental Protection Agency (EPA), the USBR, and other appropriate federal partners, must analyze factors including cost, the need to augment in-stream flows, and the availability of recycled water users and storage infrastructure to assess opportunities to increase reuse.

## Our Analysis

The UCLA Institute of the Environment and Sustainability, in partnership with Natural Resources Defense Council, has investigated water recycling progress and policy development across the seven Colorado Basin states. Our analysis—which includes quantitative assessment of the volume of influent, reuse, and discharge to the environment on a plant-by-plant basis—demonstrates that while individual treatment facilities, cities or even regions may be making substantial progress toward water sustainability, most basin states are falling well short of their potential to reuse wastewater. Overall, the Colorado River Basin states are missing opportunities to ensure a safe, sustainable, climate-resilient supply of water in a hotter, drier future. We provide an overview of current regulation and wastewater reuse outcomes for each basin state, followed by recommendations for states and the federal government at the end of the report.

4 This is in addition to challenges for increasing reuse that have been raised by states, local governments, and water treatment facilities. California, for example, identified a number of existing impediments to water reuse that may be reducing its implementation, primarily focused on lack of funding and lack of infrastructure. Other impediments included lack of recycled water users, which may be influenced by quality of the recycled water, high costs, regulatory or permitting requirements and delays, and challenges for disposal of brine (SWRCB, 2023b). An additional possible hurdle is the feasibility of reverse osmosis for inland communities, where brine disposal may present a challenge, as well as consideration of existing water rights and need for environmental flows.

## The Colorado River Compact, The Law of the River and Unsustainable Water Use

The framework establishing rights to the Colorado River's waters, the Colorado River Compact, was adopted in 1922 by the federal government and seven basin states (though Arizona did not officially sign the agreement until 1944). The compact split management between the upper basin states (Colorado, New Mexico, Utah, and Wyoming) and lower basin (Arizona, California, and Nevada) (see Figure 2), allocating 7.5 MAFY of flow from the river to each. A series of subsequent agreements, treaties and other documents known collectively alongside the compact as the Law of the River govern the overall allocation of waters among the seven states and Mexico. In 1928, the Boulder Canyon Project Act, which authorized the federal impoundment that would later be renamed Hoover Dam set apportionments for the lower basin's 7.5 MAFY as 4.4 MAFY to California, 2.8 MAFY to Arizona and 300,000 AFY to Nevada. Allocations for the upper basin states were established under the Upper Colorado River Basin Compact of 1948 and were set as a percentage of the apportioned flow available each year. Colorado holds rights to 51.75% of upper basin flows, with Utah (23%), Wyoming (14%), and New Mexico (11.25%) receiving lesser volumes (Stern et al., 2024).


Figure 2. Map of the Colorado River Basin showing division between upper and lower basin (USGS, 2016).

The Colorado River Compact was based on a major overestimation of the amount of water available from the river each year. This has made efforts to meet the demands placed on it by irrigation, industry, and an ever-growing population increasingly difficult. Accounting for drought and increasing climate variability, there is simply far less water available for cities, farms and natural ecosystems than there are allocated water rights. Demand typically exceeds supplies by 2 to 4 MAFY. Recently, the lower basin states and upper basin states released draft proposals that agreed on a cap of 3.9 MAFY of water use reductions in the basin. The lower basin states committed to 1.5 MAFY of reductions, with any additional reductions being divided equitably between the upper and lower basin. The upper basin states have proposed that all reductions should fall on the lower basin states, with the logic that the average Colorado River use by upper basin states is closer to 4.5 MAFY than the 7.5 MAFY the compact allows for. The lower basin states generally use all or the vast majority of their allocated 7.5 MAFY (Becker, 2024).

In addition, tribal water rights are extremely significant in the Colorado Basin and have not been memorialized in basin water allocations. Long overdue changes on tribal water rights should be codified as part of the post-2026 Colorado River operations plan. Negotiations with numerous tribes are ongoing, and some recent success have been achieved, but a great deal more needs to be accomplished.

## Methodology and the Challenges of Assessing Wastewater Reuse Across States

In order to assess the current state of water recycling in the West, we sought to obtain data on municipal wastewater treatment facilities, including publicly owned treatment works (POTWs) and larger privately owned facilities. We reviewed current treatment levels and influent, effluent and recycled water volumes. We coupled this analysis with review of water recycling policies across each state, as well as, where feasible, investigation of how the recycled water is being used (e.g., for municipal supply, irrigation, industrial process or other uses). What we quickly discovered was that state efforts—including how states define or characterize water recycling or reuse, whether states are tracking recycled water efforts or progress, or even whether data on recycled water production and use exists at all—vary tremendously across the Colorado River watershed.

## Wastewater Reuse Policy Is Largely Left to the States Without Formal Federal Guidance

In 2012, EPA released a comprehensive, though now outdated, document entitled "Guidelines for Water Reuse" (Stoner et al., 2012). But beyond the broad federal framework this document provides, there are no federal laws that directly control the development or use of recycled water and no formal federal policies or oversight programs[5]. While aspects of the federal Safe Drinking Water Act and Clean Water Act govern operations for wastewater treatment facilities and reuse[6], establishing policy or regulatory schemes for water reuse, as well as establishing relevant standards for water quality or allowable uses, is left largely up to each individual state (EPA & CDM Smith, 2017).

In this vacuum, the seven Colorado River Compact states have developed their own definitions, sets of regulations and policies, and guidance for use of "recycled water" or "water reuse." This has led to a lack of consistent, coherent terminology and standards, which are essential to developing a comprehensive water recycling picture.

The 2021 Infrastructure Investment and Jobs Act provides more than $50 billion for water and wastewater infrastructure improvements across the country between 2022 and 2026. The act also created a federal Interagency Working Group on Water Reuse and will invest $1 billion in funds for water recycling programs for 17 Western states (EPA, 2023). Its recently announced large-scale water recycling projects competitive grants program will provide $450 million over five years. And EPA has developed a National Water Reuse Action Plan (WRAP) to "drive progress on reuse and address local and national barriers across a range of topics including technical, institutional, and financial." But these actions, while greatly needed, do not establish a coherent federal policy or framework for states to build from and still leave the current patchwork of state-by-state regulatory approaches in place. In addition, although $1 billion is a large sum, it is an extremely small fraction of the resources needed to complete currently planned water recycling projects, let alone achieve a 40% water recycling target in each state. Greater funding, action and coordination—beyond the blueprint contained in the WRAP and current patchwork of state-by-state actions and regulatory approaches—is needed.

## What Constitutes "Water Recycling" Varies from State to State

Water recycling, also frequently referred to as water reuse or water reclamation, can take several forms. Categories of water recycling are most broadly broken up as non-potable reuse (including agriculture, industrial and irrigation), indirect potable reuse (IPR, both surface water and groundwater augmentation), and direct potable reuse (DPR). EPA defines the potable practices as:

5 EPA's Regulations and End-Use Specifications Explorer, or REUSExplorer, currently provides summaries of state water reuse regulations and guidelines, though does not provide guidance.

6 For example, the discharge of any pollutant from a point source—such as from a municipal sewage treatment plant or POTW—into a water of the United States requires a discharge permit under the National Pollutant Discharge Elimination System (NPDES) program (see, e.g., 33 USC §§ 1311(a), 1311(b)(1)(B)), 1314(d)(1)).

- IPR: Deliberate augmentation of a drinking water source (surface water or groundwater aquifer) with treated reclaimed water, which provides an environmental buffer prior to subsequent use[7].
- DPR: The introduction of reclaimed water (with or without retention in an engineered storage buffer) directly into a drinking water treatment plant. This includes the treatment of reclaimed water at an advanced wastewater treatment facility for direct distribution (EPA & CDM Smith, 2017).

In short, in IPR wastewater is filtered through an environmental buffer or barrier before being introduced into a drinking water treatment plant, providing some degree of additional treatment. Uses for recycled water may include groundwater storage and recharge, for example, among other possible practices.

But definitions of "reuse"—which may be described as recycling, reclaiming or reusing, depending on the agency involved—can vary substantially between states. For example, the state of Nevada defines "reclaimed water" as "sewage that has been treated by a physical, biological, or chemical process, which is intended for a use specified in" the Nevada Administrative Code (Nev. Admin. Code § 445A.274). However, the state does not maintain any formal database or record of wastewater treatment volumes or POTW operations, or comprehensively track water recycling by Nevada facilities.

Colorado defines "reclaimed water," partly with respect to the treatment level wastewater has received, as:

> Domestic wastewater that has received secondary treatment by a domestic wastewater treatment works (centralized system or a localized system) and such additional treatment as to enable the wastewater to meet the standards for approved uses (5 Colo. Code Regs. § 1002-84.5).

This can be contrasted with California's definition of "recycled water":

> Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource (Cal. Wat. Code § 13050(n)).

However, in contrast with the lack of accounting by Nevada and Colorado entities, California maintains a comprehensive state reporting database for wastewater facilities, including influent, effluent and reuse volumes: a potential model approach for other states. The state then strictly defines what qualifies as "recycled water" under a uniform statewide recycling criteria (see 22 Cal. Code Regs. Div. 4, Ch. 3). The state's definition does not allow

7 We acknowledge the lack of consensus over what percentage of treated effluent making up the overall volume of surface water flow for any water body would result in that body being considered IPR.

de facto reuse (discussed below) to count toward overall recycled water goals or consider water directed to environmental or habitat restoration to meet the definition of recycled water (22 Cal. Code Regs. Div. 4, Ch. 3).

Self-reported wastewater treatment information from individual facilities across the states for the most part also reflected a broad definition of reuse, incorporating not just traditional potable (including IPR and DPR) and non-potable reuse but in some cases also including "unintentional" reuse, sometimes termed de facto reuse. De facto reuse is defined by the National Research Council as:

> A drinking water supply that contains a significant fraction of wastewater effluent, typically from upstream wastewater discharges, although the water supply has not been permitted as a water reuse project (National Research Council, 2012).

In this case, effluent discharged to a surface water, though not a designated reservoir, may be counted as reuse on the theory that the water will be subsequently withdrawn by a downstream community. While this can, in some cases, result in preservation of water supply or stream flow, it does not constitute a planned reuse of water[8].

## End Uses of Treated Wastewater That Constitute Reuse

For purposes of our analysis, we limit our definition of water reuse to projects that serve to offset water demand, whether potable or non-potable. Use of this framework has implications for habitat or environmental restoration projects in other states. These projects can provide habitat and recreational benefits, in addition to removing nutrients for receiving waters and serving as natural filtration systems, and may in some cases serve as a valuable use for treated wastewater. However, while constituting a beneficial use, these projects do not replace potable or non-potable water demand from other sources, and we do not include them in our analysis.

## Definitions of Wastewater Treatment Level Vary by State

Similar to discrepancies over what constitutes recycling, states frequently define treatment levels and processes differently. EPA defines secondary treatment in terms of the "minimum level of effluent quality attainable by secondary treatment in terms of the parameters—BOD5, SS and pH" (NPDES, 2010; see 40 CFR § 133.102 (Table 1)).

8 The EPA recently solicited research on de facto reuse through a National Priorities funding opportunity to "address the knowledge gaps on the impact, risk, and mitigation of de facto reuse in drinking water sources" (EPA, 2024b).

| Parameter | 30-day average | 7-day average |
|---|---|---|
| $BOD_5$ | 30 mg/L | 45 mg/L (or 40 mg/L $CBOD_5$) |
| TSS | 30 mg/L | 45 mg/L |
| $BOD_5$ and TSS removal (concentration) | not less than 85% | — |
| pH | within the limits of 6.0—9.0* | |

* unless the POTW demonstrates that: (1) inorganic chemicals are not added to the waste stream as part of the treatment process; and (2) contributions from industrial sources do not cause the pH of the effluent to be less than 6.0 or greater than 9.0 mg/L = milligrams per liter

Table 1. Secondary treatment standards as defined under 40 CFR § 133.102 (NPDES, 2010).

California defines secondary treatment as:

> A wastewater treatment process that goes beyond primary treatment to remove colloidal and dissolved organic matter and further remove suspended matter, usually by biological processes such as activated sludge and biological filtration treatment.

It defines tertiary treatment as "a wastewater treatment process that goes beyond secondary treatment, which may include filtration, coagulation, and nutrient removal" (23 Cal. Code Regs. § 3671).

Nevada defines tertiary treatment somewhat similarly to California, as "the process of treating wastewater beyond secondary treatment units for nutrient removal or other advanced removal methods, including, without limitation, membrane filtration" (Nev. Admin. Code § 445A.289). However, New Mexico defines both treatment levels with reference to specific contaminants. Secondary treatment is defined as "a reduction of the 5-day biochemical oxygen demand (BOD5) and total suspended solids (TSS) concentrations," while tertiary treatment is "additional treatment beyond secondary treatment standards, specifically, the reduction in the total nitrogen concentration" (NM Code Regs. § 20.7.3.7).

## Methodology

Our assessment focused on analysis of wastewater treatment and discharge from facilities treating an average of greater than 1 million gallons per day (MGD) of municipal wastewater. Our objective was to identify facilities that service larger population centers and that would have the largest potential to produce substantial quantities of water for reuse, to an extent that could affect state water supply considerations. We recognize that this may have the effect of discounting pilot studies or existing, but smaller scale, reuse projects. These projects may provide locally critical supplies of water or serve other highly beneficial purposes but in the aggregate were unlikely to substantially affect a state's overall water supply picture.

Our analysis further follows California's definitions of both water recycling and treatment levels, unless otherwise noted. As stated above, while acknowledging the benefits that habitat or environmental restoration projects can provide, we also limit our definition of water reuse to projects that serve to offset other water supply demand.

Aerial view of the Donald C. Tillman Water Reclamation Plant in Los Angeles. (photo credit: L.A. Sanitation and Environment).

Completing the assessment of recycled water efforts across states was initially complicated by differences in state regulatory structures and overall policy toward reuse. For example, some states regulate and permit aquifer discharge or injection from wastewater facilities wholly separate from surface water discharge or above ground direct reuse. For some states, aquifer or groundwater discharge may be regulated directly by EPA through its underground injection control program. States also have drastically different requirements for reporting wastewater treatment and reuse volumes and varying systems for tracking or making public the data—if they collect or maintain data at all. These issues posed a substantial challenge to the analysis, including for obtaining data on influent, effluent, and reuse volumes for individual facilities and, in many cases, for even identifying wastewater facilities in the first place.

Online data sources, when present and whether state or federal, frequently proved incomplete and unreliable. The EPA operates its Enforcement and Compliance History Online (ECHO) public database, which maintains "EPA and state data for more than 800,000 regulated facilities" with inspection, violation, and enforcement data for the Clean Water

Act and data from the Safe Drinking Water Act, among other programs. While some states party to the Colorado River Compact maintain their own database or databases of wastewater treatment operations and water recycling within their boundaries, others, like New Mexico, rely almost exclusively on facility reporting to the ECHO data portal[9].

ECHO's wastewater information, however, is widely regarded as problematic. A 2021 report by the Government Accountability Office (GAO) found, for example, that "changes in state NPDES [National Pollutant Discharge Elimination System] compliance and enforcement activities since 2015 cannot be clearly identified because of problems with the reliability of data that states report to EPA" (GAO, 2021). The report further found that:

> EPA's disclosures of limitations relating to the accuracy and completeness of state data are unclear because they are posted on multiple webpages across the ECHO website, resulting in a dispersed set of information that is also incomplete and outdated (GAO, 2021).

With specific respect to states considered for this report, the ECHO database has flagged a known problem with data for Wyoming, issuing a

> Primary Data Alert: Wyoming is experiencing issues affecting the upload of data to the national program system. . . . Discharge Monitoring Report and facility compliance status data displayed on ECHO may not be accurate . . . . (Updated October 2017).

This often left direct contact with individual wastewater treatment facilities as the only available source of recent treatment and recycled water data. But relying on data reported from individual plants meant we also received data based on varying interpretations of what constituted reuse or recycling.

For example, several states, including California and Arizona, include treated wastewater that is directed to groundwater recharge within their definition of recycled water. While we include groundwater or aquifer recharge under the definition of recycled water used for this report, differences in hydrology between individual aquifers or groundwater basins make it difficult in many cases to accurately quantify the volume of wastewater that will ultimately be available for reuse. Other treatment facilities included environmental restoration in their volume calculations for recycled water, which were removed from our analysis under our definition of reuse as described above. And others simply never responded to our requests for information.

9 EPA conducts its Clean Watershed Needs Survey every four years, pursuant to sections 205(a) and 516 of the Clean Water Act (33 USC § 1375), which included some preliminary, though not comprehensive, data on reuse in its last iteration.

We also encountered significant challenges to obtaining data on the end uses of recycled water. With the exception of California, which maintains a comprehensive database of recycled water through the California Open Data Portal (see SWRCB, 2022), contact with individual wastewater treatment facilities often remained the only available source of recent treatment and recycled water data. As a result, determining how much recycled water is ultimately directed to municipal, agricultural or industrial users was often limited to more qualitative description, if information was available at all. There is substantial opportunity to expand recycled water use—in particular for agricultural irrigation—but the lack of adequate data on current use serves as a barrier to further expansion.

Ultimately, this report presents an extensive though incomplete picture of wastewater reuse in the Colorado River Basin. Below are state-by-state overviews and analysis.

The Arizona Canal near Scottsdale, Arizona (photo credit: Carol M. Highsmith Archive, Library of Congress, Prints and Photographs Division).

# States in the Colorado Basin

## Arizona

### *Statewide wastewater reuse: 52%*

***Arizona can rightly call itself a leader in development and use of recycled water among basin states, but questions over the sustainability or suitability of some of its large-scale reuse efforts reduce its overall impact.***

Arizona's current drought, which began in the mid-1990s, is the worst in the state's 110-year recordkeeping history (City of Phoenix, n.d.-a.; ADWR, n.d.-b). The state's long-term average annual precipitation is only 12.26 inches, marking Arizona as one of the driest states in the country. However, precipitation varies both spatially, according to the state's diverse topography, and temporally, with a high of 22.8 inches in 1905 and a low of 6.0 inches in 1956 (Arizona State Climate Office, n.d.). Since 1991, average annual precipitation has been decreasing at a rate of 0.92 inches per decade (see Figure 3).

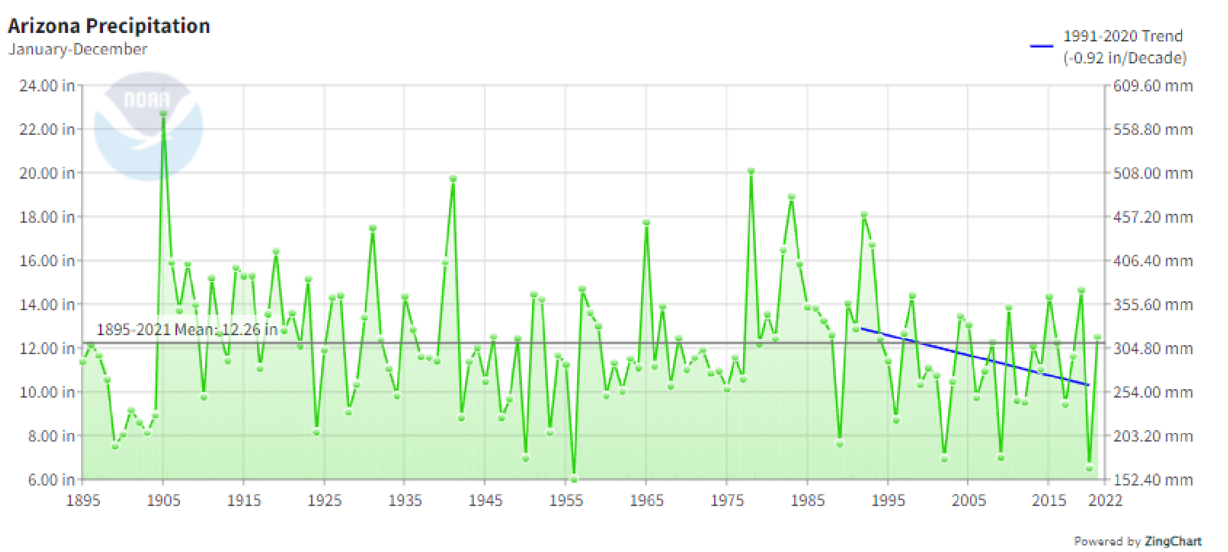



Figure 3. Average annual precipitation in Arizona, showing a steady decrease since the early 1990s across the state's current 20-year drought (Arizona State Climate Office, n.d.).

Arizona is one of the ten fastest growing states in the country, with its population increasing by 11.9% between 2010 and 2020 (U.S. Census Bureau, 2021; ADWR, 2020). Maricopa County, home to the Phoenix metropolitan area, had the highest population increase in the nation between 2021 and 2022 (O'Kray-Murphy et al., 2023). In addition to placing pressure on surface water resources, the increase in population and drought has resulted in more reliance on groundwater. In 1980, Arizona adopted a state Groundwater Management Act, which requires developers in urban areas under the state's Assured and Adequate Water Supply programs to show they have a 100-year supply of water available (see AAC R12-15-716 et. seq.). As a result of increasing strain on groundwater resources, planned developments in the Phoenix area that rely exclusively on groundwater may fail to obtain necessary approvals due to the state's finding that the region "will experience 4.86 million acre-feet (maf) of unmet demand for groundwater supplies," approximately 4% of the total cumulative demand, over the next 100 years (ADWR, n.d.-c).

The most recent data published by Arizona Department of Water Resources (ADWR) reports that Arizona used an average of approximately 7 MAFY of water since 2017[10].

10 We note that current, accurate data on per capita residential (or nonagricultural) water use is generally not available across the Colorado Basin states. The last comprehensive assessment of U.S. water use was completed by the U.S. Geological Survey for 2015 (Dieter et al., 2018). Both EPA (2024a) and the states (see, e.g., ADWR, n.d.-d) routinely cite to this data despite its being nearly a decade old. At least as of 2015, Arizona (average of 145 gal/day), Colorado (123), Nevada (126), Utah (169), and Wyoming (169) held five of the top seven states for per capita usage, with only Idaho (184) residents using a higher volume than Utah, and Hawaii (144) rounding out the list. Both California (86) and New Mexico (81) showed more moderate usage, but the values do not reflect changed conditions or policy initiatives enacted over the past ten years, and the lack of current information renders assessment of water sustainability needs a challenge.

Arizona's water supply portfolio consists of four main sources: groundwater, the Colorado River, other in-state surface waters, and reclaimed water (ADWR, 2020; Miller, 2018). In 2020, local groundwater contributed 41% of the state's water, while the Colorado River, other in-state surface waters, and reclaimed water constituted 36%, 18%, and 5% of the water supply respectively (ADWR, 2020).

Although Arizona signed the Colorado River Compact with the six other basin states in 1922, it did not actually ratify it until 1944 (Stern et al., 2024). Along with California and Nevada, Arizona saw its allocation established in 1928 under the Boulder Canyon Project Act. Arizona's annual allotment calls for 37.3% of the lower basin's 7.5 MAFY: 2.8 MAFY (Stern et al., 2024). Consumptive use of Colorado River water for 2022 was reported as 2,014,176 acre-feet. (USBR, 2023).

## Regulatory Background

Arizona's water resources are governed by the ADWR, Arizona Department of Environmental Quality (ADEQ), and the Arizona Corporation Commission.

ADEQ was created in 1987 to administer Arizona's environmental protection programs. It takes primary responsibility for the drafting and monitoring of programs and regulations related to water treatment and reuse, including water reuse regulations that cover IPR and DPR in the state. Separate internal divisions within ADEQ oversee the permitting and regulation of both surface waters and groundwater. This includes the administration of Arizona Pollutant Discharge Elimination System (AZPDES) permits, the state's surface water discharge program under the federal Clean Water Act, and Aquifer Protection Permits, the state's groundwater discharge regulation (ADEQ, 2016). ADEQ also administers the state's direct reuse permits under Type 2 Reclaimed Water General Permits and Recycled Water Individual Permits. Privately owned wastewater treatment plants are additionally regulated by the Arizona Corporation Commission. More broadly, ADWR is responsible for ensuring the long-term sustainability of Arizona's water supply and is tasked with overall water supply planning and aquifer level monitoring, among other roles (ADWR, n.d.-a).

## Water Reuse in Arizona

Reclaimed water is defined by the state legislature as "water that has been treated or processed by a wastewater treatment plant or an on-site wastewater treatment facility," while recycled water is defined as

> a processed water that originated as a waste or discarded water, including reclaimed water and gray water, for which the Department has designated water quality specifications to allow the water to be used as a supply (ADEQ, 2023 (AAC § 18-9-A701(14))).

Critically, a 1989 court decision by the Arizona Supreme Court held that reclaimed water should be treated separately from the state's surface water and groundwater resources, even when the reclaimed water was originally taken from those sources. According to the Arizona court, effluent (or reclaimed water) is owned by the entity that generates it, at least until the reclaimed water is discharged back to a qualifying surface water (*Arizona Public Service Co. v. Long*, 1989). This has the effect of eliminating water rights claims that could hinder use or sale of reclaimed water, almost the opposite of the situation in Colorado, discussed further below.

Direct reuse is defined by the state as the beneficial use of reclaimed water for one of a predetermined set of purposes explicitly outlined in Title 18 of the Arizona Administrative Code (AAC) (ADEQ, 2023 (AAC § 18-11, Art. 3, Table A); see Table 2). ADEQ may approve unlisted types of direct reuse on a case-by-case basis (ADEQ, 2023). ADEQ is currently engaged in a stakeholder rulemaking process for advanced water purification with the intent of "expanding its water reuse programs . . . through the development of regulations for the reuse of treated municipal wastewater as drinking water" (ADEQ, 2023).

The Palo Verde Generating Station near Tonopah, Arizona. (photo credit: photo from LinkedIn).

| Type of Direct Reuse | Minimum Class of Reclaimed Water Required |
|---|---|
| Irrigation of food crops | A |
| Recreational impoundments | A |
| Residential landscape irrigation | A |
| Schoolground landscape irrigation | A |
| Open access landscape irrigation | A |
| Toilet and urinal flushing | A |
| Fire protection systems | A |
| Spray irrigation of an orchard or vineyard | A |
| Commercial closed loop air conditioning systems | A |
| Vehicle and equipment washing (does not include self-service vehicle washes) | A |
| Snowmaking | A |
| Surface irrigation of an orchard or vineyard | B |
| Golf course irrigation | B |
| Restricted access landscape irrigation | B |
| Landscape impoundment | B |
| Dust control | B |
| Soil compaction and similar construction activities | B |
| Pasture for milking animals | B |
| Livestock watering (dairy animals) | B |
| Concrete and cement mixing | B |
| Materials washing and sieving | B |
| Street cleaning | B |
| Pasture for non-dairy animals | C |
| Livestock watering (non-dairy animals) | C |
| Irrigation of sod farms | C |
| Irrigation of fiber, seed, forage, and similar crops | C |
| Silviculture | C |

Table 2. Minimum reclaimed water quality requirements for direct reuse, specifying beneficial uses authorized for wastewater reuse (AAC § 18-11, Art. 3, Table A).

Reclaimed water is categorized by the technologies that are used to treat the wastewater, as well as the pathogen and microbial content of the resulting water. Based on these factors, the water receives a class categorization, with Class A+ being the highest quality and Class C being the lowest that is approved for reuse. Treatment requirements are as follows (AAC §§ 18-11-303-307).

- For Class A+ water: secondary treatment, filtration, nitrogen removal treatment and disinfection
- For Class A water: secondary treatment, filtration and disinfection
- For Class B water: secondary treatment and disinfection
- For Class C water: secondary treatment, with or without disinfection

A table detailing water quality limits for each reclaimed water class can be found as Table 3, below.

| Recycled Water Class | Treatment Process (Minimum) | Recycled Water Standards | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Turbidity | | Microbial | | | Total Nitrogen |
| | | BOD5 | TSS | 24 Hr Avg | Any Time | Fecal Coliform (FC) | | Enteric Virus | |
| | | (mg/L) | (mg/L) | (NTU) | (NTU) | Daily conc. (cfu/100mL) | Max conc. (cfu/100mL) | Blended water | (mg/L) |
| Class A+ | Secondary treatment + Filtration + Nitrogen Removal + Disinfection | NS | NS | ≤ 2 | ≤ 5 | No detectable FC in 4 of last 7 daily samples | ≤ 23/100 mL | No detectable enteric virus in 4 of last 7 monthly samples | 5-sample geometric mean conc. Less than 10 mg/L |
| Class A | Secondary treatment + Filtration + Disinfection | NS | NS | ≤ 2 | ≤ 5 | No detectable FC in 4 of last 7 daily samples | ≤ 23/100 mL | No detectable enteric virus in 4 of last 7 monthly samples | NS |
| Class B+ | Secondary treatment + Nitrogen Removal + Disinfection | NS | NS | NS | NS | ≤ 200/100 mlL in 4 of last 7 daily samples | ≤800/100 mL | NS | 5-sample geometric mean conc. Less than 10 mg/L |
| Class B | Secondary treatment + Disinfection | NS | NS | NS | NS | ≤ 200/100 mlL in 4 of last 7 daily samples | ≤800/100 mL | NS | NS |
| Class C | Secondary treatment (stabilization pond + aeration) + With or w/o disinfection [Retention time in stabilization pond >20 days] | NS | NS | NS | NS | ≤ 1000/100 mL in 4 of last 7 daily samples | ≤ 4000/100 mL | NS | NS |

NS = Not Specified

Source:
Arizona Administrative Code (AAC) Title 18 - Environmental Quality - http://www.azsos.gov/public_services/Title_18/18_table.htm

Chapter 9, Article 7: Direct Reuse of Reclaimed Water: http://www.azsos.gov/public_services/Title_ 18/18-09.htm
Chapter 11, Article 3: Reclaimed Water Quality Standards: http://www.azsos.gov/public_services/Title_18/18-11.htm

Table 3. Each type of beneficial use for reclaimed water is assigned a minimum class of water that may be used (Rock et al., 2012). State listed beneficial uses and their corresponding minimum treatment levels can be found in Table 2.

## Wastewater Reuse Data

Data on POTWs and other urban wastewater treatment facilities in Arizona was compiled from a combination of EPA's NPDES database; available AZPDES permits and ADEQ's dataset; Arizona State University's Arizona Water Blueprint mapping project, which maintains a list of wastewater treatment facilities in the state and their treatment capacity; and then a search of Arizona's 50 largest census-designated jurisdictions to incorporate any additional wastewater treatment facilities not included in the listed datasets. As discussed below, a number of factors presented a challenge for even properly identifying a full set of wastewater treatment plants operating in the state.

A 2017 report from the Environmental Finance Center at the University of North Carolina at Chapel Hill (UNC) estimated that there are 131 POTWs operating in Arizona, 81 of which treat 1 MGD or less (UNC Environmental Finance Center, 2017). Because Arizona maintains authority for administering the federal NPDES program through issuing its own AZPDES permits for facilities in the state, the majority of permitted facilities did not appear in the EPA NPDES permit database (EPA, 2015a). Problematically for our analysis, a substantial number of wastewater treatment facilities in Arizona also do not discharge to surface waters but rather use all of their treated effluent for reuse or inject wastewater to belowground aquifers for groundwater recharge and thus do not require an AZPDES permit. Wastewater facilities are required to obtain an Aquifer Protection Permit for water that is injected into groundwater or is reasonably expected to reach an aquifer.

We requested data from ADEQ on influent, effluent and reuse volumes, among other metrics, for all water treatment facilities in the state. While the agency was generally responsive to our requests, ADEQ stated that it did not currently have the level of database functionality necessary to provide a full response and noted that the data it did provide came with complications. The agency stated that it had "450 permitted facilities, over 500 reclaim permits" and that the information it provided was "raw data and comes with QA/QC issues that would need to be independently reviewed" (ADEQ, pers. comm.).

After review of available state and federal data, we contacted 36 different jurisdictions, including county and municipal agency personnel, for information on their facilities' average or total treatment, discharge, and reuse volumes, as well as the level of treatment or technologies used and designated uses of recycled water if reuse occurred. We received responses from 26 of these jurisdictions, covering approximately 40 different facilities. The data included both private facilities that we did not review and facilities processing under 1 MGD of influent, and in some cases collated values for multiple facilities serving the same jurisdiction. Ultimately, we were able to obtain partial or complete data for 13 of the 15 largest census-designated jurisdictions in the state that utilize public providers for their wastewater, including the greater Phoenix, Tucson, and Flagstaff regions. As a result, our analysis likely presents an incomplete picture of the state's wastewater treatment processes.

The 2017 UNC study estimated that approximately 77% of the population was served by a POTW in 2016 (UNC Environmental Finance Center, 2017). We conclude that our assessment covers more than 80% of the state's municipal wastewater based on population and incorporates its three largest municipalities.

## Wastewater Reuse Analysis

Arizona touts itself as one of the country's leaders in water management and planning, while making assurances that it will continue to provide a reliable supply of water for the future (Hirt et al., 2017). Self-reported data from the jurisdictions we surveyed in part bears this out: Of the 505,639 acre-feet of wastewater influent reported by the 26 facilities that provided data for this analysis, the facilities claimed that they recycle nearly 400,000 acre-feet of water annually, approximately 78% of the total influent. Under detailed review of the data, however, the vast majority of claimed reuse stems from two projects in the Phoenix region: reclamation to supply the Tres Rios Environmental Restoration project, and cooling water supply for the Palo Verde Nuclear Generating Station. As discussed below, use of reclaimed wastewater by the Palo Verde station avoids withdrawal of some 72,000 acre-feet of freshwater per year. This amount of water savings is plainly beneficial for a water-stressed state like Arizona. However, the recycled water consumed as cooling water by the Palo Verde plant also raises significant questions as to the sustainability of this use. And under the definition of "recycled water" employed for this analysis, the Tres Rios project does not qualify as reuse because it was constructed predominantly as a nature-based solution to reduce nutrients in the downstream receiving waters of the Salt River. Despite its benefits, this project does not directly replace need for potable water supply.

Removing the effluent allocated to the Tres Rios project from the state's reuse portfolio reduces Arizona's overall reuse total to 264,304 AFY, a still noteworthy 52% of assessed influent. Despite some additional potential for discrepancy between facilities over the definition of reuse, this percentage far exceeded all other Colorado Compact states—with the exception of Nevada, discussed further below.

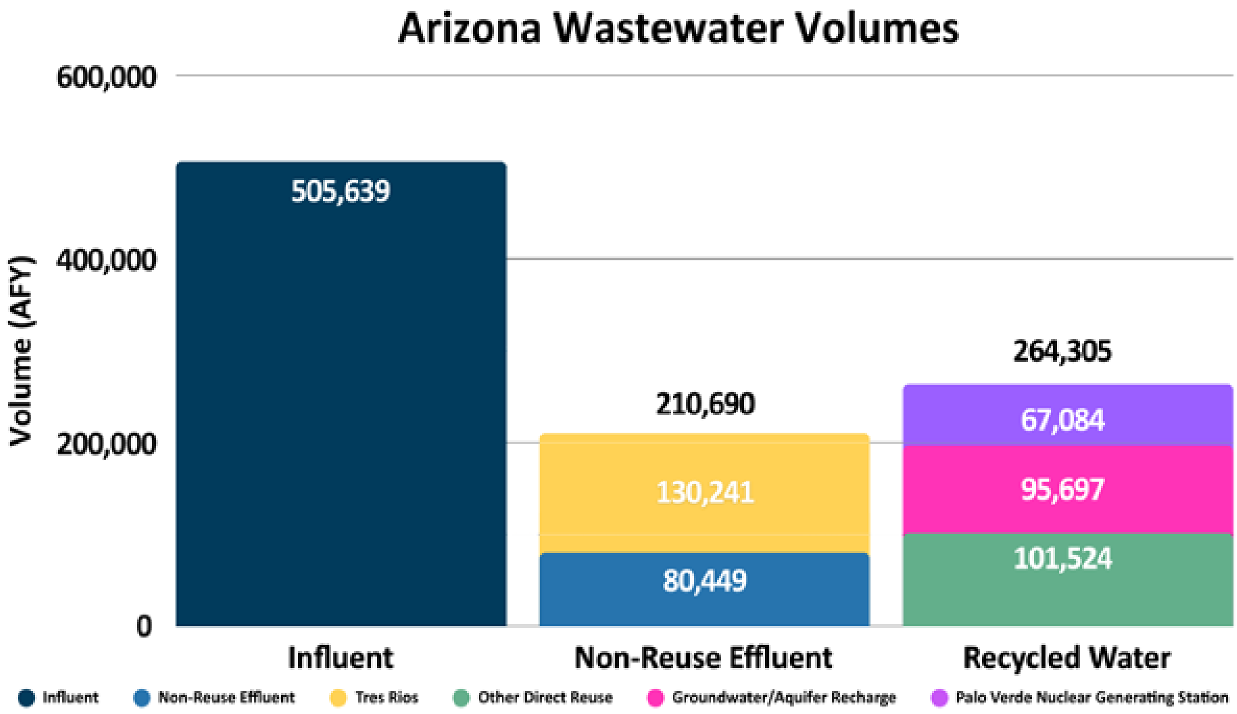



Figure 4. Arizona wastewater volumes, based on 2022 data.

As shown in Figure 4, 25% of the reuse total is ultimately evaporated and consumed as cooling water for the Palo Verde Nuclear Generating Station, and 36% is diverted for aquifer recharge, with an unknown volume actually becoming available for reuse elsewhere. As much as 130,000 AFY of effluent from Phoenix area wastewater facilities, 25% of the total influent we assessed in Arizona, is used to supply the Tres Rios wetlands project (see Figure 5), a nearly 700-acre water quality and habitat restoration project that ultimately discharges to the Salt River (City of Phoenix, n.d.-b). The Tres Rios project is a constructed wetlands built near the confluence of the Salt, Gila and Agua Fria Rivers to the southwest of Phoenix in the 1990s. The project was developed as an alternative compliance approach for meeting nutrient standards for effluent from the Phoenix region and additionally restored riparian habitat that had been lost to urban and agricultural development (Elkins, 2011; Brown et al., 2011).

Although the Tres Rios project is an innovative, nature-based, multi-benefit facility, it was not constructed to offset existing water demand. Though staff we contacted for Phoenix area wastewater treatment facilities—as well as other regulators we spoke to in Arizona—considered the project to be "reuse," this purpose does not meet our definition. Further, effluent that is routed through the Tres Rios wetlands is ultimately discharged back to the Salt River. While this process provides flood control and habitat benefits, and significant volumes of the water may subsequently be withdrawn from the river for agricultural irrigation use, the pathway best fits the description of de facto reuse and showcases the need for clearer and more consistent water reuse definitions and regulatory frameworks between states.

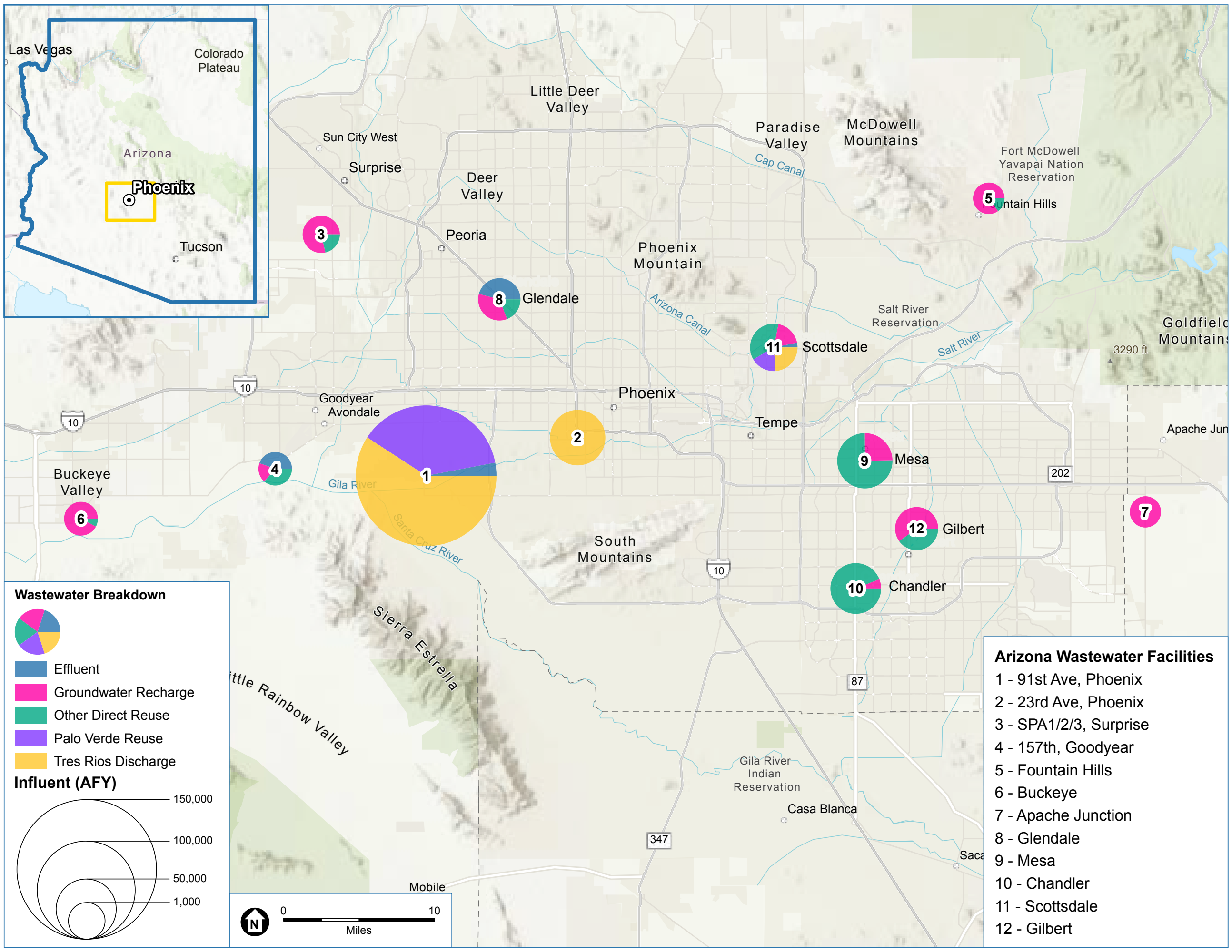



Figure 5. Individual wastewater facility water budgets in the greater Phoenix area.

A similarly high percentage of the Phoenix region's wastewater is diverted to the Palo Verde Nuclear Generating Station. The plant, located roughly 55 miles to the west of Phoenix, is the largest single-site nuclear facility in the country. It generates 32,000,000 megawatt-hours of electricity each year, approximately 80% of the output of Hoover Dam. The Palo Verde facility relies heavily on recycled wastewater for cooling purposes. Under full load reactor conditions, the plant evaporates approximately 45,000 gallons per minute, with an average water demand of approximately 72,000 acre-feet per year (AFY).

The generating station is a "zero-liquid-discharge facility," meaning all of the water conveyed to the facility is eventually evaporated on site and is therefore unavailable for additional beneficial use (Middleton et al., 2021). While the use is beneficial and replaces demand for other supply of cooling water (see, e.g., Fleischli & Hayat, 2014), meeting our definition of reuse, it is notable that such a large proportion of the water from the Phoenix area is ultimately lost to evaporation. Interestingly, as a result of the rising cost of recycled water from Phoenix's 91st Avenue Wastewater Treatment Plant, the generating station is investigating alternate sources for cooling water, including potentially a dry-cooling pilot project (AP, 2022). This could open opportunities to use some or all of the roughly 70,000 AFY of recycled water currently employed by the plant to offset other water supply needs in the region.

Overall, Phoenix is embracing use of advanced wastewater treatment for water supply. The City has proposed two future indirect potable reuse projects, which may include a DPR component. The Cave Creek Water Reclamation Plant rehabilitation project could provide up to 7 MGD of recycled water using advanced treatment by 2027 or 2028, with potential for further expansion. The 91st Avenue Wastewater Treatment Plant rehabilitation and expansion project could provide 50 to 80 MGD of advanced treated water by recapturing effluent flows sent to the Tres Rios project that would otherwise be discharged into the Salt River. The combined increase in available recycled water could be enough to supply more than 150,000 homes. (City of Phoenix, n.d.-c; City of Phoenix Water Services Dept., pers. comm.)

Finally, 95,697 AFY (or 36% of Arizona's total assessed reuse) is designated for aquifer recharge. As discussed earlier, this renders it difficult to assess what percentage of the water actually becomes available for reuse. However, given the widespread use of recharge as a recycled water goal, we include that total here and for the other basin states.

Ira J. Chrisman Wind Gap Pumping Plant (photo credit: Department of Water Resources).

## California

### *Statewide wastewater reuse: 22.5%*

***California leads the Colorado River Basin states in overall volume of recycled water use, but given the similarly vast amount of wastewater the state produces, it has missed opportunities to develop reuse as a resource.***

California's most recent drought period from 2020 to 2022 was the state's driest three-year period on record. The previous driest period spanned from 2013 to 2015. The droughts were followed by two of the state's wettest years on record, in 2017 and 2023 (much of California received near-normal precipitation for 2024). (Witherow, 2022; CA Department of Water Resources, 2022; Sheffield & Kalansky, 2024). The increasing variability and climate whiplash has exposed the inadequacies of the state's water management approach, which was developed in the early and mid-20th century based on historical precipitation and flows.

One of the challenges California faces is that 75% of the state's water supply comes from rain and snow runoff from watersheds north of Sacramento; the Sierra Nevada snowpack serves each year as California's largest surface water reservoir. But 80% of the water demand comes from the southern two-thirds of the state, resulting in complex water distribution infrastructure issues. California is the most populous state in the country, and of its 39 million residents, nearly 24 million live in the southern, generally more arid region of the state (CA Department of Finance, 2023). The state utilizes approximately 40 MAFY of water, with around 8 MAFY going to urban uses and a little over 32 MAFY going to agricultural uses (Newsom et al., 2023). Groundwater overdraft leading to wells running dry has deprived vulnerable communities of the human right to water. Subsidence, seawater intrusion, groundwater contamination, and loss of aquifer storage capacity are additional consequences stemming from an overall lack of sustainable groundwater management. The growing climate crisis—exemplified by the two major droughts in the last decade and extreme swings in temperature, snowpack volume, and overall precipitation—has demonstrated the vulnerability of the state's water supply approach. Long-simmering tensions between agriculture and urban users over water rights are escalating in California, and the biggest losers are the biodiversity in the state's rivers, watersheds, and wetlands and its recreational and commercial fisheries.

California receives the largest allotment of water from the Colorado River of any state, 4.4 MAFY (58.7% of the lower basin's 7.5 MAFY total). Of that, 3.85 MAFY is allotted to agricultural irrigation districts: the Imperial Irrigation District (3.1 MAFY), Coachella Valley Water District (433,000 AFY), and Palo Verde Irrigation District (317,000 AFY). The Metropolitan Water District has a 550,000 AFY water right for its over 19 million predominantly urban customers. As a result of additional apportionments, largely from system conservation water, the state's total consumptive use of Colorado River water for 2022 was reported as 4,424,247 acre-feet (U.S. Department of the Interior, 2023).

## Regulatory Background

The California State Water Resources Control Board (SWRCB) administers the Clean Water Act in California and "set[s] statewide water quality standards, issuing statewide general permits, conducting statewide surface and groundwater monitoring assessments, and issuing orders for contaminated sites." Any new diversion of water requires a state water permit. Loans and grants are also provided through the SWRCB to promote pollution cleanup and safe drinking water. Nine regional water quality control boards make decisions for their respective regions by "setting standards, issuing waste discharge requirements, determining compliance, and taking appropriate enforcement actions" (SWRCB, 2019). A map of the regional boards is provided below as Figure 6.


Figure 6. Map of California's nine regional water quality control boards (SWRCB, 2024a).

The SWRCB's Division of Drinking Water additionally regulates public water supply systems in California, through conducting inspections, issuing permits, determining compliance with the federal Safe Drinking Water Act, and enforcement. The division additionally is responsible for integration of recycled water with potable water uses.

Finally, the Department of Water Resources manages the state's water resources and infrastructure, including the State Water Project, which spans more than 700 miles and provides flood control, hydroelectric power generation, recreational opportunities, and water supply to 750,000 acres of farmland, the Metropolitan Water District of Southern California and its suppliers, and to urban areas in the San Joaquin Valley (CA Department of Water Resources, n.d.-a). The Department of Water Resources also develops the California Water Plan, a strategic plan and reference document that is updated every five years. At the federal level, the USBR operates the Central Valley Project, which supplies an average of 5 MAFY to farmland and 600,000 AFY for municipal and industrial users in the Central Valley of California (USBR, 2024b).

# Water Reuse in California

## OVERVIEW

California adopted a recycled water policy in 2009 with a stated objective of increasing "the acceptance and promoting the use of recycled water [as] a means towards achieving sustainable local water supplies" (SWRCB, 2009). The policy set a goal of developing 1.5 MAFY of recycled water by 2020 and 2.5 MAFY by 2030. Yet there has been little substantial progress on recycled water volumes in California in the last 14 years. Despite passage of the recycled water policy, water reuse reported by the state has only increased to 749,317 AFY as of 2022, far short of the state's 1.5 MAFY goal (SWRCB, 2022; see Figure 7).[11]

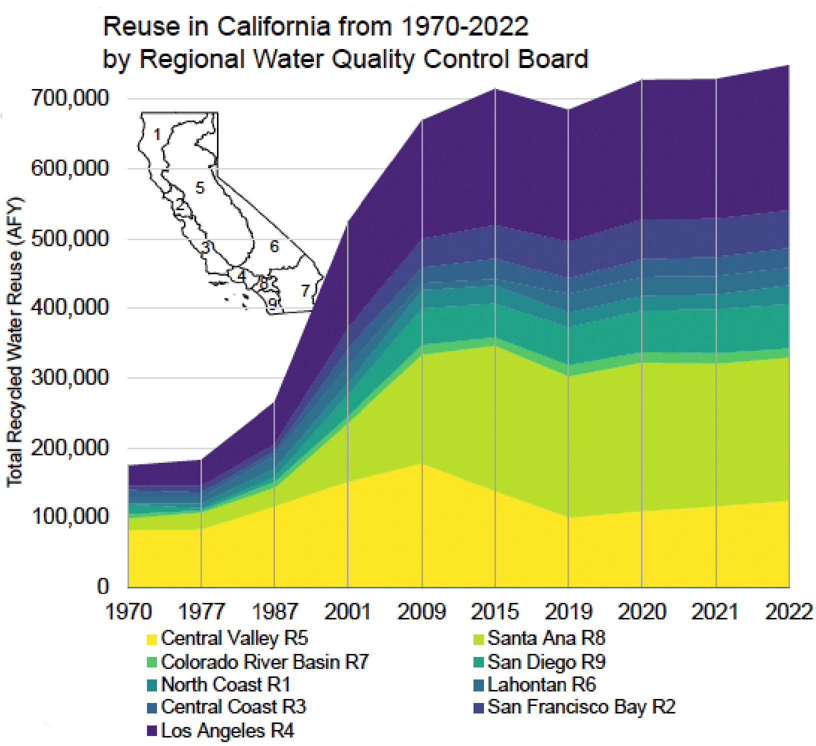



Figure 7. Historical water reuse volumes for California regional water quality control board regions from 1970 through 2022 (SWRCB, 2022b).

In 2022, Governor Newsom released "California's Water Supply Strategy: Adapting to a Hotter, Drier Future." The document states, "We know that hotter and drier weather could diminish our existing water supply by up to 10% by 2040. So we are taking action" (CA Natural Resources Agency et al., 2022). But despite taking an "all of the above" approach to water management that includes both gray infrastructure storage projects and sustainable surface and groundwater management approaches that emphasize nature-based solutions, the 2022 strategy effectively abandoned the state's earlier and more ambitious recycled

11 The methodology used in the state's volumetric annual report changed significantly post-2019, and so does not allow for easy comparison with earlier surveys or with data collected prior to passage of the recycled water policy.

water targets. The 2022 policy replaced the 1.5 MAFY and 2.5 MAFY targets with goals of recycling at least 800,000 AFY by 2030—barely a step above the self-reported total use of 749,000 AFY in 2022—and 1.8 MAFY by 2040. It is a substantial step back (CA Natural Resources Agency et al., 2022).[12]

Reverse osmosis units at the Orange County Water District's Groundwater Replenishment System plant. (photo credit: Orange County Water District).

The Orange County Sanitation Districts and the Los Angeles County Sanitation Districts (LACSD) have been national water recycling leaders for decades. However, since 2009, limited progress has been made in most of the state's most populous areas. Water reuse in Region 4, which includes LA and Ventura counties, increased by 40,000 AFY, nearly 25% over the 13-year period, and reuse in Region 8, which includes north Orange County and has a long, successful history of IPR through groundwater injection and recharge, increased by more than 50,000 AFY or a 33% rise. However, reuse in Region 2, covering the San Francisco Bay Area, has risen by only 6,000 AFY to 54,360 AFY in 2022, and lags far behind Southern California's efforts. Other regions in the state (Regions 1, 3, 6 and 7) have only minimal to modest water reuse efforts.

12 We note that the state estimates that for efforts to meet its goal of 2.5 MAFY in wastewater reuse, the total wastewater influent for 2022 statewide was 3.3 MAFY, and after accounting for the 749,000 AFY recycled water, remaining effluent was 2.21 MAFY, including discharges to inland surface waters subject to CA Wat. Code § 1211. This figure was not available until after the 2019 volumetric annual report.

Surprisingly, Region 5, a heavily agricultural section of the state that covers much of California's Central Valley, was responsible for more than half of California's total water reuse as early as 1970. While, as discussed above, pre- and post-2019 reuse surveys cannot be easily compared, recycled water use in Region 5 appears not to have increased significantly over the past 40 years. Details on water reuse practices in this region, discussed further in the section on our data analysis below, remain somewhat uncertain.

There are three major proposed water recycling projects in Southern California that could generate over 450,000 AFY of new water, an amount comparable to the volume of water used by the city of Los Angeles annually. San Diego's Pure Water San Diego project, LA County Sanitation District's and Metropolitan Water District's Pure Water Southern California (PWSC) Project, and the city of Los Angeles' Pure Water LA project are all scheduled to deliver new water supply to the region over the next two decades. The potential costs of full build-out and distribution systems for these three projects could exceed $25 billion. Despite the importance of these projects for water security and climate resilience, there has been only modest state investment in them. And federal investment—apart from a recent $155 million award from the USBR to the Tillman Water recycling project for $30 million and PWSC for $125 million—has been largely part of the state revolving fund and Water Infrastructure Finance and Innovation Act programs as loans rather than grant awards (LADWP, 2024). These low-interest loans are important in keeping costs affordable for numerous critical water projects in the state, but water reuse grant funding has never been substantial in California in comparison to project cost needs and has been nearly eliminated in the last two state budgets (Von Roekel, 2024). In November, California voters approved a $10 billion climate bond that allocates $386 million to new water reuse projects. But without more state or federal investment, the cost to ratepayers for water supplies from these projects will increase substantially, which may lead to public opposition because of affordability concerns.

## WATER REUSE REGULATION

Currently, California has the most comprehensive regulatory approach for water reuse in the nation. The state has been a national leader in developing and approving regulations for IPR through discharges to groundwater basins and reservoirs as public health buffers. Recently, the state released DPR regulations that were approved by the SWRCB in December 2023 (SWRCB, 2024b). Those regulations, in conjunction with the state's IPR regulations for groundwater and surface water augmentation and Title 22 regulations for water reuse, together form a comprehensive approach to water recycling regulation designed to protect public health and the environment. Groundwater basins, surface waters, coastal waters, and drinking water supplies must be protected from salts, nutrients, and chemicals of emerging concern, and California regulations are designed to achieve those protections as long as there are robust monitoring, reporting, and response programs to ensure water quality protection (CA Department of Water Resources, n.d.-b).

California defines recycled water as:

> Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource (Cal. Wat. Code § 13050(n)).

Title 22 of the California Code of Regulations creates the uniform statewide recycling criteria, which establish the water quality standards, level of treatment, and allowed uses for recycled water (22 Cal. Code Regs., Div. 4, Ch. 3). The state's comprehensive recycled water regulatory framework includes log reduction requirements for fecal indicator bacteria, enteric viruses, *Giardia* and *Cryptosporidium*, as well as requirements for chemical constituent removal, facility operations, monitoring, reporting, and other factors. In general, there are two levels of Title 22 recycled water. Disinfected secondary treated water must meet the most probable number (MPN) of 23 total coliform per 100 mL for the last seven samples. Disinfected tertiary recycled water requirements state that treated water must not exceed an MPN of 2.2 per 100 mL for the last seven samples. Additional disinfection requirements are tied to virus inactivation and chlorine residual. The standards exclude on-site reuse in recycled facilities and POTWs. Treatment levels are specified in each of the recycled water categories: irrigation, impoundment, industry and other uses (see Figures 8a and 8b). The water recycled receives more treatment if it comes into contact with media or crops closely related to human interaction.

## RECYCLED WATER USES* ALLOWED IN CALIFORNIA

This summary is prepared by WateRuse Association of California, from the Dec 2, 2000, Title 22 adopted Water Recycling Criteria, and supersedes all earlier versions.

| | Treatment Level | | | |
|---|---|---|---|---|
| **Recycled Water Use** | Disinfected Tertiary Recycled Water | Disinfected Secondary 2.2 Recycled Water | Disinfected Secondary 2.3 Recycled Water | Undisinfected Secondary Recycled Water |
| **Irrigation for:** | | | | |
| Food crops where recycled water contacts the edible portion of the crop, including all root crops | ALLOWED | NOT ALLOWED | NOT ALLOWED | NOT ALLOWED |
| Parks and playgrounds | | | | |
| School grounds | | | | |
| Residential landscaping | | | | |
| Unrestricted-access golf courses | | | | |
| Any other irrigation uses not specifically prohibited by other provisions of the California Code of Regulations | | | | |
| Food crops, surface-irrigated, above-ground edible portion, not contacted by recycled water | | ALLOWED | | |
| Cemeteries | | | ALLOWED | |
| Freeway landscaping | | | | |
| Restricted-access golf courses | | | | |
| Ornamental nursery stock and sod farms with unrestricted public access | | | | |
| Pasture for milk animals for human consumption | | | | |
| Nonedible vegetation with access control to prevent use as a park, playground or school grounds | | | | |
| Orchards with no contact between edible portion and recycled water | | | | ALLOWED |
| Vineyards with no contact between edible portion and recycled water | | | | |
| Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest | | | | |
| Fodder and fiber crops and pasture for animals not producing milk for human consumption | | | | |
| Seed crops not eaten by humans | | | | |
| Food crops undergoing commercial pathogen-destroying processing before consumption by humans | | | | |
| Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest | | | | |
| **Supply for impoundment:** | | | | |
| Nonrestricted recreational impoundments, with supplemental monitoring for pathogenic organisms | ALLOWED[2] | NOT ALLOWED | NOT ALLOWED | NOT ALLOWED |
| Restricted recreational impoundments and publicly accessible fish hatcheries | ALLOWED | ALLOWED | | |
| Landscape impoundments without decorative fountains | | | ALLOWED | |
| **Supply for cooling or air conditioning:** | | | | |
| Industrial or commercial cooling or air conditioning involving cooling tower, evaporative condenser, or spraying that creates a mist | ALLOWED[3] | NOT ALLOWED | NOT ALLOWED | NOT ALLOWED |
| Industrial or commercial cooling or air conditioning not involving cooling tower, evaporative condenser, or spraying that creates a mist | ALLOWED | ALLOWED | ALLOWED | |

2 With "Conventional tertiary treatment". Additional monitoring for two years or more is necessary with direct flitration.
3 Drift eliminators and/or biocides are required if public or employees can be exposed to mist.

Figure 8a. Other allowed uses of recycled water in California with required treatment levels (WateReuse Association of California, 2000). This figure was last updated in 2000, and the SWRCB is developing a new table to address subsequent changes to policy, including addition of regulations for potable uses such as reservoir augmentation and direct potable reuse.

**RECYCLED WATER USES* ALLOWED IN CALIFORNIA**

This summary is prepared by WateRuse Association of California, from the Dec 2, 2000, Title 22 adopted Water Recycling Criteria, and supersedes all earlier versions.

| | Treatment Level | | | |
|---|---|---|---|---|
| **Recycled Water Use** | Disinfected Tertiary Recycled Water | Disinfected Secondary 2.2 Recycled Water | Disinfected Secondary 2.3 Recycled Water | Undisinfected Secondary Recycled Water |
| **Other Uses:** | | | | |
| **Groundwater Recharge** | **ALLOWED under special case-by-case permits by the RWQCB[4]** | | | |
| Flushing toilets and urinals | **ALLOWED** | **NOT ALLOWED** | **NOT ALLOWED** | **NOT ALLOWED** |
| Priming drain traps | | | | |
| Industrial process water that may contact workers | | | | |
| Structural fire fighting | | | | |
| Decorative fountains | | | | |
| Commercial laundries | | | | |
| Consolidation of backfill material around potable water pipelines | | | | |
| Artificial snow making for commercial outdoor use | | | | |
| Commercial car washes, not heating the water, excluding the general public from the washing process | | | | |
| Industrial process water that will not come into contact with workers | | **ALLOWED** | **ALLOWED** | |
| Industrial boiler feed | | | | |
| Nonstructural fire fighting | | | | |
| Backfill consolidation around nonpotable piping | | | | |
| Soil compaction | | | | |
| Mixing concrete | | | | |
| Dust control on roads and streets | | | | |
| Cleaning roads, sidewalks and outdoor work areas | | | | |
| Flushing sanitary sewers | | | | **ALLOWED** |

Refer to the full text of the the December 2, 2000 version Title 22: California Water Recycling Criteria. This chart is only an informal summary of the uses allowed in this version.

4 Refer to Groundwater Recharge Guidelines, available from the California Department of Health Services.

*Charts are adapted from WateReuse Association of California charts, originally prepared by Bahman Sheikh and edited by the EBMUD Office of Water Recycling. This is a summary, not the official version of the referenced regulations.*

Figure 8b. Other allowed uses of recycled water in California with required treatment levels (WateReuse Association of California, 2000). This figure was last updated in 2000, and the SWRCB is developing a new table to address subsequent changes to policy, including addition of regulations for potable uses such as reservoir augmentation and direct potable reuse.

IPR has been practiced successfully in California, as both an environmental buffer and for groundwater augmentation, for more than 50 years. IPR in California is defined as the "planned use of recycled water to replenish drinking water supplies with a suitable environmental barrier" and includes groundwater replenishment reuse projects and surface water source augmentation projects (both regulated under 22 Cal. Code Regs., Div. 4, Ch. 3). In fact, the Orange County Water District's groundwater replenishment system is currently the largest facility for IPR in the nation, if not the world, recycling some 134,000 AFY (SWRCB, 2023a). The regulations for groundwater augmentation require, in part, 12-log enteric virus reduction, 10-log *Giardia* cyst reduction, and 10-log *Cryptosporidium* oocyst reduction, in addition to meeting levels equal or less than maximum contaminant levels or action levels specified in California's Drinking Water Regulations for a number of contaminants (22 Cal. Code Regs., Div. 4, Ch. 3). Surface reservoir augmentation requires a minimum 8-log enteric virus reduction, 7-log *Giardia* cyst reduction, and 8-log *Cryptosporidium* oocyst reduction, as well as similarly meeting maximum contaminant levels or action levels for a number of contaminants (22 Cal. Code Regs., Div. 4, Ch. 3).

In December 2023, the SWRCB approved regulations to allow DPR in California, which the board defined as the "planned introduction of recycled water . . . either directly into a public water system or into a raw water supply immediately upstream of a water treatment plant" (22 Cal. Code Regs. § 64669.05). To reduce the public health risk of all pathogens, the regulation requires "20 log reduction for enteric virus, 14 log reduction for *Giardia lamblia* cyst, and 15 log reduction for *Cryptosporidium* oocyst" (Cal. Code Regs. § 64669.45(a)(1)). These reference pathogens are targeted in three out of four treatment processes, and system operation will discontinue the delivery of treated water when the log reductions are below 16, 11 and 10 for viruses, *Crypto,* and *Giardia* (Cal. Code Regs. § 64669.45(b)(5)). Treatment for DPR requires membrane physical separation, chemical inactivation, and UV inactivation and strongly suggests ozone or biologically activated carbon followed by reverse osmosis, followed by advanced oxidation through UV and often peroxide (Cal. Code Regs. § 64669.45(a)(3); § 64669.50(a)). Although there currently are no DPR projects in California, potential candidates include the Santa Monica Sustainable Water Infrastructure Project, Pure Water Southern California, and the Pure Water Los Angeles project.

## WASTEWATER REUSE DATA

California has comprehensive recycled water data from 2019 to the present for wastewater treatment plants and recycled water producers available through California Open Data Portal. (SWRCB, 2022a). All facilities must submit annual reports to the SWRCB with plant influent, effluent, and recycled water volumes. State Water Quality Order 2019-0037-EXEC includes permittees covered by NPDES permits, waste discharge requirements, master recycling permits, and dischargers that have a facility design flow greater than 20,000 gallons per day that treat municipal waste in part or in whole (SWRCB, 2020). As of 2022, the state notes a 97% reporting compliance rate from 749 facilities. The collection and reporting of data by the state is substantially above that of the other Colorado Basin states.

Influent, effluent, and reuse data for 2022 was taken from the state's "Volumetric Annual Report of Wastewater and Recycled Water" (SWRCB, 2022). In order to identify POTWs, we merged the annual report data with the state's "Wastewater Facilities Permits & Orders" dataset to include all identified POTWs and private municipal wastewater plants with an effluent flow greater than 1 MGD (CA Open Data Portal, 2024). Many of the private facilities were operated as part of multi-facility wastewater systems in which public facilities feed water to private plants for more advanced treatment. When compared against data provided by the SWRCB, our analysis covered approximately 98% of total reported influent for the state, as well as 96% of the effluent and 99% of the recycled water reported.

## WASTEWATER REUSE ANALYSIS

California treats by far the most influent and produces the most wastewater by volume of any of the Colorado Basin states, recycling 744,522 acre-feet in 2022 out of the 3.31 million acre-feet of wastewater influent treated in our analysis (Figure 9).[13]

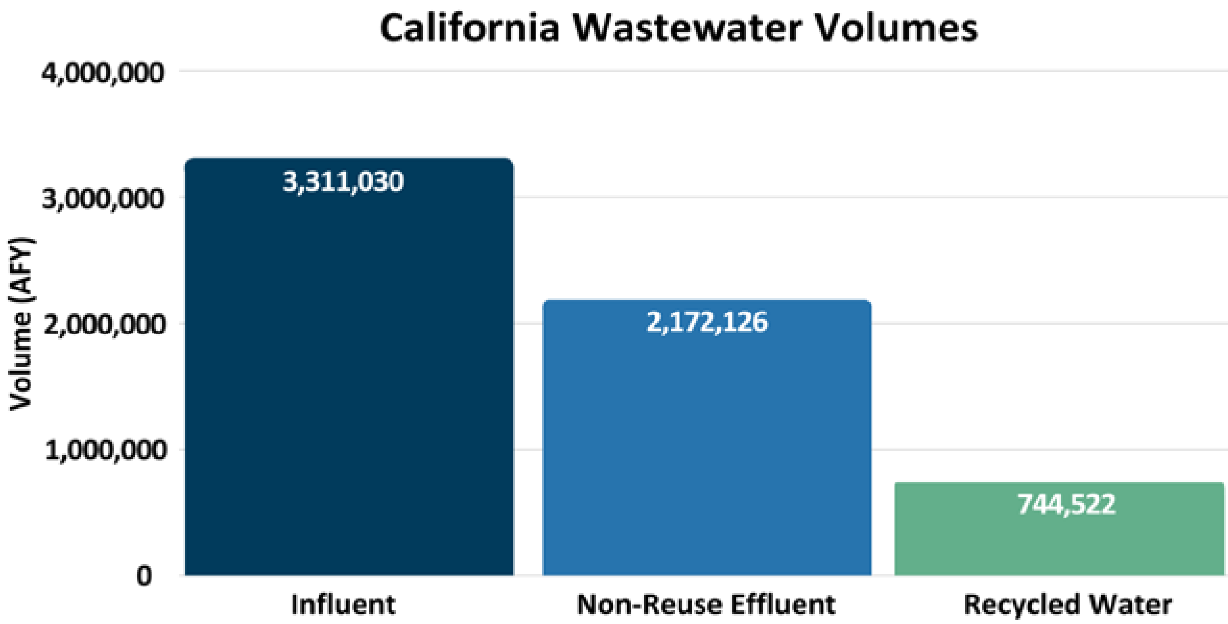



Figure 9. California statewide wastewater volumes for 2022.

However, as discussed above, the recycled water volume falls far below state targets originally set in 2009 and translates to only 22.5% of the total influent,[14] far below water reuse rates in Nevada and Arizona.

Wastewater reuse efforts vary considerably by region and are dominated by the coastal southern region of the state, which, between Regions 4 (Los Angeles), 8 (Santa Ana), and 9 (San Diego), treats 50% of the state's total influent but produces 64% of its recycled water

13 We note our total differs slightly from the SWRCB's official total for recycled water of 749,000 acre-feet. This is largely the result of our selection parameters for wastewater treatment plants, which excluded private municipal treatment facilities treating less than 1 MGD.

14 The total volume of effluent and reclaimed water assessed here only represents approximately 89% of the total reported influent. The SWRCB notes that the discrepancy can be due to a combination of meter-reading errors, the presence of "sewer mining" plants, and water loss from treatment such as process water, evaporation and other effects (SWRCB, 2022).

(Figure 10). A majority of the region's treated wastewater is used for landscape irrigation, groundwater recharge, industrial application, and golf course irrigation.

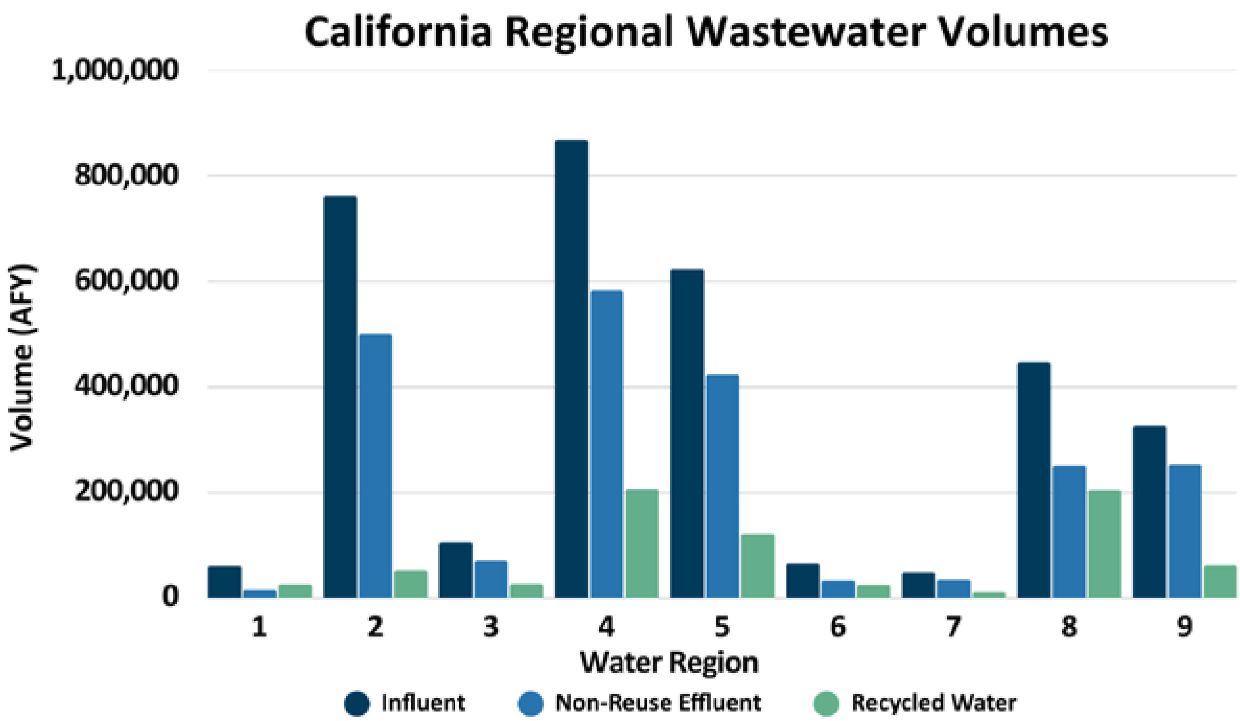



Figure 10. California wastewater and reuse volumes by region for 2022.

The Los Angeles region (Region 4) is the state's most populous and treats the largest volume of influent in the state. The LACSD has traditionally promoted use of recycled water, reporting that the LACSD's 11 wastewater treatment plants treat approximately 436,000 AFY and make some 145,000 acre-feet of recycled water available for reuse (LACSD, n.d.). But the city of Los Angeles has lagged far behind and, after decades of efforts focused on water efficiency and supply planning, still only meets about 2% of its water supply needs with recycled water. In 2019, the city released its Green New Deal plan, which calls for recycling 100% of all wastewater for beneficial reuse (including environmental uses) by 2035, but currently the city is not planning to fully complete the plan until 2050 or later. (City of Los Angeles, 2019).

Region 8 encompasses northern Orange County, which as stated above has a rich history of water reuse for IPR through groundwater recharge. The region began utilizing wastewater recycling and aquifer injections in 1975 and opened the world's first reverse osmosis treatment plant to treat wastewater to drinking water standards in 1977. Orange County now hosts the world's largest advanced wastewater purification system, which is utilized to replenish groundwater aquifers through IPR. The facility produces over 130 MGD of advanced treated water (134,000 AFY) (SWRCB, 2023a). Overall, our analysis showed that Region 8 produces over 200,000 AFY of recycled water, the most in the state and approximately 46% of its total assessed influent. Similar to data reported by SWRCB, our investigation showed that the Orange County region continues to disproportionately contribute to the state's reuse efforts, by producing 28% of the state's recycled water in 2022 from only 14% of the state's treated influent.

The Colorado River region (Region 7) covers the southeastern portion of the state and the most arid region of California. The region's Coachella Valley, which includes the wintertime resort city of Palm Springs, has less than 1% of Southern California's population but nearly 30% of its golf courses (Colorado River Basin Regional Water Quality Control Board, 2024; Lopez, 2021). The incredible concentration of golf courses—120 in the region alone—places intense stress on existing water resources; golf courses are estimated to use 25% of the valley's total water supply. (Lopez, 2021). The Coachella Valley Water District has been utilizing recycled water on golf courses since 1968, and in 2022, the district claimed that it produced some 10,000 acre-feet of recycled water. Seventeen of the valley's golf courses used a mix of recycled and Colorado River water for reuse by irrigators (Coachella Valley Water District, n.d.).[15]

But the volume of recycled water used for golf course irrigation is dwarfed by the volume of recycled water available, let alone overall golf course irrigation demand. Irrigation water usage ranges from roughly 300 AFY for smaller courses in the region to as much as 1,400 AFY for larger courses or courses in windy, unprotected areas, with an estimated average of 942 AFY (Water Counts, n.d.). This means that the 120 golf courses are using as much as an astonishing 113,000 AFY, and current water recycling efforts—even if directed solely at irrigation for these courses—supply less than 10% of the actual need. Increased efforts to produce recycled water will be critical for maintaining future supplies.

The Central Valley region (Region 5) includes the Sacramento River and San Joaquin River Basins, which alone cover approximately 25% of California's total area and 30% of the state's irrigable land, while supplying as much as 51% of the state's total water supply (Longley et al., 2019). The vast region extends from the northern border of LA County all the way to the Oregon border and covers roughly 60,000 square miles—nearly 40% of the state and 80% of California's irrigated agricultural land (Central Valley Regional Water Quality Control Board, 2024). Two massive water infrastructure projects, the federal Central Valley Project and the California State Water Project, supply water from the delta formed by these systems' confluence to the San Francisco Bay Area, Central Valley, and Southern California, among other regions (Central Valley Regional Water Quality Control Board, 2024).

15 The Coachella Valley Water District states that another 36 golf courses are currently irrigated with water from its irrigation canal system that it deems non-potable (Water Counts, n.d.).

As discussed in the introductory section, Region 5 was reportedly responsible for more than half of California's total water reuse as early as 1970, but (despite challenges posed by comparing different years due to changes in survey methodology after 2019) it does not appear to have significantly increased its reuse since. Information on the specific reuse practices employed or end uses for recycled water were also generally not easily available; in discussions with California regional water quality control boards, staff assumptions were that the majority of reuse occurred via discharge into the region's extensive canal systems. For example, the city of Modesto alone reuses approximately 16,800 AFY by discharging tertiary-treated water into the Delta-Mendota Canal for irrigation reuse (City of Modesto, n.d.; Scheuber, 2021).

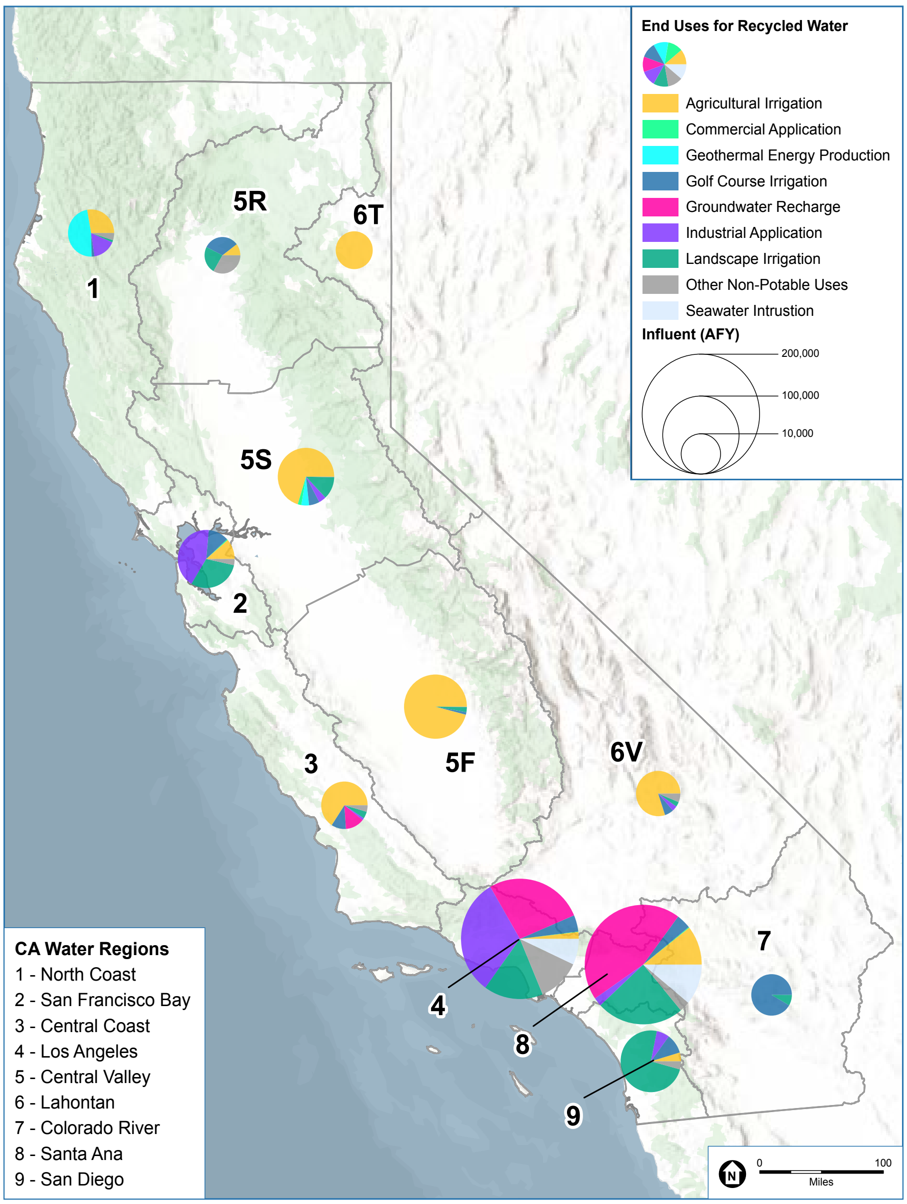


Figure 11. Uses of wastewater by region in California.

Finally for our discussion, Region 2, which contains the San Francisco Bay Area, has lagged significantly relative to wastewater recycling efforts of other regions of the state. Region 2 accounts for 23% of the state's influent, treating some 761,000 AFY of wastewater in 2022, but contributed only 57,000 AFY of recycled water, 7% of the state's total. Efforts to increase reuse in the region have met resistance due to claims of cost, space, geographic limitation or even perceived barriers from jurisdictional boundaries (see, e.g., Romero, 2023). Greater water reuse in the region would increase the state's climate resiliency to drought and increasing aridity, as well as reduce nutrient loading to the Bay-Delta region—a major environmental benefit.

Across California, the largest end uses for recycled wastewater in 2022 were agricultural irrigation (184,000 AFY), landscape irrigation (158,000 AFY), groundwater recharge (151,000 AFY), industrial uses (105,000 AFY), and golf course irrigation (50,000 AFY).

Overall, California is vastly underutilizing recycled water as a resource. Increasing the percentage of wastewater diverted for reuse from the current 22.5% to 40% would increase the available volume of water supply by 580,000 AFY, a critically needed hedge against drought in the state. Beyond that, California needs to return its focus to achieving the ambitious targets originally set in the SWRCB's 2009 recycled water policy.

Gross Reservoir in Boulder County, Colorado (photo credit: Denver Water).

## Colorado

### *Statewide wastewater reuse: 3.6%*

***Colorado should be well situated to take advantage of the potential for recycled water, but a lack of developed reuse programs and infrastructure—coupled with a number of technological, legal, and financial hurdles—has severely restricted development of recycled water in the state.***

Colorado's unique topography is punctuated by the Continental Divide, which splits the state, separating watersheds that lead to the Pacific Ocean to the west from those that drain to the Gulf of Mexico to the east. About 80% of the roughly 18 inches of average annual precipitation falls on the western slope of the Continental Divide, yet almost 90% of the population resides on the eastern side, which receives only about 20% of the precipitation (Adams, 2021). Of Colorado's 5.81 million residents, more than 3.2 million live in the Denver metropolitan area. This has led to Colorado's use of trans-basin projects—consisting of pumps, aquifers, and reservoirs—to carry water across the state, including across the Continental Divide, for residents to access (Coleman, 2014).

Colorado's consumptive water use averages approximately 5.3 MAFY, though with claimed return flows giving the state credit toward additional withdrawals, the state diverts a total of 15.3 MAFY from surface flows and supplies another 2 MAFY from groundwater (State of Colorado, 2015; CWCB, 2023). Agriculture accounts for nearly 90% of consumptive use, with municipal water use accounting for only approximately 7%. Almost one-third of the state's population relies on groundwater for domestic usage. In 1995, the state passed aquifer recovery and storage rules, which allow treated water to be pumped back into aquifers for later use (Colorado State University, 2017).

Colorado's entitlement to water from the Colorado River itself is governed by the 1948 Upper Colorado River Compact. The compact, which assumed a total allocation of 7.5 MAFY to the upper basin states, nevertheless apportioned water to each of the states—Colorado, Utah, Wyoming and New Mexico—as a percentage due to uncertainty in year-to-year flow (Stern et al., 2024). Colorado was apportioned 51.75% of the upper basin flow, which averaged 2.275 MAFY consumptive use between 2016 and 2020 (USBR, 2022).

## Regulatory Background

The Colorado Department of Public Health and Environment (CDPHE) is responsible for environmental protection and public health services in the state. Within the CDPHE, the Water Quality Control Division oversees implementation of the Colorado Water Quality Control Act (the state's version of the Clean Water Act) and has responsibility for ensuring that all drinking water systems provide safe drinking water through enforcement of state regulation 11. The division issues permits, ensures compliance, and enforces state and federal regulations. The Water Quality Control Division administers NPDES permits, while EPA issues discharge permits on federal and tribal lands.

Under the Colorado Department of Natural Resources (DNR), the Division of Water Resources (also known as the Office of the State Engineer)

> administers water rights, issues water well permits, represents Colorado in interstate water compact proceedings, monitors streamflow and water use . . . issues licenses for well drillers and assures the safe and proper construction of water wells, and maintains numerous databases of Colorado water information (DNR, 2024).

Also under the DNR is the Colorado Water Conservation Board (CWCB), which maintains and implements the Colorado Water Plan.

## Water Reuse in Colorado

Water reuse, in some form, has been practiced in Colorado for more than 50 years, beginning with early reclaimed water projects in Colorado Springs and Aurora in the 1960s (Reimer & Bushman, 2021). In 2015, the CWCB developed the state's first Colorado Water Plan, noting that the gap between Colorado's "water supply and water demand is real and looming" (Hickenlooper, 2013). And in November 2022, Colorado adopted regulations to allow DPR of wastewater as a new source of drinking water supply, touting the rule as "the first of its kind in the nation" and requiring that "water providers meet high standards for treatment, testing and community engagement" (CDPHE, 2023).

But the state's efforts at water recycling are hampered by its complex and restrictive system of water rights laws and related permitting requirements. The state has effectively formalized a system known as the prior appropriation doctrine (common in the Western United States) under the Colorado Doctrine. Under Colorado's Water Rights Determination Act of 1969, water reuse is not allowed for any given water division in the state unless explicitly authorized by a decree. (Reimer & Bushman, 2021; Colo. Rev. Stat. §§ 37-92-101 et seq. (2019)). The state's legal and regulatory framework, while providing a means of allocating water during drought or scarcity, has also severely hampered reuse efforts.

Colorado defines non-potable water or "reclaimed water" as:

> Domestic wastewater that has received secondary treatment by a domestic wastewater treatment works (centralized system or a localized system) and such additional treatment as to enable the wastewater to meet the standards for approved uses (5 Colo. Code Regs. 1002-84.5(41)).

Colorado defines three categories of non-potable use for reclaimed water:

> **Category 1**: secondary treatment with disinfection, with an E. coli limit of 126/100 mL single sample maximum, TSS of 30 mg/L as a daily maximum
>
> **Category 2**: secondary treatment with filtration and disinfection, with an E. coli limit of 126/100 mL monthly geometric mean and 235/100 mL single sample maximum, and turbidity not to exceed 3 NTU as a monthly average and not to exceed 5 NTU in more than 5% of the individual analytical results during any calendar month
>
> **Category 3**: secondary treatment with filtration and disinfection, with no E. coli detected in at least 75% of samples in a calendar month and 126/100 mL single sample maximum, and turbidity not to exceed 3 NTU as a monthly average and not to exceed 5 NTU in more than 5% of the individual analytical results during any calendar month

> **Category 3 Plus**: secondary treatment with filtration and disinfection. The filtration must be performed with conventional filtration, direct filtration, membrane, bag, or cartridge filtration (in accordance with 5 Code Colo. Regs. § 1002-11), or alternative filtration technologies that are third-party tested to reliably remove 99.9% of particles that are 3 microns at most. The disinfection must provide a minimum 5-log inactivation of viruses using either free chlorine or monochloramines, or a minimum UV of 40 mJ/cm2 (5 Colo. Code Regs. § 1002-84.7).

Approved uses are defined under the code and include a range of industrial, commercial, agricultural, landscape irrigation, fire protection, and toilet and urinal flushing applications (5 Colo. Code Regs. § 1002-86.9). But within this established structure, water reuse in Colorado is only authorized where a facility has obtained an authorization under the state's reclaimed water control regulation (5 Colo. Code Regs. § 1002-84), and even then only when, under the state's Water Rights Determination Act of 1969, recycling is explicitly allowed by a specific water division's decree (Reimer & Bushman, 2021).

Colorado's reuse program enables facilities to apply for authorization to either be reuse treaters or reuse users. Regulation 84 applies to the following uses of non-potable reclaimed water:

> Landscape irrigation, agricultural irrigation (including crops not grown for human consumption, Non-Commercial Food Crop Growing Operation, Commercial Food Crop Growing Operation and Edible and Non-Edible Hemp), fire protection, industrial, commercial, and toilet and urinal flushing uses identified in section 84.10 of this regulation.

The regulations do not apply to the use of irrigation at treatment plant sites or internal process uses, or to wastewater that has been treated and discharged to state waters prior to subsequent use.

Once facilities receive a treater authorization, their reclaimed water must meet standards and limits for E. coli, TSS, and turbidity under one of the three categories of treatment levels. For the highest level, Category 3 Plus, in addition to meeting Category 3 standards, virus inactivation and specific filtration techniques are required. Category 3 Plus uses include certain agricultural irrigation uses and toilet and urinal flushing.

Despite relatively extensive regulations to support and authorize use of reclaimed water, as of 2023, only 36 public and private utilities in Colorado currently operate as treaters to produce even non-potable water in the state. In large part, this is because of Colorado's complex and restrictive water rights systems, which heavily proscribe the right to divert or reuse water.

In January 2023, Colorado additionally passed regulations specifically authorizing DPR of treated wastewater (5 Colo. Code Regs. § 1002-11.14). DPR is defined in Colorado as

> using a series of processes that produce finished drinking water [water that is supplied to the distribution system of a public water system and intended for distribution and human consumption without further treatment] utilizing a source containing treated wastewater that has not passed through an environmental buffer (5 Colo. Code Regs. § 1002-11.14(1)(k)).

Treatment requirements for DPR are established under 5 Colo. Code Regs. § 1002-11.14(7)(b):

> (ii) Unless the Department has approved alternative treatment requirements based on treated wastewater characterization in 11.14(5)(a)(ii), the sum of the log reduction values across the pathogen critical control points specified in 11.14(7) must reliably be at least:
>
> (A) 10-log treatment of *Cryptosporidium*.
>
> (B) 10-log treatment of *Giardia lamblia*.
>
> (C) 12-log treatment of viruses.
>
> (iii) If the Department has approved alternative treatment requirements based on treated wastewater characterization in 11.14(5)(a)(ii), the sum of the log reduction values across the pathogen critical control points specified in 11.14(7) shall not be less than:
>
> (A) 5.5-log treatment of *Cryptosporidium*.
>
> (B) 6-log treatment of Giardia lamblia.
>
> (C) 8-log treatment of viruses.

While more stringent than the non-potable reuse requirements, the Colorado requirements are less protective of human health than those in California. Like California, the regulations have not been in place long enough to determine the impacts on potential DPR projects.

## Wastewater Reuse Data

A complete dataset for wastewater treatment facilities in Colorado was not available from either federal or state agency sources. Data for POTWs and for water recycling, where occurring, was compiled from a mixture of sources, including federal databases (EPA's ECHO); CDPHE's database of Colorado state active permits, including facilities with reclaim treater authorizations; state fact sheets for facilities, where available (though many of these appeared to contain outdated information); and direct communication with individual facilities. Our analysis identified 103 POTWs operating in Colorado with a design flow over 1 MGD. Of these, only 47 of the treatment plants or state reuse treaters reported an actual average daily influent of greater than 1 MGD. We were ultimately able to obtain 2022 treatment data from 44 of these 47 facilities, of which only 12 were identified as having received an authorization for reuse.

## Wastewater Reuse Analysis

Ultimately, Colorado recycles relatively little of the domestic wastewater it treats. Our analysis of the 44 POTWs treating an average of over 1 MGD in 2022 that provided data found that less than 13,500 acre-feet were treated for reuse out of nearly 370,000 acre-feet of total treated discharge, or less than 4% of the total.

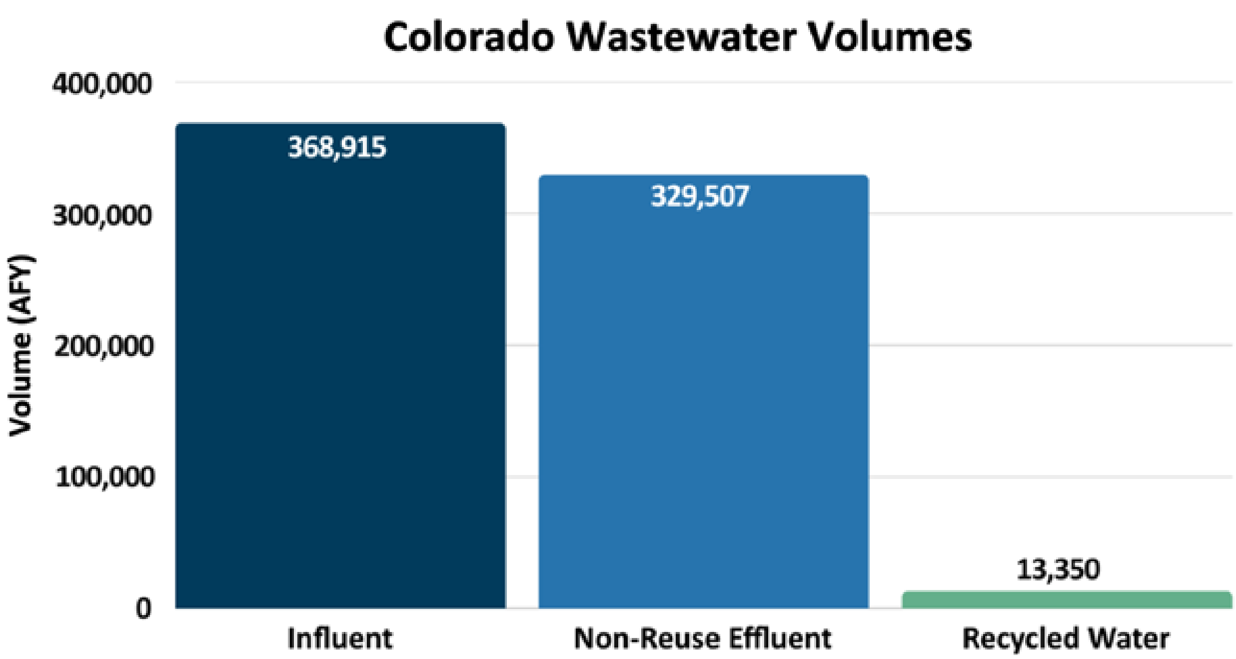



Figure 12. Colorado wastewater volumes. The total influent, effluent and recycled water volumes calculated for 44 wastewater treatment facilities in the state of Colorado based on 2022 data.

As discussed earlier, the definition of reuse employed for this study excludes discharges to surface waters that may be recaptured by a downstream user, so the total volume of "reused water" calculated in this report may differ from Colorado's self-reported programs. Many facilities in Colorado are supported by de facto reuse, where cities and users downstream receive discharged water, in addition to water exchanges and IPR, where water is first discharged to an environmental buffer such as a river, lake or stream. One example can be found in the city of Aurora's Prairie Waters project, which involves treatment and "reuse" of water imported from outside of the South Platte River Basin treated through riverbank filtration methods to recharge aquifers and supply the water back to residents (City of Aurora, 2024).

The vast majority of wastewater in Colorado treated for reuse was treated to meet Category 2 standards, including from 10 out of 12 facilities reporting reuse. Facilities primarily reported using reclaimed water for irrigation practices, including landscaping, agriculture, and parks and golf courses. Other reported uses included water for the Denver Zoo, cemeteries, fire hydrants, and industrial processes, though volumes of reuse were not reported.

DPR in Colorado currently requires treatment to the state's log reduction standards under 5 Colo. Code Regs. § 1002-11.14(7)(b). As DPR regulations are new, we would expect to see an increase in test projects and funding for efforts to meet these standards in the coming years. Pilot projects are already underway. For example, Colorado Springs has launched a PureWater demonstration project, and additional pilot projects are underway in the cities of Castle Rock and Aurora (Carollo Engineers, 2022). It remains to be seen whether the state's restrictive water rights will impede further progress, and meaningful reform of the state's complicated water rights regime would necessarily involve multiple legal pathways, including legislative action potentially at both the state and federal level, as well as possible re-ratification of interstate compacts.

The Colorado River flows past Lauglin, Nevada (photo credit: Niaz Uddin).

## Nevada

***Statewide wastewater reuse: 85%***

***Nevada has increasingly employed water reuse as a critical means of meeting the state's supply needs, including adopting formal IPR regulations in 2016. The overwhelming majority of Nevada's water recycling efforts involve indirect use approaches, primarily in the southern region of the state, through discharging treated wastewater to Lake Mead or to its tributaries such as the Las Vegas Wash. This greatly increases the amount of water that the state has available to it from the Colorado River system, and has led to the state reusing the highest percentage of its wastewater of the Colorado Basin states.***

Nevada is the driest state in the country. The state's average rainfall is only 10.3 inches, but that figure drops to 7.1 inches annually for the southern region of the state, where nearly 75% of Nevada's 3.1 million residents live (and where 75% of the state's water demand comes from) (Nevada State Climate Office, 2024; Legislative Counsel Bureau, 2021; EPA, 2016). Las Vegas receives only a scant 4.18 inches of rain per year, which creates enormous challenges to supply water for 641,903 residents in the city, nearly three million people in the Las Vegas metro area, and an average of more than 38 million annual visitors (National Weather Service, n.d.; LVCVA, 2024). Adding to the strain on scant water sources, the state's population has been increasing at a rate of 25% or higher per decade for the last three decades (EPA, 2016).

Nevada's dry climate is punctuated by its lack of major surface water resources. The state has a number of small and perennial streams that flow from the western flank of the Rocky Mountains, but most of the state's surface water resources were developed before the start of the 20th century (EPA, 2016; Legislative Counsel Bureau, 2019). Water from surface rivers, including the Colorado River, supply almost 70% of the state's total overall water supply (EPA, 2016). Groundwater accounts for the other 30%, but more than 50% of the state's groundwater basins, including all of its basins in southern Nevada, are overcommitted (Legislative Counsel Bureau, 2019).

Nevada holds the smallest allocation of Colorado River water of the seven basin states. Nevada's apportionment is only 1.8% of the overall flow, or 300,000 AFY (Stern et al., 2024). Even still, southern Nevada relies on the Colorado River for 90% of its water supply, accounting for the vast majority of the state's total allotment. In part, this is possible due to Las Vegas' proximity to Lake Mead. In 2022, Nevada's consumptive use of Colorado River water was reported as 223,670 acre-feet. But under provisions of the 1928 Boulder Canyon Project Act, Nevada receives "return-flow" credits for water used then returned to the Colorado River or its reservoirs, such as Lake Mead (CRC, 2024). Through use of these credits, Nevada's actual 2022 withdrawals from the Colorado River were 465,767 acre-feet (USBR, 2023).

Despite Nevada's focus on urban uses in the Las Vegas area, about 78% of the state's total water supply is used for agriculture, almost entirely irrigation, with about 13% being used for commercial and domestic uses and 7% for mining (Singletary, 2005).

## Regulatory Background

Reuse of wastewater in Nevada is overseen by the Nevada Division of Environmental Protection (NDEP) and the Office of the State Engineer. The NDEP is responsible for issuing permits for projects surrounding water reuse and ensuring projects meet applicable water quality standards. Reuse projects can be funded through Nevada's state clean water revolving fund, which is administered by the NDEP Office of Financial Assistance.

## Wastewater Reuse in Nevada

The Nevada Administrative Code defines "reclaimed water" as

> sewage that has been treated by a physical, biological, or chemical process, which is intended for a use specified in [the code] . . . and that meets the corresponding water quality criteria for the specified use (Nev. Admin. Code § 445A.27445).

Under the Nevada Revised Statutes, effluent is considered to be water that is subject to appropriation for beneficial use otherwise applicable to all other water in the state (Nev. Rev. Stat. § 533.440(3)).

The Nevada code defines water reuse under six categories depending on the reclaimed water's quality, ranging from A to E based on treatment level (see Table 4). It then provides a broad range of potential approved uses for reclaimed water, subject to the category of water used. Reuse programs first arose in the state in the early 1980s and initially authorized use of reclaimed water only for agricultural irrigation. After several decades of growth, the state in 2016 adopted regulations expanding approved uses to include IPR, which the state defines as

> the discharge of reclaimed water into an aquifer for the purpose of augmentation or recharge of a drinking water source where the reclaimed water travels through an environmental buffer before the reclaimed water is recovered into an extraction well for potable use (Nev. Admin. Code § 445A).

IPR projects discharging treated wastewater through injection wells or spreading basins require the use of category "A+" water, which was created under the 2016 legislation.

Minimum standards that apply to all categories of reuse include secondary treatment that meets:

- A pH between 6-9;
- TSS of ≤30 mg/L; and
- BOD5 concentration of ≤30 mg/L.

| Category of Reuse | Allowable Uses for Reclaimed Water |
|---|---|
| A+ | • Indirect potable reuse through groundwater augmentation and other allowed uses |
| A | • Spray irrigation of food crops, cemetery, commercial lawn, golf course, greenbelts and parks<br>• Impoundment and outdoor decorative water features<br>• Snowmaking (may require additional treatment)<br>• Commercial toilet and urinal flushing<br>• Commercial window washing or pressure cleaning<br>• Any activity approved for reuse category B, C, D or E |
| B | • Spray irrigation of cemetery, commercial lawn, golf course, greenbelts and parks<br>• Cooling water for industrial processes<br>• Firefighting in urban areas<br>• Commercial chemical mixing<br>• Street sweeping<br>• Any activity approved for reuse category C, D or E |
| C | • Spray irrigation of cemeteries, nurseries, commercial lawns, golf courses, green belts and parks with 100-foot buffer<br>• Establishment, restoration or maintenance of wetlands — with buffer zone<br>• Firefighting of forest or wildland fires<br>• Any activity approved for reuse category D or E |
| D | • Spray irrigation for agriculture with 400-foot buffer<br>• Dust control<br>• Flushing sewer lines or impoundment (with conditions)<br>• Any activity approved for reuse category E |
| E | • Spray irrigation of agriculture with 800-foot buffer |

Table 4. Nevada allowable uses for reclaimed water (Ormerod et al., 2020).

For bacteriological quality, specific categories must achieve the following:

- Category A requirements include total coliform of ≤2.2 CFU or MPN/100 mL (30-day average) and ≤23 CFU or MPN/100 mL (single sample maximum).
- Category B requirements include fecal coliform requirement of ≤2.2 CFU or MPN/100 mL (30-day average) and ≤23 CFU or MPN/100 mL (single sample maximum).
- Category C requirements include fecal coliform requirement of ≤23 CFU or MPN/100 mL (30-day average) and ≤240 CFU or MPN/100 mL (single sample maximum).
- Category D requirements include fecal coliform requirement of ≤240 CFU or MPN/100 mL (30-day average) and ≤400 CFU or MPN/100 mL (single sample maximum).

Category A+ reuse, required for all IPR uses, must meet all requirements for EPA's National Primary Drinking Water Regulations (40 CFR § 141) and must meet Nevada's secondary maximum contaminant levels for public water systems (see Nev. Admin. Code § 445A.455). For enteric viruses, this translates to a 12-log reduction, and for coliform bacteria, ≤2.2 CFU or MPN/100 mL (30-day geometric mean), or ≤23 CFU or MPN/100 mL (maximum daily number) (EPA, 2021a). Under the national primary standards, no more than 5% of all collected samples can be total coliform-positive in a month. For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive. Any sample positive for total coliform must be analyzed for either fecal coliforms or E. coli (EPA, 2015b).

## Water Reuse Data

The state of Nevada does not maintain a comprehensive dataset of wastewater treatment facility treatment or reuse volumes. The 2017 UNC report on water and wastewater facilities stated there are 50 POTWs operating in the state, 35 of which treat 1 MGD per day or less (UNC Environmental Finance Center, 2017). Our analysis identified at least 12 wastewater treatment facilities operating in the state with a daily average influent of greater than 1 MGD. Flow data was primarily obtained through review of permits and direct contact with individual identified facilities.

## Water Reuse Analysis

In large part due to their return flows to the Colorado River system, the 12 POTWs treating an average of greater than 1 MGD in the state in 2022 reclaimed an impressive 233,380 out of 272,569 acre-feet of total influent, or 85% of the total effluent volume (Figure 13). This volume includes both direct reuse of treated wastewater and discharges that were counted as return flow for credit purposes. As discussed below, reuse efforts varied significantly in their approach across the state.

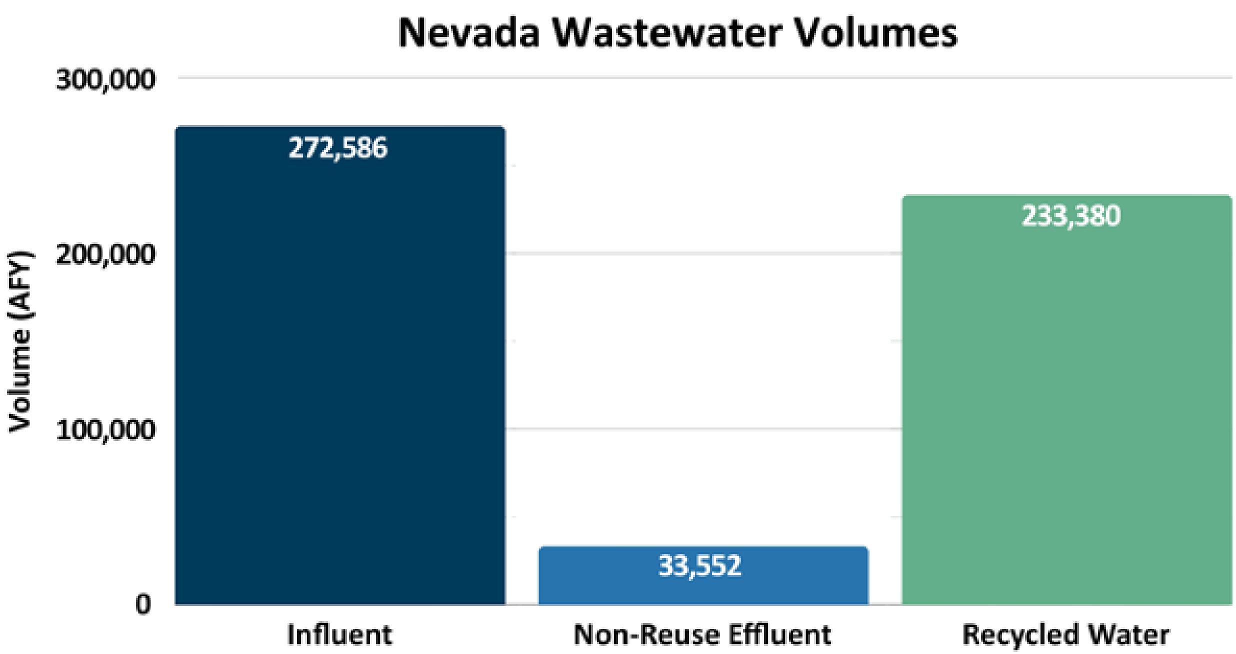
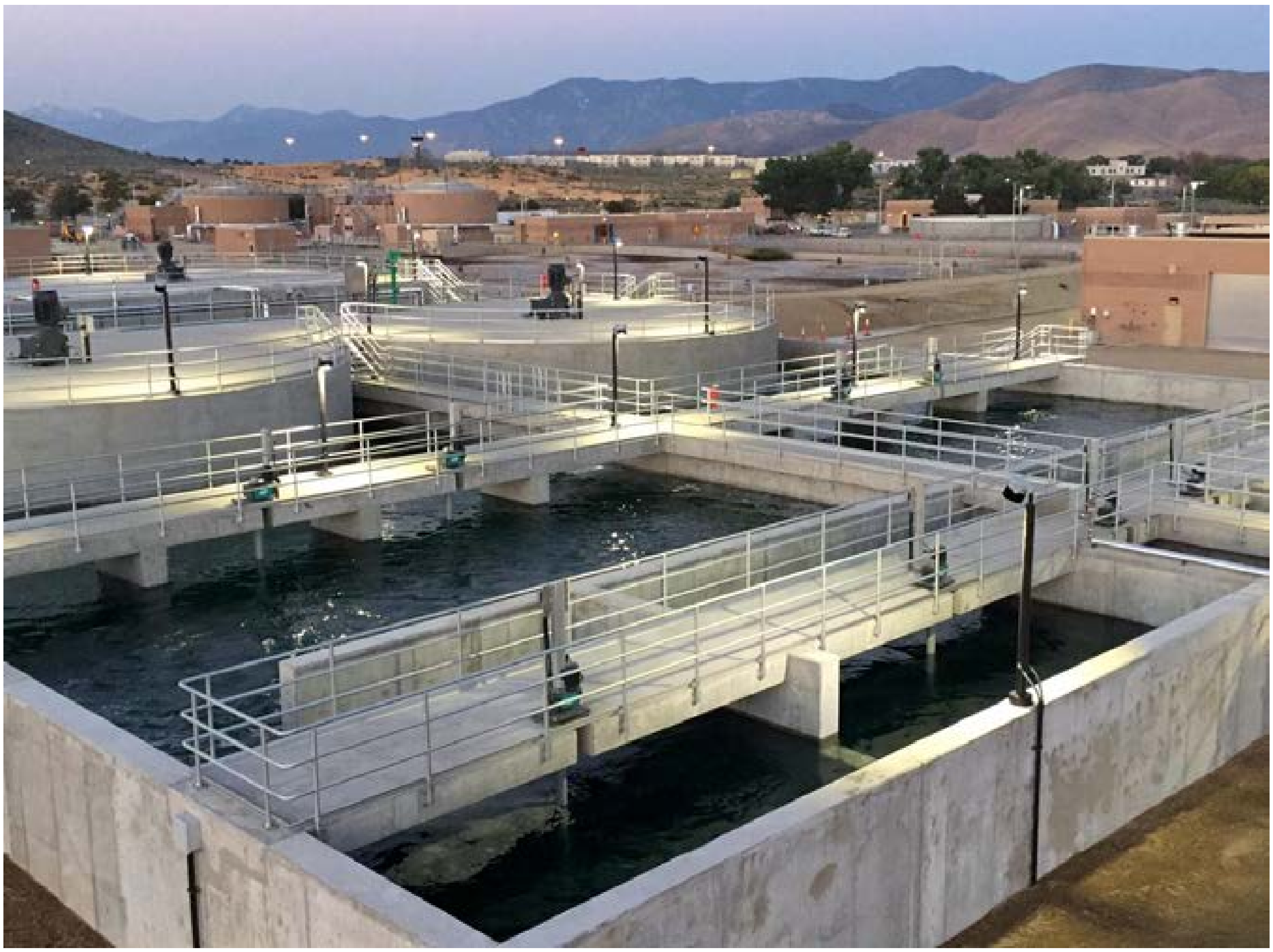



Figure 13. Nevada wastewater volumes. The total influent, effluent and recycled water volumes calculated for 12 wastewater treatment facilities in the state of Nevada based on 2022 data.

Las Vegas Wash, which drains the Las Vegas Valley, contributes some 184 MGD (206,000 AFY) of runoff to Lake Mead—roughly 1.5% of the total inflows to the reservoir (Las Vegas Wash Coordination Committee, 2023). Ninety percent of the baseflow to the wash is supplied by treated wastewater, which, combined with urban runoff and shallow groundwater seepage, are considered return flow to the Colorado River system.[16] Because Nevada receives a one-to-one credit for every gallon of water returned to Lake Mead, the state is able to withdraw far more than its allocated 300,000 AFY.

According to the Southern Nevada Water Authority (SNWA), a government agency founded in 1991 to manage southern Nevada's water needs on a regional basis, 99% of the wastewater treated in its service area is recycled (SNWA, 2024). The vast majority of the recycled water is accomplished through return-flow credit. In fact, in 2017 SNWA adopted a policy prioritizing return of treated wastewater to Lake Mead over further development of direct-use projects, particularly for consumptive use outside of the Las Vegas Valley (SNWA, 2024).



Carson City water resource recovery facility. (photo credit: Carson City Public Works).

16 As the water is discharged through Las Vegas Wash, it is not covered by the state's IPR regulations as "discharge of reclaimed water into an aquifer."

In contrast, reuse in the northern portion of the state often features more direct reuse, in particular for agricultural and golf course irrigation. For example, both the Elko and Carson City wastewater treatment facilities claim to be zero discharge. The Elko Water Reclamation Facility states that 100% of its treated wastewater from April through October is reused for golf course and hayfield irrigation or for dust abatement, and in winter months the effluent is either sent to rapid infiltration basins for ground percolation or used in small amounts for plant operations and continued hayfield watering.

Reuse in the northwestern portion of the state surrounding Reno is complicated by requirements of the Truckee River Operating Agreement. Surface water withdrawn from the Truckee River system is subject to a return-flow requirement. Under the agreement, water that is then recycled, and thus diverted from return to the Truckee River, must generally either have been sourced from groundwater or must be covered by surface water rights that are dedicated to in-stream flows. As a result, while Truckee River flow is preserved, current attempts at recycling additional water face barriers. A regional agency collaboration, known as OneWater Nevada, between the Truckee Meadows Water Authority, the cities of Reno and Sparks, the University of Nevada at Reno, Washoe County, the Western Regional Water Commission, and the Truckee Meadows Water Reclamation Facility is developing an advanced purified water facility located at American Flat, with a goal of producing 2 MGD of drinking water (OneWater Nevada, n.d.).


Balloons over the Rio Grande outside Albuquerque, New Mexico (photo credit: Adobe stock photography).

## New Mexico

### *Statewide wastewater reuse: 18%*

***New Mexico recycles the highest percentage of its wastewater of the upper basin states, but a convoluted and overlapping regulatory system governing wastewater reuse and a lack of formal state guidance or programs have hindered overall efforts.***

New Mexico has the lowest surface water-to-land ratio in the United States, with lakes and rivers covering only 0.002% of the state's land. Of the lakes the state does have, most are artificial reservoirs (EROS Center, n.d.). Precipitation in the state is highly variable: On average, precipitation ranges from less than 10 inches in the southern desert region and Rio Grande Valley to greater than 20 inches at higher elevations and in the mountains. But annual extremes demonstrate the high variability of precipitation in the state. Over a 71-year record for Carlsbad, annual precipitation has ranged from 2.95 to 33.94 inches. Average rainfall over the state is 13.9 inches (New Mexico Weather, n.d.).

The vast majority of the state's population is concentrated in the Rio Grande Basin, which includes the cities of Albuquerque, Santa Fe, and Las Cruces; in 2015, 73% of the state's 2,085,109 residents lived in the basin. Total withdrawals in the basin account for 46% of the state's overall water use each year (Magnuson et al., 2019). In recent years, New Mexico's population growth has leveled off compared to neighboring states in the Colorado Basin, and projections now show the state experiencing potential population decline over the next decade.

The most recent report from the New Mexico Office of the State Engineer (OSE) on water use in the state, covering the 2015 calendar year and released in 2019, reported total water withdrawals of 3,114,225 acre-feet, 52.3% from surface water sources and 47.7% from groundwater (Magnuson et al., 2019). The report did not provide a comprehensive estimate of consumptive use, though it did discuss consumptive use from agricultural irrigation, which utilized the bulk of the withdrawals, 76.3%. Public water supply accounted for 9.1% of the water use. Self-supplied domestic water, livestock, commercial, industrial, mining, and power each accounted for less than 2% of the total, with reservoir evaporation accounting for the rest.

Like other upper basin states, New Mexico's entitlement to Colorado River water is governed by the 1948 Upper Colorado River Compact. New Mexico is allotted 11.25% of the upper basin's 7.5 MAFY of flow, though this resulted in an average of only 420,000 AFY of total consumptive use from the basin between 2016 and 2020 (Stern et al., 2024).

## Regulatory Background

Treatment and reuse of wastewater in New Mexico is overseen by the New Mexico Environment Department (NMED) and the OSE. But New Mexico is also one of only three states in the country that does not administer the NPDES program within its borders. As a result, the federal EPA plays a relatively large role in the permitting and oversight of wastewater treatment facilities in the state and administers all of New Mexico's NPDES surface water discharge permits under the Clean Water Act.

## Wastewater Reuse in New Mexico

Regulation of wastewater reuse in New Mexico is a complex framework with aspects, sometimes overlapping, governed by multiple state agencies. NMED has primary responsibility for regulating the reuse of wastewater in the state. But in a somewhat tortuous arrangement, authority is housed in NMED's Ground Water Quality Bureau, and "above ground use of reclaimed domestic wastewater" is permitted through the bureau's groundwater discharge permits (GDP) program (see NMED, 2007).

To this end, water reuse is explicitly allowed, and encouraged, in the New Mexico state code, which directs state agencies to develop a state water plan to "develop water conservation strategies and policies; [and] to maximize beneficial use, including reuse and recycling by conjunctive management of water resources” (NM Stat § 72-14-3.1 (2021)). In 2007, NMED issued guidance on “above ground use of reclaimed domestic wastewater” (NMED, 2007). NMED defines reclaimed wastewater as “domestic wastewater that has been treated to the specified levels for the defined uses set forth in this guidance document and other applicable local, state, or federal regulations.” (NMED, 2007). All producers and users of reclaimed water are required to obtain a GDP, regardless of the volume that the facility treats or uses.

However, the OSE is responsible for administering water rights in the state, which includes governing how reuse is allowed within the existing water rights system. Branches of the OSE are tasked with “processing water rights applications, conducting the scientific research for making those water rights decisions, maintaining water rights records, and enforcing any conditions or restrictions on water use.” Additionally, the OSE plays a role in the regulation of IPR through permitting aquifer storage and recharge projects (19.25.8 NMAC (2001)). Aquifer recharge projects are additionally required to have an OSE underground storage and recovery permit, in addition to a GDP issued by NMED (19.25.8 NMAC (2001)).

Water that is applicable for reuse is categorized in one of four classes: 1A, 1B, 2, and 3. Each class of wastewater has associated pollutant limitations for BOD5, turbidity, fecal coliform, and total residual chlorine or UV transmissivity. The various classes of water also have differing monitoring requirements and measuring frequencies. (See Table 5 for associated values and limits.)

| Class of Reclaimed Wastewater | Wastewater Quality Parameter | Wastewater Quality Requirements | | Wastewater Monitoring Requirements | |
|---|---|---|---|---|---|
| | | 30-Day Average | Maximum | Sample Type | Measurement Frequency |
| Class 1A | $BOD_5$ | 10 mg/l | 15 mg/l | Minimum of 6-hour composite | 3 tests per week for major WWTP;<br>1 test per 2 weeks for minor WWTP |
| | Turbidity | 3 NTU | 5 NTU | Continuous | Continuous |
| | Fecal Coliform | 5 per 100 ml | 23 per 100 ml | Grab sample at peak flow | 3 tests per week for major WWTP;<br>1 test per week for minor WWTP |
| | TRC or UV Transmissivity | Monitor Only | Monitor Only | Grab sample or reading at peak flow | Record values at peak hourly flow when<br>Fecal Coliform samples are collected |
| Class 1B | $BOD_5$ | 30 mg/l | 45 mg/l | Minimum of 6-hour composite | 3 tests per week for major WWTP;<br>1 test per 2 weeks for minor WWTP |
| | TSS | 30 mg/l | 45 mg/l | Minimum of 6-hour composite | 3 tests per week for major WWTP;<br>1 test per 2 weeks for minor WWTP |
| | Fecal Coliform | 100 organisms per 100 ml | 200 organisms per 100 ml | Grab sample at peak flow | 3 tests per week for major WWTP;<br>1 test per week for minor WWTP |
| | TRC or UV Transmissivity | Monitor Only | Monitor Only | Grab sample or reading at peak flow | Record values at peak hourly flow when<br>Fecal Coliform samples are collected |
| Class 2 | $BOD_5$ | 30 mg/l | 45 mg/l | Minimum of 6-hour composite for major WWTP;<br>Grab sample for minor WWTP | 1 test per week for major WWTP;<br>1 test per month for minor WWTP |
| | TSS | 30 mg/l | 45 mg/l | Minimum of 6-hour composite for major WWTP;<br>Grab sample for minor WWTP | 1 test per week for major WWTP;<br>1 test per month for minor WWTP |
| | Fecal Coliform | 200 organisms per 100 ml | 400 organisms per 100 ml | Grab sample at peak hourly flow | 1 test per week for major WWTP;<br>1 test per month for minor WWTP |
| | TRC or UV Transmissivity | Monitor Only | Monitor Only | Grab sample or reading at peak hourly flow | Record values at peak hourly flow when Fecal Coliform samples are collected |
| Class 3 | $BOD_5$ | 30 mg/l | 45 mg/l | Minimum of 3-hour composite for major WWTPS;<br>Grab sample for minor WWTP | 1 test per week for major WWTP;<br>1 test per month for minor WWTP |
| | TSS | 75 mg/l | 90 mg/l | Minimum of 3-hour composite for major WWTP;<br>Grab sample for minor WWTP | 1 test per week for major WWTP;<br>1 test per month for minor WWTP |
| | Fecal Coliform | 1,000 organisms per 100 ml | 5,000 organisms per 100 ml | Grab sample at peak hourly flow | 1 test per week for major WWTP;<br>1 test per month for minor WWTP |
| | TRC or UV Transmissivity | Monitor Only | Monitor Only | Grab sample or reading at peak hourly flow | Record values at peak hourly flow when Fecal Coliform samples are collected |

Table 5. New Mexico wastewater quality requirements and monitoring frequencies by class of reclaimed wastewater (NMED, 2007).

Each class of reclaimed water can be used for only prescribed reuse activities (see Table 6). Dischargers are allowed to petition for alternative requirements for a stated activity and must demonstrate the water class provides equivalent protection of public health.

| Class of Reclaimed Wastewater | Approved Uses |
|---|---|
| Class 1A | All Class 1 uses. *No setback limit* to dwelling unit or occupied establishment. |
| | Backfill around potable water pipes |
| | Irrigation of food crops |
| Class 1B | Impoundments (recreational or ornamental) |
| | Irrigation of parks, school yards, golf courses |
| | Irrigation of urban landscaping |
| | Snow making |
| | Street cleaning |
| | Toilet flushing |
| | Backfill around non-potable piping |
| Class 2 | Concrete mixing |
| | Dust control |
| | Irrigation of fodder, fiber, and seed crops for milk-producing animals |
| | Irrigation of roadway median landscapes |
| | Irrigation of sod farms |
| | Livestock watering |
| | Soil compaction |
| Class 3 | Irrigation of fodder, fiber, and seed crops for non-milk-producing animals |
| | Irrigation of forest trees (silviculture) |

Table 6. New Mexico approved uses for reclaimed wastewater by class (NMED, 2007).

New Mexico does not have specific regulations covering potable reuse of wastewater. Yearslong efforts to develop guidance for IPR and DPR in the state have largely stalled (see NMED, n.d.). Nevertheless, the state does appear to allow IPR under their current regulatory schemes (EPA, 2021b). In early 2024, the state released its 50-year water action plan, which specifically calls for the state to "develop and implement comprehensive water reuse rules for potable and non-potable reuse of treated wastewater" (State of New Mexico, 2024).

OSE is responsible for permitting aquifer storage and recovery projects under the state's 1999 Groundwater Storage and Recovery Act (NM Code Regs. § 72-5A). GDPs for aquifer projects set limits for water quality and require water quality monitoring (19.25.8 NMAC (2001)). NMED can also permit aquifer storage and recovery projects on a case-by-case basis through issuing a GDP with site-specific water quality requirements (NM Code Regs. § 20.6.2.5000). Overall, however, the lack of coordinated management has left the state with relatively low efforts of IPR.

## Wastewater Reuse Data

According to the 2017 UNC report, there are 125 POTWs operating in New Mexico, of which 100 treat 1 MGD of influent or less (UNC Environmental Finance Center, 2017).

Because New Mexico is one of only three states that do not administer the Clean Water Act's NPDES program at the state level, EPA maintains responsibility for issuing discharge permits for wastewater facilities that discharge to surface waters in the state. In addition, a subset of New Mexico wastewater treatment facilities discharge solely to groundwater (or reuse wastewater), and are governed by NMED's GDP scheme. This split of authority means that there is no single entity maintaining records for wastewater treatment facilities in the state, which—as with many of the basin states—complicated efforts to identify then obtain data on treatment facilities.

We first reviewed EPA's issued NPDES permits and EPA's ECHO database to generate a list of municipal wastewater treatment facilities holding surface water discharge permits with an average discharge volume of greater than 1 MGD. We also obtained a list of all GDPs in the state and sorted for wastewater producers and users from NMED's Ground Water Quality Bureau. While the information we obtained included *permitted* reuse or recharge volumes, NMED staff responded that "information pertaining to actual reported reuse volumes was maintained only as part of each permittee's monitoring reports, which could be found in hard copy at NMED's offices in either Santa Fe or Albuquerque" (NMED, pers. comm.). This left us to contact remaining identified facilities directly for information on influent, effluent, and reuse volumes—though many either did not respond or did not provide any data in their response. At the same time, we began to identify errors and data quality issues with information supplied from ECHO. For example, ECHO's entry for one of our surveyed facilities reported an average effluent flow for the facility seven times greater than the facility's permitted design flow, and 7.5 times greater than the value reported by the facility in response to our communication. As a result, where possible, we obtained data directly from facilities and compared available information against ECHO's reporting.

We ultimately obtained data we deemed reliable for 14 facilities treating greater than 1 MGD, including those serving nine of the state's 10 largest municipal jurisdictions. However the lack of response from a number of facilities and overall concerns with data from ECHO precluded us from completing a comprehensive picture of the state's wastewater programs.

The UNC study estimated that, as of 2016, 1,791,255 residents out of the state's 2,081,015 total population (86%) were served by a POTW. This contrasts somewhat from a 2012 estimate from the American Society of Civil Engineers that only 73% of households in New Mexico were serviced by POTWs (American Society of Civil Engineers, 2012). We conclude that our assessment likely covers 60% of the total population, but between 68% and 78% of the sewered population.

## Wastewater Reuse Analysis

Of the treatment facilities we obtained data for in New Mexico, 18,151 acre-feet out of 97,222 total acre-feet treated for 2022—18.7% of influent reported—were ultimately recycled (Figure 14). The reuse volume includes water designated as reuse through aquifer recharge. Irrigation and agricultural use were the most common reuse applications reported by the surveyed facilities, followed by industrial or process water and then aquifer recharge. Specific volume data for these practices was not available.

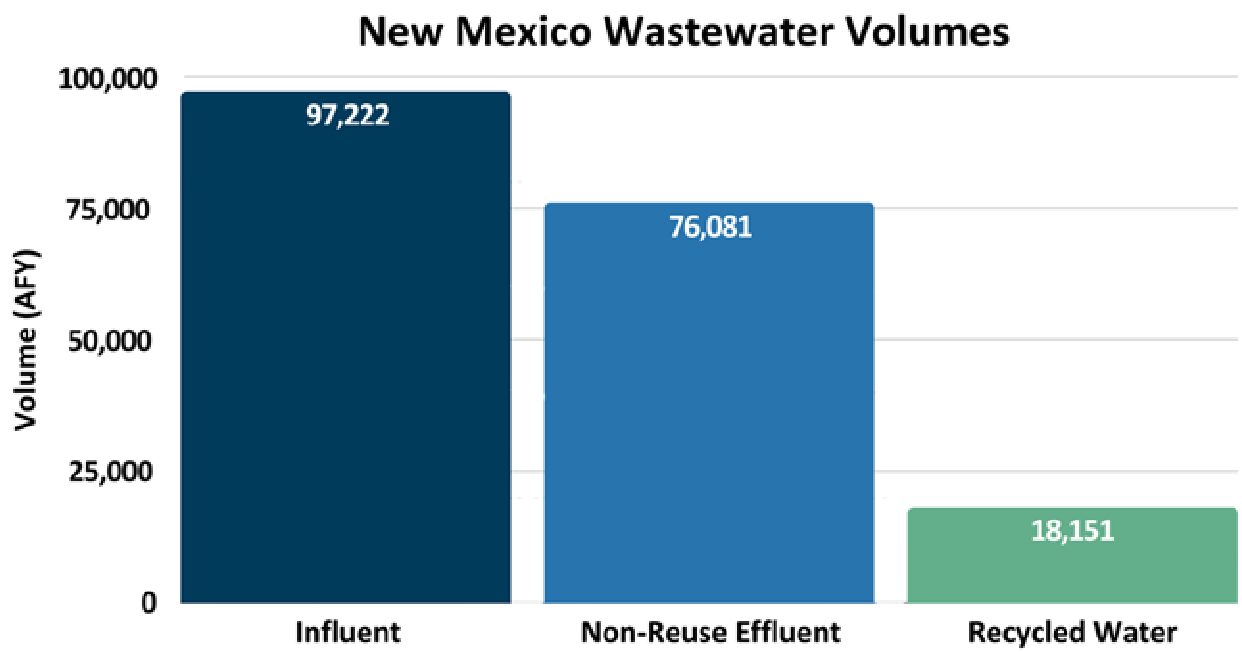



Figure 14. New Mexico wastewater volumes. The total influent, effluent, and reclaimed water volumes calculated for 14 wastewater treatment facilities in the state of New Mexico based on 2022 data.

This total far exceeds recycling efforts in Colorado, Utah and Wyoming (the latter states discussed further below), and reflects the highest percentage of recycling in the upper basin. However it also significantly lags behind the efforts of the lower basin states. Finalizing guidance and regulation for IPR and DPR programs in the state, and increasing state focus and resources for reuse, would greatly increase the potential for reuse across New Mexico.

Railroad tracks on the Great Salt Lake (photo credit: Urvish Oza on Pexels).

## Utah

***Statewide wastewater reuse: less than 1%***

***Utah was the fastest growing state in the U.S. from 2010 to 2022, and its population is expected to double by 2065, creating severe concerns over the already vulnerable status of the state's water supply. But the state has historically not developed recycled water as a resource, and recent changes to state law have introduced significant barriers to any potential expansion of water reuse in the state's most populous region.***

Utah has an annual average rainfall that ranged from a high of 20.3 inches in 1941 to the recent lowest historically recorded level of 6.2 inches in 2020 (Frankson et al., 2022). The state is highly susceptible to drought; following the state's record low snowpack in 2020-2021, by July 2021, 99.4% of Utah was listed as being in "exceptional" to "extreme" drought by the U.S. Drought Monitor (Utah Division of Water Resources, 2021). In 2022, both the Great Salt Lake in the northern part of the state and Lake Powell along its southern border reached record low levels (Utah Division of Water Resources, 2024).

More than half of Utah's current—and rapidly growing—population of 3.38 million residents live in Salt Lake and Utah counties within the Great Salt Lake watershed, and 80% live along a roughly 120-mile stretch of the Wasatch Front that includes Ogden, Provo and Salt Lake City (Kaufusi & Ramsey, 2023). The Great Salt Lake, which drains from the Wasatch Front, is the largest saline lake in the Western Hemisphere and the eighth largest in the world, and is central to Utah's hydrologic and economic well-being (Utah Division of Water Resources, 2024). It generates an economic output of $1.9 billion annually and employs nearly 8,000 Utahns (Great Salt Lake, n.d.; Utah Division of Water Resources, 2024). But the same tributaries that supply the Great Salt Lake also supply the region's water: 90% of Salt Lake City's water comes from snowpack in the Wasatch Mountains, which supply a number of other towns and districts along the front (Briefer, 2018). Consumptive water use in the Great Salt Lake watershed, predominantly for agriculture (63% of consumptive use), has reduced water flows to the lake from its surface tributaries by an estimated 39% (Null & Wurtsbaugh, 2020). This in turn has reduced the lake's area by 51% and its volume by 64% (Null & Wurtsbaugh, 2020). Coupled with effects of recent and recurrent severe drought, Great Salt Lake levels reached a record low in November 2022. Though levels rebounded somewhat in 2023 due to heavy snowpack, the long-term trend of decreased lake levels is having negative effects on the region's ecology and its human population.

Utah's entitlement to flows from the Colorado River is governed by the 1948 Upper Colorado River Compact. Utah is allotted 23% of the upper basin's flow, and 27% of Utah's water is supplied from the Colorado River (Utah Division of Water Resources, n.d.). The state accounted for an average of just over 1 MAFY of total consumptive use from the basin between 2016 and 2020 (USBR, 2022). In total, Utah diverted or withdrew an average of approximately 4.75 MAFY from all sources between 1989 and 2018, with consumptive use totaling an average of 2.957 MAFY (Utah Division of Water Resources, 2021). Agricultural water use constitutes the largest proportion of the state's overall water consumption—around 80%—while municipal water use only constitutes 9% of the water consumed (State of Utah, 2022; Utah State University, n.d.).

Water recycling efforts in Utah have historically been extremely limited. Reuse is allowed for certain purposes under the Utah code, and in regions such as the relatively fast-growing Washington County in the southwest corner of state, water recycling is receiving increased focus. The county released a 20-year plan "to secure new water supplies for Washington County, Utah" in July 2023, which proposes that multiple, "large-scale projects are needed to treat, convey, store, and deliver reuse water to the county" (Bowen Collins & Associates, 2023). However, in order to prevent even further reductions in lake volume and area, a new law passed in 2023—H.B. 349, the Water Reuse Project Amendments—threatens to effectively prohibit future water reuse projects in the Great Salt Lake watershed to the north, stalling the state's already meager progress (H.B. 349 (2023)). Ironically, as discussed below, the law has potentially increased interest in wastewater reuse projects, while also serving as a roadblock to them.

One potentially promising project in Salt Lake City is a new 35 MGD water reclamation facility that includes biological nutrient removal. The $800 million project will be completed in 2026 and will discharge directly into Farmington Bay of the Great Salt Lake, which should reduce harmful algal bloom problems because of nutrient reduction. However, there are no plans to reuse the water because it is needed to help clean up the Great Salt Lake and stabilize lake levels. Salt Lake City is in the process of filing a water right reuse application to dedicate water rights associated with the advanced treated wastewater to the Great Salt Lake (Salt Lake City Department of Public Utilities, pers. comm.). While the project is admirable because of its benefits to the lake, we do not consider it as water reuse because it does not offset water demand.

## Regulatory Background

Utah's water reuse systems are managed by a combination of agencies within the Utah Department of Natural Resources, such as the Division of Water Rights (overseen by the Utah State Engineer), and within the Department of Environmental Quality (UDEQ), which houses the Division of Water Quality.

## Wastewater Reuse in Utah

Under the 2006 Utah Wastewater Reuse Act, reuse water is defined as "domestic wastewater treated to a standard acceptable under rule made by the Water Quality Board" (housed within the Division of Water Quality) (Utah Code Ann. §§ 73-3c-101 – 401). The law addresses regulation of POTWs and requires that any entity applying for a reuse project be a public agency, in effect limiting the implementation of water reuse projects (Reimer & Bushman, 2021).

Utah lacks regulations specifically addressing IPR or DPR. The state currently sets two classifications for non-potable water for reuse, Type I and Type II, depending on whether human contact is likely or not (Utah Admin. Code 317-3-11). Type I uses include residential irrigation; all "urban uses," such as golf course and landscape irrigation, toilet flushing, and fire protection; irrigation of food crops where the recycled water is "likely to have direct contact with the edible part"; irrigation of pastures for milking animals; and all spray irrigation. Type I uses require at least secondary treatment and additionally filtration and disinfection to destroy, inactivate, or remove pathogenic microorganisms through an approved physical, chemical, or biological process such as chlorination, ozone, or UV radiation. Type I requirements specify additional filtration and disinfection steps beyond Type II (discussed below) and higher water quality standards. Water quality limits for Type I water include:

- The monthly arithmetic mean of BOD shall not exceed 10 mg/L.
- The daily arithmetic mean turbidity shall not exceed 2 NTU, and turbidity shall not exceed 5 NTU at any time.
- The weekly median E. coli concentration shall be none detected, as determined from daily grab samples, and no sample shall exceed 9 organisms/100 mL (Utah Admin. Code 317-3-11.4(C)).

Type II uses of reuse water include irrigation of sod farms, irrigation of feed crops where the recycled water is not likely to have direct contact with the edible part, irrigation of animal feed crops or pasture not used for milking animals, and cooling water or impoundments where human contact is unlikely. Type II uses require at least secondary treatment and additionally filtration and disinfection to destroy, inactivate, or remove pathogenic microorganisms through an approved physical, chemical, or biological process such as chlorination, ozone, or UV radiation. Water quality limits for Type II water include:

- The monthly arithmetic mean of BOD shall not exceed 25 mg/L.
- The monthly arithmetic mean TSS concentration shall not exceed 25 mg/L, and the weekly mean TSS concentration shall not exceed 35 mg/L.
- The weekly median E. coli concentration shall not exceed 126 organisms/100 mL, and no sample shall exceed 500 organisms/100 mL (Utah Admin. Code 317-3-11.5(C)).

**Regulatory Hurdles to Expanding Wastewater Reuse**

In 2023, the Utah legislature passed H.B. 349, the Water Reuse Project Amendments (enacted as Utah Code 73-3c-103). The bill effectively prohibits future water recycling projects within the Great Salt Lake watershed, stating:

Water reuse projects and the Great Salt Lake—Exception. (1) Except as provided in Subsection (3) and notwithstanding the other provisions of this chapter, the director and the state engineer may not approve a water reuse project if the water related to the water reuse project would have otherwise been discharged into a tributary of the Great Salt Lake.

The bill was ostensibly passed in order to prevent further loss and degradation of the Great Salt Lake by increasing treated wastewater discharge volumes to the lake. While the bill represents a significant potential barrier to wastewater reuse, it also contained a provision that allows reuse project applications filed before November 1, 2023, to move forward. Utah has only approximately 25 water reuse projects operating across the state currently, but the Division of Water Quality received a reported 45 applications for new projects before the November deadline. While many of the permits may ultimately be deemed incomplete for failing to include a “replacement plan” for diverted water, this rush may paradoxically result in a possible boost for recycled water efforts.

## Water Reuse Data

The UDEQ and its Division of Water Quality maintain a permit database for wastewater facilities but do not track or maintain data on facility flow or other volume metrics. Influent and effluent volumes included in this analysis were taken either from EPA's ECHO database, where they were reported, or directly from the facilities. UDEQ similarly does not maintain any comprehensive list of facilities that treat reclaimed effluent for reuse, but wastewater reuse volumes were provided by UDEQ for some of the identified facilities. Our analysis identified 28 municipal treatment plants operating in Utah with an average daily influent over 1 MGD. We were able to obtain both influent and effluent data for 11 of the 28 wastewater treatment facilities assessed. For the remaining 18 facilities, influent volumes for each facility were calculated as the combined total of effluent as reported by ECHO and reuse volumes reported by the state or facility. Data from ECHO was checked against reported facility discharge volumes to ensure large-scale errors were not present.

Based on our review, only 2,717 acre-feet of wastewater were ultimately reused out of 296,329 total acre-feet of wastewater treated in 2022—less than 1% of the calculated influent. This is the smallest percentage of wastewater recycled by any state in the Colorado River Basin by a wide margin.

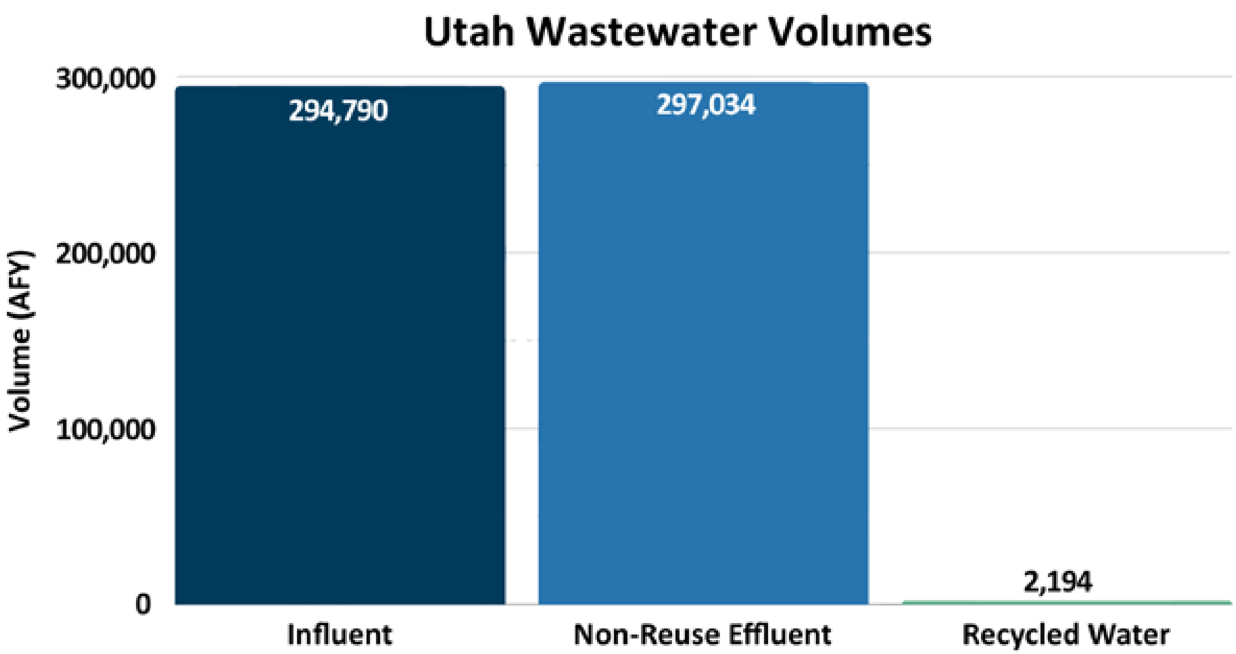



Figure 15. Utah wastewater volumes based on 2022 data.

Demonstration projects are beginning to come online in the state. For example, Pure SoJo—a demonstration project in South Jordan, a city south of Salt Lake City that imports 100% of its water supply—is showcasing the potential to treat reclaimed water to drinking water standards (Pure SoJo, n.d.). The Division of Water Quality has also awarded a total of $15 million in funding across 12 wastewater reuse projects under the Southern Utah Reuse ARPA Grant Program, a competitive awards program (UDEQ, 2022). But to date, these projects have added up to a literal drop in the bucket; at least for now, Utah does not significantly recycle wastewater (Figure 15).

Castle Rock and the Green River in Green River, Wyoming (photo credit: Jasperdo/flickr).

## Wyoming

### *Statewide wastewater reuse: 3.3%*

### *The least populated state in the nation has no formal wastewater reuse program at the state level. It comes as no surprise that Wyoming doesn't reuse much wastewater.*

The fifth driest state in the country, much of Wyoming has experienced a prolonged moderate to extreme drought since 1999. The state's total average annual rainfall is only 15.9 inches per year, but its climate exhibits wide variability from year to year, with additional fluctuation due to geography. Annual precipitation can vary from more than 36 inches in the mountains to as little as 6 inches at lower elevations or on the plains. The state relies heavily on snowpack for surface water supplies, and it serves as a significant headwaters for four major river basins—the Missouri-Mississippi Basin, Snake-Columbia River Basin, Great Salt Lake Basin, and Green-Colorado River Basin—which drain approximately 17% of Wyoming's total land area (Hansen et al., 2015).

Wyoming is also the least populated state in the U.S., with a total of only 576,851 residents as of 2020. Its largest city, Cheyenne, checks in at only 65,132 residents, which would place it outside the top 10 cities by population in Colorado or Arizona, and outside the top 100 in California. Wyoming's entitlement to flows from the Colorado River is governed by the 1948 Upper Colorado River Compact. The state is allotted 14% of the upper basin's flow. Wyoming accounted for an average of 421,000 AFY of total consumptive use from the basin between 2016 and 2020, notably less than its theoretical entitlement (USBR, 2022).

Estimates of overall water use in Wyoming vary, but for surface water consumption range from 3 MAFY to 3.5 MAFY (Wyoming Water Development Commission, 2020; Wyoming Water Development Office, 2018). A further 300,000 acre-feet of supply is estimated to be sourced from groundwater as of 2015. Because of its relatively small population, the state estimates that municipal and domestic water use in 2018 accounted for less than 3% of the statewide total, only approximately 91,000 acre-feet. Agricultural irrigation—of some 1.7 million acres of land—accounts for as much as 90% of the water use in the state (Wyoming Water Development Office, 2018).

While the state authorizes the use of reclaimed water for a limited set of purposes, such as irrigation and industrial processes, given Wyoming's small population it is perhaps unsurprising that the state does not currently have a formal program devoted to water recycling. This is reflected in the low percentage of the state's wastewater that is currently diverted for reuse.

## Regulatory Background

Environmental protection and conservation in Wyoming is overseen by the Wyoming Department of Environmental Quality (WDEQ), including, under its Water Quality Division (WQD), oversight of Wyoming's surface and groundwater resources. The EPA issues NPDES permits on tribal lands, but the WQD issues permits for the rest of the state through the Wyoming Pollutant Discharge Elimination System (WYPDES) program, which regulates point source discharges into surface waters under the Clean Water Act (Wyoming Administrative Rules: Chapter 2; statutes in Title 35, Public Health and Safety (DEQ)). WQD also maintains an authorized permit archive. The Wyoming Water Development Commission provides for planning, operation and other aspects of projects to promote optimal development of the state's water resources, and the Wyoming State Engineer's Office is responsible for administering water rights and setting requirements that all facilities must comply with. Wyoming is currently the only state that does not participate in the public water system supervision program under the federal Safe Drinking Water Act.

## Wastewater Reuse in Wyoming

Wyoming has specific requirements for reusing wastewater (see Chapter 11 Part H: Standards for the Reuse of Treated Domestic Water). Wyoming defines "treated wastewater" as "domestic sewage discharged from a treatment works after completion of the treatment process" (020-0011-11 Wyo. Code Regs. § 11). Permitting for reuse of wastewater is overseen by WDEQ. Chapter 11: Part H. Section 73 outlines treatment standards for three categories of reused water, defined as Class A, B and C wastewater:

- Class A wastewater is treated wastewater that has received advanced treatment and/or secondary treatment and a level of disinfection so that the maximum number of fecal coliform organisms is 2.2/100 mL or less.
- Class B wastewater is treated wastewater that has received the equivalent of secondary treatment and a level of disinfection so that the maximum fecal coliform level is greater than 2.2/100 mL but less than 200/100 mL.
- Class C wastewater is treated wastewater that has received the equivalent of primary treatment and a level of disinfection so that the maximum fecal coliform level is 200/100 mL or greater but less than 1000/100 mL.

Reuse applications are then governed by the potential for human exposure—from low to moderate to high—with Class A wastewater authorized to be used for applications with high potential for exposure:

(i) Irrigation of land with a high potential for public exposure

(ii) Irrigation of land with a moderate potential for public exposure

(iii) Irrigation of land with a low potential for public exposure

(iv) Irrigation of direct human consumption food crops

(v) Irrigation of indirect human consumption food crops (Part H. Section 82).

Class C is allowed only for irrigation of land with a low potential for public exposure and irrigation of indirect human consumption food crops.

## Water Reuse Data

Wyoming maintains requirements for recordkeeping and reporting of wastewater reuse under Chapter 11: Part H, sections 85 and 86, which include annual reporting to the state of data including treatment level, location where treated wastewater is applied, and cumulative volume of water reused. However, we were unable to obtain much of the relevant information directly from the state. More broadly, we had difficulty compiling a complete list of POTWs operating in Wyoming, as data and listings maintained in the EPA ECHO database, from the WYPDES program, and from other state sources were either incomplete or directly conflicted with the other data sources. In fact, ECHO maintains a disclaimer about information displayed for Wyoming, stating:

> Known data problems from ECHO database: Primary Data Alert: Wyoming is experiencing issues affecting the upload of data to the national program system ICIS. Discharge Monitoring Report and facility compliance status data displayed on ECHO may not be accurate.... *(Updated October 2017)*.

With specific regard to recycling efforts, WDEQ staff informed us that “our WYPDES program does not track water recycling activities, since they are not regulated discharges,” and referred us back to EPA’s ECHO database (WDEQ, pers. comm.). Given the lack of available public data, in order to identify wastewater treatment plants in Wyoming treating an average of greater than 1 MGD, we compiled a list of all Wyoming cities with a population of greater than 10,000 people, then contacted the relevant local county or city agency or contacted an identified local wastewater facility directly to collect data on influent, effluent, treatment level, and water recycling, if any. Treatment data was ultimately collected for a total of 12 major POTWs.[17] Total influent treated across the 12 for 2022 was 38,533 acre-feet, while only 1,276 acre-feet of reuse was reported, amounting to 3.31% of the total wastewater. This was the third lowest reuse percentage, and by far the lowest volume, of the seven Colorado River Basin states (Figure 16).

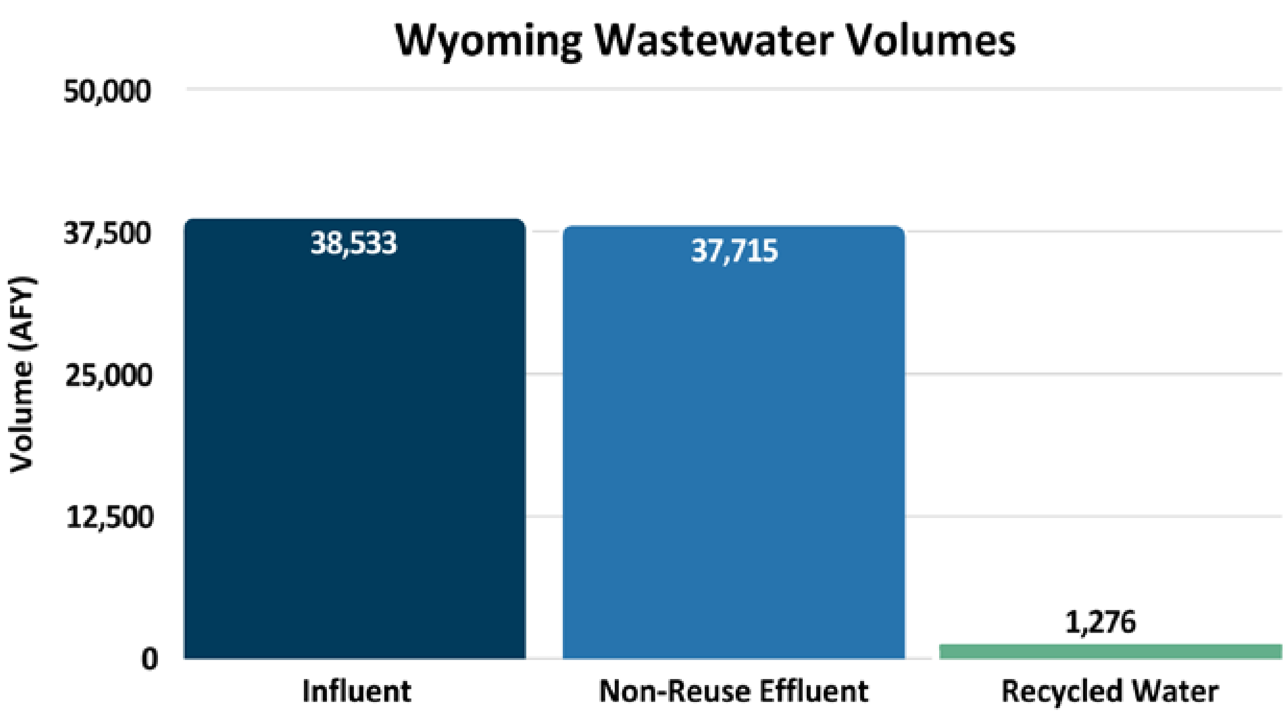



Figure 16. Wyoming wastewater volumes based on 2022 data.



17 The 2017 UNC study stated that there are 96 POTWs operating in Wyoming, 83 of which treat 1 MGD or less, largely in line with our findings (UNC Environmental Finance Center, 2017).

We note again that data for the state was extremely difficult to obtain. We were unable to obtain data for five plants we identified based on population that could exceed the 1 MGD threshold, including Kemmerer (Diamondville, WY), Big Goose (Sheridan, WY), Powell (Powell, WY), Marbleton WWP (Marbleton, WY) and Pinedale (Pinedale, WY), as these facilities did not respond to our requests. Overall, however, our analysis indicates reuse efforts in Wyoming are sporadic and limited, and water reuse does not appear to be a high priority for the state.

91st Avenue Wastewater Treatment Plant in Phoenix, Arizona (photo credit: Phoenix Water Services Department).

# Conclusion

As detailed throughout this report, the lack of federal wastewater reuse policy, regulations or up-to-date guidance, clear definitions and consistency among and between states, state-level oversight or awareness of reuse efforts, and publicly available data severely hampers water reuse development and progress across the Colorado Basin. Below we present recommendations for both federal and state-level action. We urge strong action be taken to avert or reduce potential impacts of decreasing availability of Colorado River flows and to establish sustainable, climate-resilient and reliable water supply for the future.

At the federal level, EPA should:

- Working with state partners, water agencies, and nongovernmental organizations, within two years develop a model state program and ordinance for recycling of municipal wastewater with minimum elements. The program should provide clear definitions, including for different levels of treatment and types of water reuse, as well as frameworks for standardized monitoring and reporting programs, cost information, guidance on residuals management for facilities, and other resources for states.
- Improve data acquisition and management, including developing guidance for standardized, electronic facility-level reporting and state data sharing to ensure availability of information and comparability of data between states. Reporting should include, at

minimum, volume of influent, non-reuse effluent, facility losses and reuse, as well as level of treatment, discharge receiving waterbody and end use of reclaimed water.

- Further develop and disseminate the latest science and technical information on treatment processes and pathogen risk assessment for different sources of water and reuse applications, both potable (IPR and DPR) and non-potable. This could include recommended log pathogen and pathogen indicator removal targets and monitoring requirements to ensure recycled water quality is protective of public health.
- Develop a model monitoring program for DPR in collaboration with the states and other stakeholders with technical expertise. In order to provide consumer confidence that DPR water is safe to drink without an environmental buffer, monitoring requirements should include flow cytometry to determine whether *Giardia*, *Cryptosporidium* and fecal indicator bacteria are passing through treatment. Real-time monitoring of viruses can't be done cost-effectively at this time, but bacteria and protist monitoring can. Real-time monitoring of TDS and turbidity and total inorganic nitrogen would be ideal. The potential public health risk of an illness outbreak due to operator error, equipment malfunction, inadequate monitoring or overdue maintenance makes relying on quantitative microbial risk assessment alone an ill-advised approach.
- Provide information on water reuse permitting best practices.
- Develop wastewater water reuse goals and timelines, in partnership with the states.
- Develop and implement funding strategies, including furthering the Pilot Program for Alternative Water Source grants to accelerate major water reuse investments. In order to make recycled water affordable for all, EPA, working with other federal agencies such as the USBR (which currently provides funding through the Title XVI Water Reclamation and Reuse Program, the Desalination Construction Program, and the Large-Scale Water Recycling Program) and the U.S. Departments of Agriculture, Energy and Defense must start providing substantial grant funding for water recycling in addition to expansion of their current low-interest loan programs.

At the state level, assessing the progress or effectiveness of different state programs and conducting comparisons between states or even gaining a comprehensive understanding of each individual state is severely hampered by lack of oversight and data.

State governments should, in coordination with federal agencies where appropriate:

- Establish numeric targets for wastewater reuse for each state, with timelines and interim goals. Figure EX-2 provided a breakdown of the total water supply that would be made available for each state with targeted goals of 30%, 40% or 50% reuse, a number already exceeded by two of the basin states.
- Work with local water reclamation or reuse agencies to develop funding strategies to meet targets for 30%, 40%, or 50% goals.
- Improve data acquisition and management, as well as reporting requirements where applicable, for wastewater treatment facilities and for wastewater reuse operations. The widespread lack of information availability across the Colorado River Basin renders coordinated efforts to improve wastewater reuse challenging and hampers efforts to identify greater opportunities.
- Conduct assessments of current state legal and regulatory requirements to identify barriers to wastewater reuse and develop formal state policies for overcoming those barriers and increasing wastewater recycling.

Opportunities exist to increase wastewater reuse by more than 1 MAFY within 10-15 years, greatly improving water security across the Colorado River Basin. But it will require a strong commitment from all participants.

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