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The Narrows on the Blanco River.

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Water Reuse in the Hill Country: Lessons from Existing Reuse Facilities in Texas and Opportunities to Advance Reuse in Comal County

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Abstract: The Greater Edwards Aquifer Alliance outlines the opportunities present in the Texas Hill Country to use recycled water to alleviate the burdens placed on the Edwards and Trinity aquifers by focusing on the present state of recycled water use in Comal County, Texas. The impacts of population growth, prolonged drought, and wastewater disposal on water sources in Comal County are analyzed along with current sources of water reuse to show where recycled water can be utilized effectively. Reclaimed water systems in seven municipalities across Texas are analyzed as case studies to provide examples for further implementation. Water reuse is integral to protecting water supplies and ensuring counties in the Hill Country can adequately protect the health, safety, and quality of life of current and future residents. Water reuse is a vastly underutilized tool in the effort to manage water supplies in the Hill Country, and there are a variety of authorization, financing, and implementation opportunities present in the region to take better advantage of this resource.
Keywords: potable water, purple pipe infrastructure, Texas Hill Country, water reuse

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Terms used in paper

Acronym / Initialism	Descriptive Name
AWCRD	Alamo Water Conservation and Reuse District
CRMWD	Colorado River Municipal Water District
CWSRF	Clean Water State Revolving Fund
DFund	Texas Water Development Fund
EAA	Edwards Aquifer Authority
EPA	U.S. Environmental Protection Agency
EPW	El Paso Water
GBRA	Guadalupe-Blanco River Authority
LWVCA	League of Women Voters of Comal Area
MGD	million gallons per day
MUD	municipal utility district
NBU	New Braunfels Utilities
SAWS	San Antonio Water System
SB	Senate Bill
SPP	State Participation Program
SWIFT	State Water Implementation Fund for Texas
SWWC	SouthWest Water Company
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TLAP	Texas Land Application Permits
TPDES	Texas Pollutant Discharge Elimination Systems
TWC	Texas Water Company
TWDB	Texas Water Development Board
USBR	U.S. Bureau of Reclamation
USCB	U.S. Census Bureau
USGS	U.S. Geological Survey
WIFIA	Water Infrastructure Finance and Innovation Act

INTRODUCTION

The purpose of this report is to provide the rationale for the development of water reuse districts in the Hill Country based on an analysis of the status of water reuse in Comal County. The Hill Country is known for its many natural treasures, including springs, rivers, and underlying aquifers. These inviting waters serve as an attraction for people who want to live, work, and play surrounded by the beauty of the Hill Country. It is unsurprising then that development in the region is occurring at an unprecedented pace (Texas Water Development Board [TWDB], 2023). This development, however, is placing great strain on the natural resources for which the region is known and on which millions of people depend. The unique environment of Comal County and the Hill Country—overlying two karstic aquifers and subject to intense rainfall and drought—means water sources are highly vulnerable to shortages caused by drought, and to contamination caused by wastewater disposal practices. Water reuse systems could allow the region to meet the challenges posed by population growth and water scarcity while preserving the quality and availability of existing water supplies.

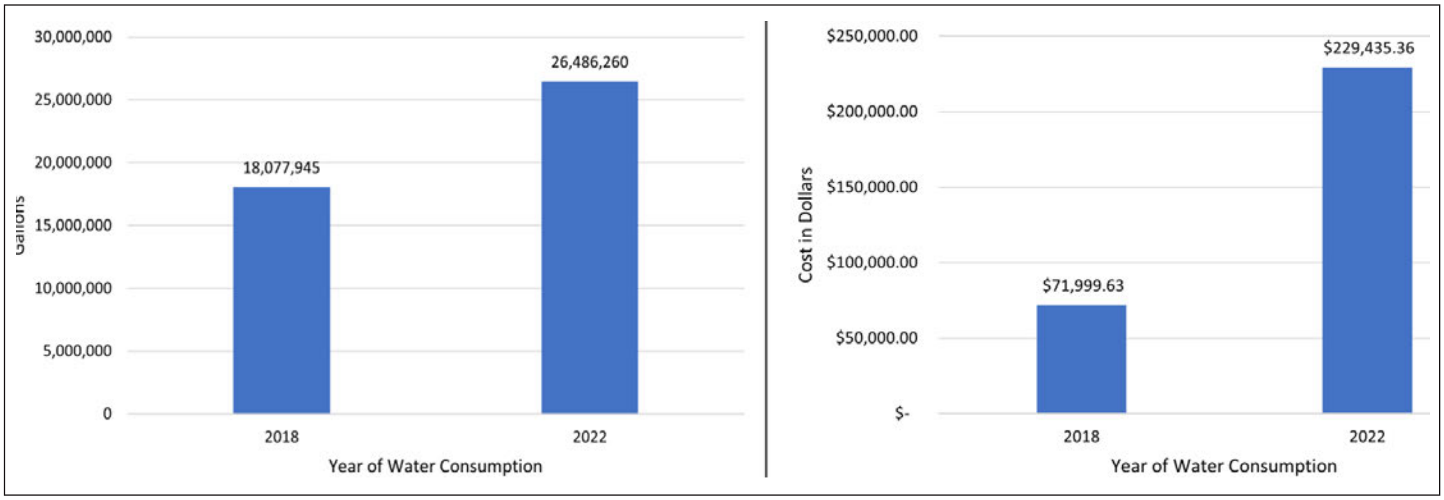

Figure 1. Charts showing the 46.5% increase in water consumption compared to the 218.7% increase in the cost of water consumption for county operations in Comal County 2018–2022 (Comal County Auditor, 2023).

Water reuse—using reclaimed and treated wastewater—could help ensure Comal County will have the water supplies it needs to safeguard the health, safety, and quality of life of its residents in the years to come. Water reuse systems protect the availability of groundwater by providing an alternative or supplement to existing water supplies. Using reclaimed and treated wastewater also protects the quality of existing water supplies by reducing groundwater drawdown and diverting wastewater effluent previously being disposed into sensitive waterways. Unfortunately, in Comal County, there is currently no comprehensive system in place for reusing treated wastewater, nor major effort by county water providers to implement reuse systems. In fact, in 2020, reuse in Comal County accounted for just 1.5% of the total water use.

The status of water reuse in Comal County underscores both the long way Hill Country counties have to go in implementing water reuse systems and the unique opportunities present to do so. Examples from communities large and small across Texas show that water reuse systems can successfully be implemented; these case studies provide blueprints for how Comal County can move forward in realizing a more comprehensive water reuse system. In addition to these examples, this report highlights different methods for authorizing water reuse districts or systems, multiple funding opportunities, and unique opportunities for implementation within Comal County. These are by no means the only methods by which reuse districts or systems could be authorized, funded, or implemented, but they can provide policy makers and residents with a solid foundation.

WATER MANAGEMENT CHALLENGES

Population Growth

Considered one of the fastest growing counties in the United States between 2010 and 2020 and between 2021 and 2022, Comal County is at the forefront of urban development, outpacing growth in Texas and the nation overall (U.S. Census Bureau [USCB], 2020; USCB, 2023). Between 2010 and 2020, the county's population grew 48.9%. In comparison, over those same 10 years, Texas' population grew 15%—roughly 34 percentage points less than Comal County. The population of the United States, meanwhile, grew just 7.35% (USCB, 2022). During this same time frame, between 2010 and 2020, municipal groundwater use in Comal County increased by 55.9%, outpacing population growth by 6.9 percentage points (TWDB, n.d.).

TWDB projected in 2017 that Comal County would have a population of 178,399 by 2030. As of July 2022, however, USCB estimated the population of Comal County to be 184,642, a 3.5% increase over the 2030 projection and 8 years in advance. In the last 5 years, from 2018 to 2022, the population of Comal County increased 24.4% (USCB, 2018). During this same time, Comal County itself saw a 46.5% increase in water consumption for its county operations and a 218.7% increase in the cost of this water consumption (Figure 1; USCB, 2022; Comal County Auditor, 2023).[1]

[1] According to a phone call with a Comal County Auditor's Office representative, "county operations" in this instance refers to water use on and for all county properties and buildings.

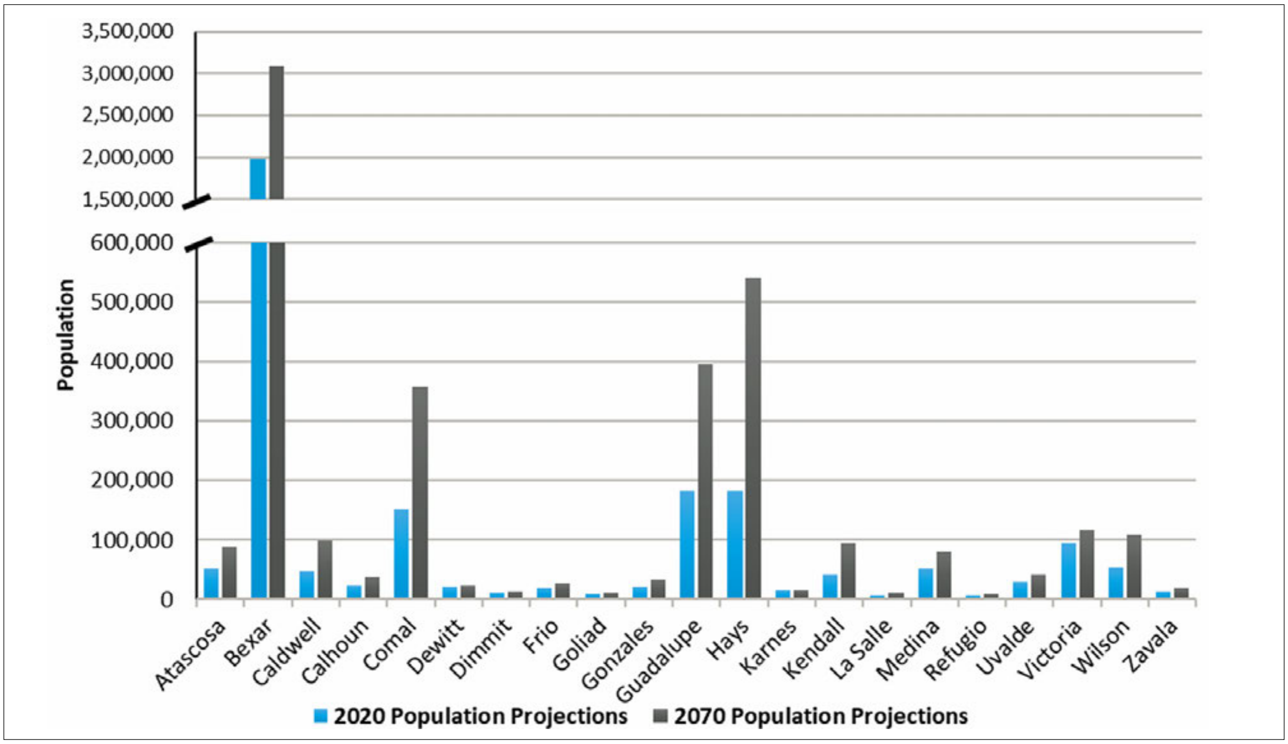

Figure 2. Chart from the 2021 South Central Texas Regional Water Plan showing Comal County projected to have the second highest water demand by acre-feet per year in the region by 2070 (South Central Texas Regional Water Planning Group, 2020).

This increase in population is not expected to slow in the coming decades. TWDB now predicts that Comal County will have a population of 193,188 by 2030 and 357,464 by 2070, a 4.6% and 93.6% increase from 2022, respectively (League of Women Voters of Comal Area [LWVCA], 2017; USCB, 2022; TWDB, 2022b).

With the increase in population, the county will likely see an increase in water demand. According to the South Central Texas Regional Water Planning Group, between 2020 and 2070, Comal County is expected to have the second greatest growth in water demand volumes in the region, just behind Bexar County (Figure 2; South Central Texas Regional Water Planning Group, 2020).

Hydrogeology and Climate Extremes

Comal County is located along the Balcones Escarpment in the Hill Country, within the San Antonio River and Guadalupe River basins, and overlaying both the Trinity and Edwards aquifers (Figure 3). The Trinity and Edwards aquifers are at least partially hydrologically connected, and water from the Trinity Aquifer has been shown to contribute to some of the recharge of the Edwards Aquifer (Eckhardt, n.d.-a; Flores et al., 2020). The two major aquifers are also highly connected to surface water in the region. Groundwater contributes to roughly 30% of surface water flows in Texas, and the greatest such contributions occur in the Hill Country (Siglo Group, 2022). All three zones of the Edwards Aquifer—the contributing, recharge, and artesian—are present within Comal County's borders (Figure 4; Flores et al., 2020). Comal Springs, the largest spring in the state, is fed by the Edwards Aquifer and located in Comal County.

The county sees an average annual precipitation of 33–37 inches and is situated in the region known as Flash Flood Alley, which is "one of the most flood-prone regions in North America" due to heavy rains and efficient drainage (LWVCA, 2017; San Antonio River Authority, 2024, Why does it flood?). The region is just as well known, however, for its periods of intense drought. Flows in streams and rivers in the Hill Country are characterized by similar extremes: short periods of high flow following heavy precipitation events and then longer periods of low flows in between (Ross, 2011).

Precipitation is the primary source of recharge for the two main Hill Country aquifers. As such, spring flows and well elevation have been shown to decline during periods of drought in the Edwards and Trinity aquifers, from both of which Comal County draws large portions of its water supply (Ding & McCarl, 2019; Smith et al., 2023). While both aquifers are adversely affected by drought, long-term trends of the water levels in the Trinity Aquifer show a limited ability to recover from drought even during very high rainfall events (Smith et al., 2023).

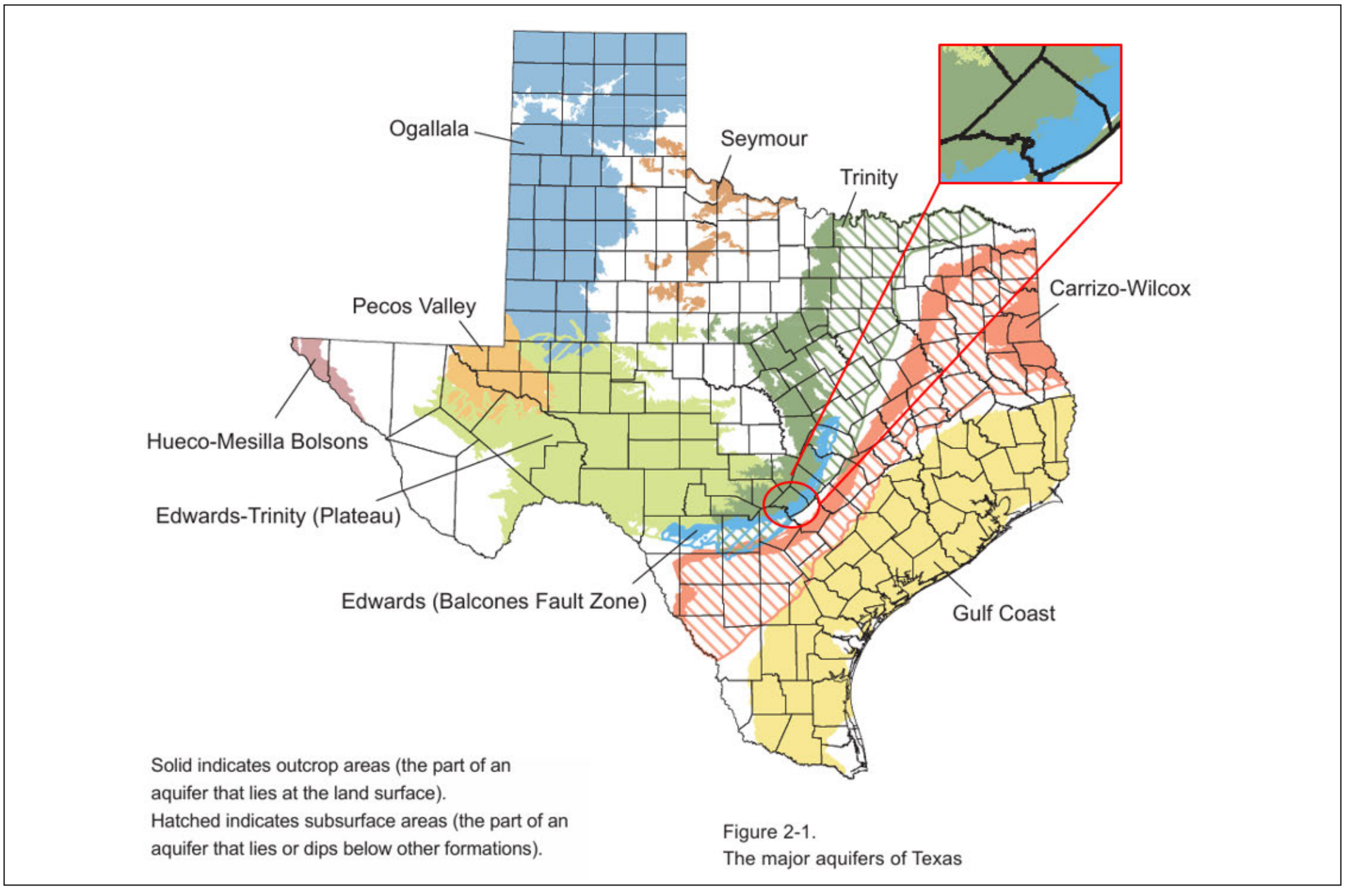

Figure 3. Map of the aquifers in Texas with an addition (in red pop-out box) showing Comal County overlying the Edwards (blue) and Trinity (green) aquifers (George et al., 2011).

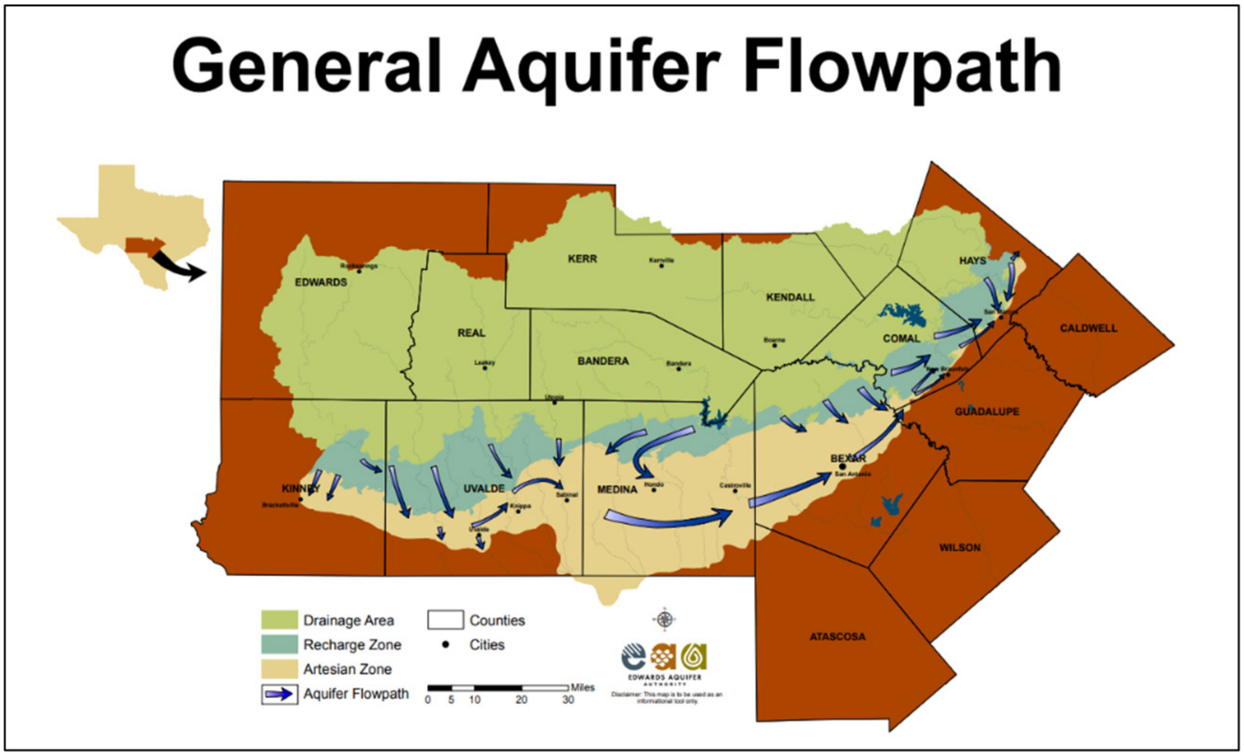

Figure 4. Map showing the three zones of the Edwards Aquifer and the aquifer flowpath underlying Comal County (Edwards Aquifer Authority, n.d.).

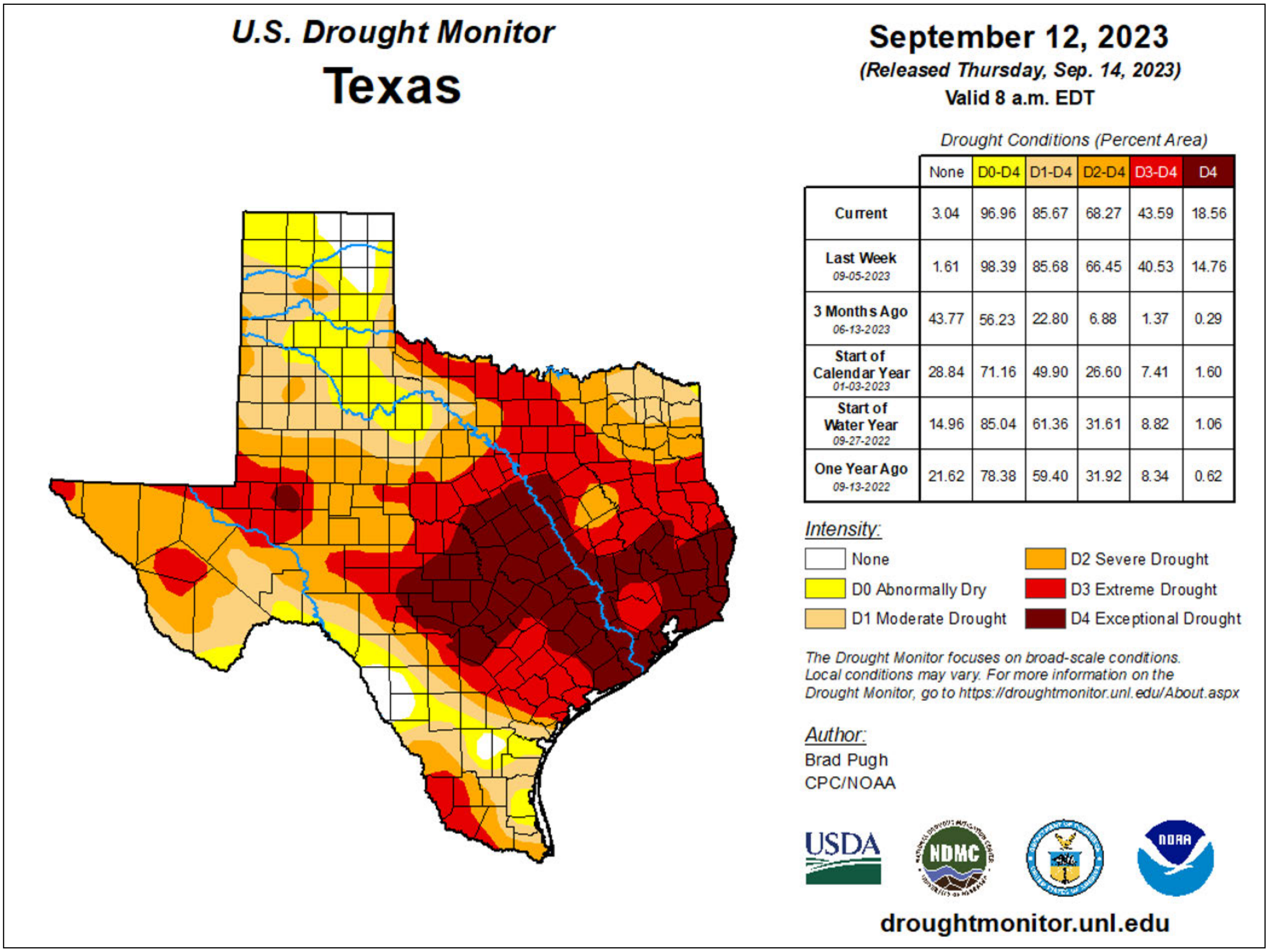

Figure 5. Picture showing the state of drought in Texas on September 12, 2023 (U.S. Drought Monitor, 2024).

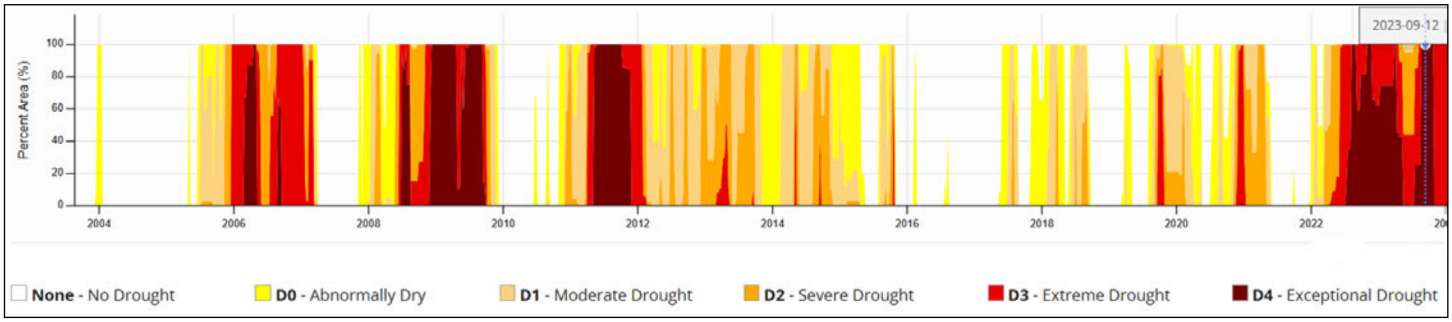

Figure 6. Graph showing years where land in Comal County was classified as being in drought, September 9, 2003–September 12, 2023 (Water Data for Texas, n.d.).

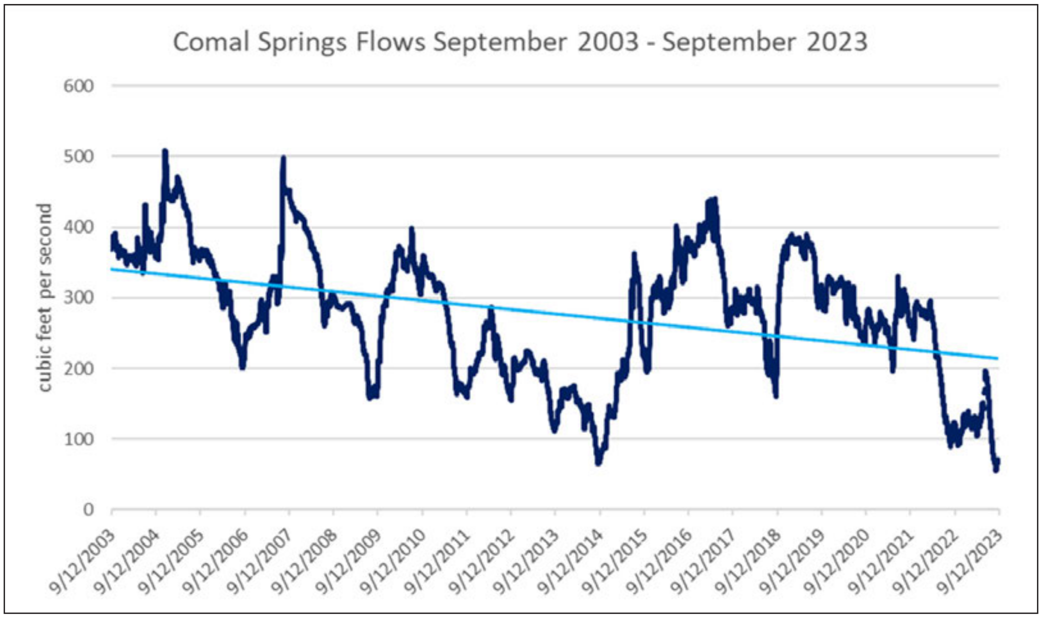

Figure 7. Spring flow data at Comal Springs showing a declining trend line between September 12, 2003, through September 12, 2023 (USGS, n.d.).

The National Oceanic and Atmospheric Administration has categorized Comal County as being in exceptional drought in at least 6 of the last 20 years and in moderate to exceptional drought more often than not (Figures 5 and 6; Water Data for Texas, n.d.). Over the same time period, 2003–2023, Comal Springs has seen an overall declining trend in spring flows (Figure 7; U.S. Geological Survey [USGS], n.d.). As of September 2023, 100% of Comal County had been categorized as being in moderate to extreme drought for over a year (Water Data for Texas, n.d.). Conditions such as these are unlikely to be rare occurrences in the coming years, as Texas is expected to experience more frequent drought (Ding & McCarl, 2019). Unfortunately for a region experiencing rapid population growth, expected increases in temperature and frequency of drought are anticipated to lead to an increase in water demand while simultaneously lowering water supply (Ding & McCarl, 2019).

Reliance on Groundwater for Supply

There are three major utilities that serve customers in Comal County: New Braunfels Utilities (NBU); Texas Water Company (TWC), formerly the Canyon Lake Water Service Company; and SouthWest Water Company (SWWC), formerly Water Services, Incorporated. NBU draws its water supplies from Guadalupe River surface water, Edwards Aquifer wells, and Trinity Aquifer wells. TWC and SWWC draw their water supplies from Canyon Lake surface water and Trinity Aquifer wells (Arcadis U.S., Inc., 2021; TWC, n.d.-a; SWWC, 2016). The city of Garden Ridge has its own water system, for which it pumps water from the Edwards and Trinity aquifers (Garden Ridge Texas, n.d.). Rural water users in the county draw their water supplies from onsite wells from the underlying aquifers, while residents not covered by the above utilities are served by several smaller local purveyors (LWVCA, 2017).

The majority of Comal County's water supply is sourced from groundwater. In 2020, the last year for which TWDB had published county water use estimates as of the preparation of this report, roughly 62.5% of the county's total water use was groundwater, while surface water accounted for 36%, and reuse accounted for just 1.5%. In Comal County, groundwater makes up as much as 57% of municipal use (TWDB, n.d.). Meanwhile, across the state as a whole, only around 33% of municipal water use was supplied by groundwater (TWDB, 2022g).

Table 1. Table showing 2020 water use data estimates for Comal County. Water use survey historical summary estimates (includes reuse) by county, revised as additional or more accurate data becomes available through survey responses (TWDB, n.d.). One acre-foot is equivalent to 325,851 gallons.

Year	County	Population	Municipal	Manufacturing	Mining	Power	Irrigation	Livestock
2020	Comal	161,501	23,943	754	3,967	0	699	337
Type	**Municipal**				**Manufacturing + Mining + Power + Irrigation**			
Total	23,943	23,943	23,943		5,420	5,420	5,420	
Groundwater	13,704				4753			
Surface Water		10,095				365		
Reuse			144				302	
Percent of Total	57.2	42.2	0.60		87.7	6.7	5.6	

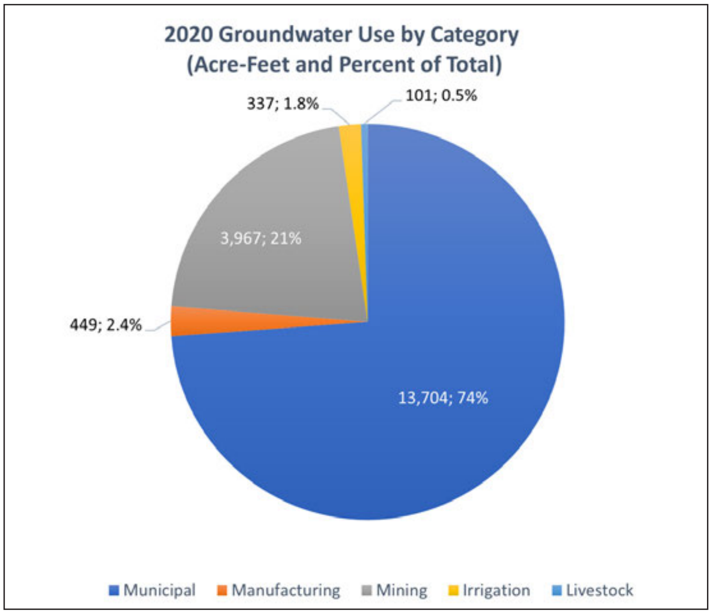

Figure 8. Table showing the percent of aggregate mining water use supplied by groundwater in Comal County in 2020 (1 acre-foot is equivalent to 325,851 gallons) (TWDB, n.d.).

Water use for manufacturing, aggregate mining, power, and irrigation in Comal County is almost entirely sourced from groundwater. Groundwater made up 87.7% of water use for these combined categories in 2020, while 6.7% was sourced from surface water and 5.6% was from reuse (Table 1). For mining water use alone, groundwater made up 100% of the supply, accounting for over one-fifth of the total groundwater use in the county (Figure 8; TWDB, n.d.). Because aquifer recharge relies primarily on precipitation, groundwater supplies may be negatively affected by the expected increase in drought frequency (Ding & McCarl, 2019).

Limited Existing Reuse Systems

As of 2011, NBU operated a reclaimed water system that provided water to one development for the irrigation of rights-of-way and common area landscaping (Espey Consultants, Inc., 2011). TWC, meanwhile, uses some effluent on irrigation fields within its service area, including a golf club, elementary school, and its office building (TWC, n.d.-b). As of the preparation of this report, these two instances appeared to be the extent to which reclaimed wastewater has been used consistently as a water supply source within Comal County.

In the NBU 2021 Water Resources Plan Update, the utility service did not consider wastewater reuse a projected supply between 2021 and 2028, nor was wastewater reuse slated for further evaluation (Arcadis U.S., Inc., 2021). In the city of New Braunfels' One Water Roadmap, the city did, however, call for the development of a reclaimed or reuse water master plan and for the prioritization of reuse options as a method to provide a reliable water supply (One Water Working Group, 2021).

Degradation of Water Quality

Portions of the contributing and recharge zones of the Edwards Aquifer and portions of the Trinity Aquifer are present in Comal County. Water quality in the streams and creeks in the contributing zone directly impacts the water quality of the Edwards Aquifer, as these streams and creeks flow over and into the recharge zone. Furthermore, portions of creeks in the Edwards Aquifer contributing zone appear to provide some level of recharge to the Trinity Aquifer, meaning negative impacts to water quality from wastewater disposal in the Edwards Aquifer contributing and recharge zones may not be strictly limited to the Edwards Aquifer water supply (Hunt & Smith, 2016).

As land in Comal County is developed and urbanized, less of that land is available to facilitate the recharge of integral groundwater supplies. Runoff that recharges the aquifers is at greater risk of being contaminated after encountering pollutants associated with increasing development, such as oil, pesticides, gasoline, and other chemicals. Surface water supplies are also at greater risk of degradation as they often act as receiving pools for polluted runoff and wastewater effluent (LWVCA, 2017).

Wastewater Impacts

Increases in population and water use inevitably lead to increases in wastewater. Investigations in the Barton Springs segment of the Edwards Aquifer show that increased wastewater disposal can be linked to increased nitrates in both surface and groundwater and that "this increase matches the timing of development" (Flores et al., 2020, p. 53). The unique environment of Comal County—overlying two karstic aquifers and subject to intense rainfall events and droughts—means water sources in the county and the region are highly vulnerable to contamination by wastewater disposal practices (TCEQ, n.d.-a).

Even treated wastewater, or effluent, still contains pharmaceuticals, metals, chemicals, phosphorous, and nutrient nitrogen (Ross, 2011). In waterways where they were not previously present in meaningful quantities, phosphates and nitrates can act similar to a fertilizer. This fertilization effect can lead to algae blooms and microbial growth, which can cause existing vegetation and aquatic life to sicken or die (Mabe, 2007).

Rivers and creeks in the Hill Country generally have very good water quality and clarity. Those that have not been impacted by wastewater effluent have low nutrient concentrations and are clear, with low levels of algae and high levels of dissolved oxygen (Ross, 2011). On the other hand, rivers and creeks that have been impacted by development tend to show nutrient concentrations that far exceed natural levels, which can result in algae growth, "reduced clarity, foul odor, and bad taste" (Hill Country Alliance, n.d.; Flores et al., 2020, p. 48).

As early as 2006, USGS published a report showing that Hill Country streams with wastewater present had five times more nitrate and 18 times more phosphate than in streams without detected wastewater (Mabe, 2007). Occasionally, bacteria, viruses, and other contaminants, such as un-metabolized pharmaceuticals, can also be found in these water sources. Under the current permitting scheme for wastewater disposal, analysis has shown that increased development and increased wastewater discharge will result in greater negative impacts to the quality of groundwater recharge (Flores et al., 2020).

Wastewater Administration

New municipal and industrial wastewater discharges into or adjacent to water that would create additional pollutant loading are prohibited by Texas Administrative Code (TAC) Rule 213.8 within the recharge zone of the Edwards Aquifer. Wastewater discharge is permitted in the contributing zone, though, as detailed above, this does not necessarily reduce the risk of degradation in the aquifer. Land application systems that rely on percolation of wastewater for disposal are also prohibited in the recharge zone, under TAC Rule 213.6. Wastewater disposal through land application methods—evaporation or irrigation—is not prohibited, but this method of disposal must be approved on a case-by-case basis (30 TAC § 213.1–213.14).

The Texas Commission on Environmental Quality (TCEQ) is the state's environmental agency in charge of issuing permits for the disposal of wastewater effluent. There are two main TCEQ permits for the disposal of wastewater effluent:

1. *Texas Pollutant Discharge Elimination Systems (TPDES):* Permits for facilities in which effluent from wastewater treatment plants may be discharged into waterways, including surface waters and dry creek beds.
2. *Texas Land Application Permits (TLAP):* Permits for facilities in which effluent may be disposed of by application to ground surface by way of subsurface or surface irrigation (30 TAC § 213.1–213.14).

Comal County residents regularly contest TPDES permits due to concerns about the impacts of direct discharge of treated wastewater into Hill Country waterways and surface water sources. The rationale behind TPDES permits is that vegetation and soils in waterways will help absorb and dilute excess nutrients. However, waterways in the Hill Country—including in Comal County—have limestone stream beds with few methods of nutrient absorption, leading to excess nutrient buildup when wastewater effluent is disposed into them (Clifford, n.d.).

The absorption and dilution of contaminants is made even more difficult when these stream beds are dry, which they often are during the region's frequent droughts (Peace, 2018). Additionally, many of the streams in the Hill Country are the method by which water flows into the Edwards and Trinity aquifers, as the stream beds are fractured and lay along faults that allow water to flow underground (Clifford, n.d.). Once this water is in the underlying aquifer, it can move through the aquifer, potentially causing the contaminants to spread over a much larger area (Slade, 2018).

Recent data show that, within Comal County as a whole, there are TPDES permits for a combined effluent discharge of up to 27.66 million gallons per day (MGD) from wastewater

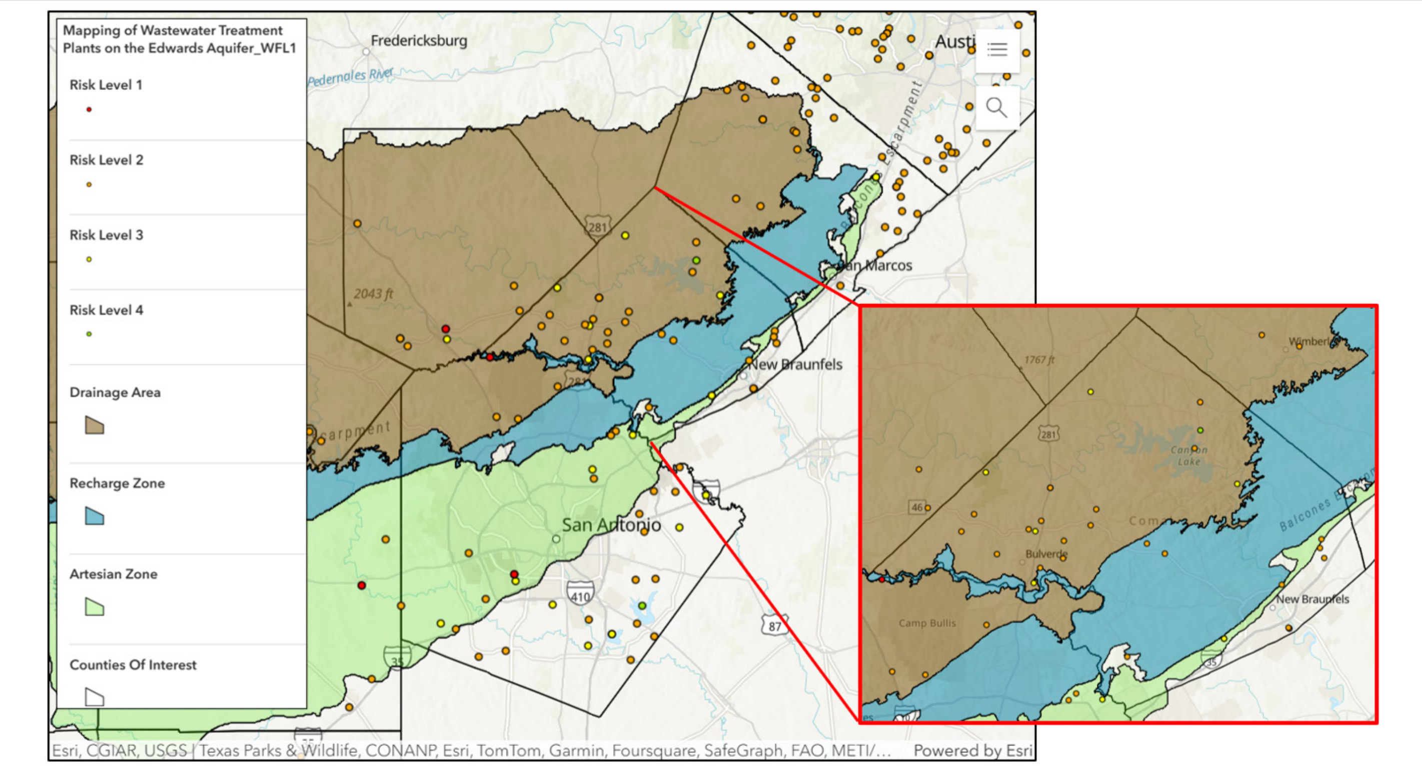

Figure 9. Map showing wastewater treatment plants, including those with Texas Pollutant Discharge Elimination Systems permits in Comal County (Greater Edwards Aquifer Alliance, 2023).

treatment plants (Figure 9). Of this combined total, for sites within the Edwards Aquifer Zones, effluent discharge from TPDES sites is permitted for up to 8.86 MGD, and for sites just outside the Edwards Aquifer Zones, up to 18.8 MGD (Greater Edwards Aquifer Alliance, 2023). Many wastewater treatment plants can be converted to systems that allow for the creation of reuse water (Nelson, 2018; Foglia et al., 2023).

Although sewage plants that discharge treated wastewater into water bodies in Texas must have a TCEQ-approved permit, i.e., the TPDES permit, simply having the permit is no guarantee the discharged wastewater will meet all permit requirements. In fact, between January 2017 and June 2020, 81% of the Hill Country's publicly owned sewage plants that discharged into waterways exceeded at least one pollutant limit. The 48 plants analyzed averaged 188 days of pollutant exceedances, with six plants exceeding pollutant limits for over 500 days during the study period (Zabcik, 2020). A 2020 assessment of four Hill Country streams showed the vulnerability of the region's streams to nutrient enrichment from wastewater disposal under TPDES permits. This assessment and a separate study conducted in 2020 analyzed the Blanco River upstream and downstream of a permitted wastewater discharge and found that "nitrogen and phosphorous levels were significantly higher at the downstream location" (King & Back, 2020; Zabcik, 2020, p. 30).

Additionally, many environmental groups allege that TCEQ's system of issuing permits to control water pollution is inadequately protective and that the agency is negligent in enforcing the provisions of the Clean Water Act. A petition that 21 environmental groups filed with the U.S. Environmental Protection Agency (EPA) in 2021 maintains that TCEQ lacks an effective water quality anti-degradation policy as part of its permit review process. The groups allege TCEQ too often approves dischargers' claims that the impact on downstream waterways—even in the sensitive Hill Country waterways—will be so minor as to not make any difference (Environmental Integrity Project, 2021). EPA is currently conducting an informal investigation to determine if there is cause to withdraw approval of Texas' National Pollutant Discharge Elimination System program (Karins, 2023).

Of the two TCEQ permitting systems, TLAP provides a greater measure of assurance that contaminants from wastewater effluent will not reach water supplies. Land application allows an opportunity for "soil, sunlight, plants, and microbes to further reduce contaminants and nutrients in effluent before they come directly in contact" with streams and aquifers (Hill Country Alliance, 2019, p. 2). Contaminants from effluent disposed through land application can make their way into water sources during heavy rainfall and runoff events, but this occurs sporadically, unlike effluent disposed directly into surface water and stream beds. Due to the sporadic occurrence of

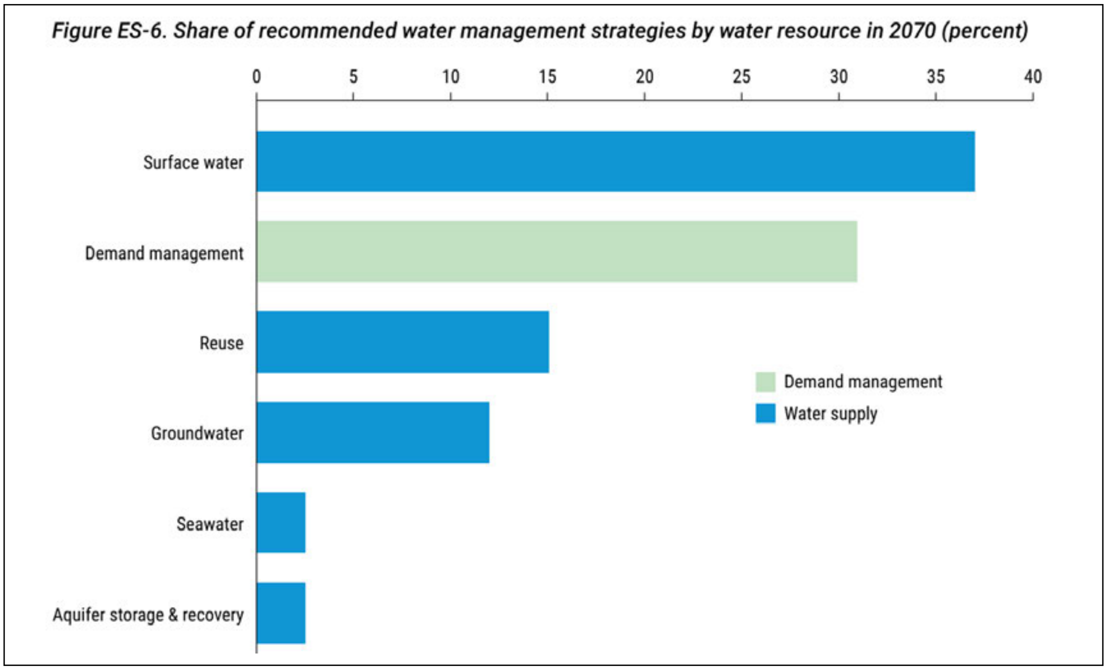

Figure 10. Graph showing Texas Water Development Board (TWDB) recommended reuse supply (percent) for Texas by 2070, with reuse recommended to make up at least 15% of the expected water supply (TWDB, 2022a).

large runoff events and the ability of land application to provide better absorption and dilution of contaminants, effluent disposal under the TLAP system leads to a smaller risk of contaminant release into the aquifers in the Hill Country region than disposal under TPDES (Hill Country Alliance, 2019; Flores et al., 2020).

While generally more protective of water sources than TPDES, the TLAP system does not, however, eliminate the risk of contamination entirely. The thin soils, aquifer recharge features, and steep slopes of the Hill Country can sometimes make it difficult to discharge effluent through land application in a manner that appropriately protects water quality (Ross, 2011). Meanwhile, the beneficial reuse of wastewater for purposes such as municipal irrigation or as an industrial water supply can allow for greater oversight by water providers, reuse districts, or municipalities. Wastewater reuse may require wastewater to be treated to a higher standard, and it allows for a targeted approach to land application.

In 2023, the 88th Texas Legislature passed Senate Bill (SB) 1289, which removes regulatory barriers to the onsite treatment and non-potable reuse of alternative water sources, such as rainwater, stormwater, and wastewater, within a building or across multiple buildings. Prior to the passage and implementation of this legislation, TCEQ required owners of reuse systems to have either a TPDES or TLAP permit, which made the adoption of a wastewater reuse system difficult (Wright, 2023; WateReuse, 2023). Now, onsite treatment and reuse of non-potable water will be allowed without a TPDES or TLAP permit as long as the owner of the treatment system has a backup disposal method through a wastewater collection system and has the consent of the operator of that system and any other wastewater treatment facility that would further treat the water. The owner of the onsite system will also no longer be required to be the owner of an associated permitted domestic wastewater treatment facility (Texas Water Code § 26.02715).

WATER REUSE AND IMPLEMENTATION

Need for Water Reuse: Water Supply and Quantity

For Texas to meet its future water demands, TWDB estimates that annual reuse supplies in the state will need to make up about 15% of the state's total water supply by 2070 (Figure 10). In 2020, however, reuse supply made up just under 4% of Texas' total water supply and only 1.5% of Comal County's total (TWDB, 2022a).

Water reuse in the county, where it occurs, happens in a highly fragmented manner. As such, high quality potable water is often used in instances that do not require it, such as lawn and landscape irrigation, parks irrigation, manufacturing, mining, and power plant cooling. This scenario places greater than necessary strain on surface and groundwater supplies in the county, especially as residents will continue to expect consistent water supplies even in the face of population growth and a projected increase in drought frequency (Ding & McCarl, 2019).

Water reuse allows for a twofold protection of water quality in the Hill Country. Spring flows are "a measurable indicator of the overall health of a region's water supply" (Siglo Group, 2022, p. 35). When groundwater is drawn down, spring flows are reduced or can even cease entirely. When wastewater effluent is then applied to dry or semi-dry stream beds, there is often a buildup of excess nutrients and a subsequent decline in water quality. The beneficial reuse of wastewater, rather than its discharge into streams, can help protect the quality of water sources by reducing the drawdown of groundwater supplies—thereby increasing spring flows—and by keeping wastewater effluent and any of its associated negative impacts out of stream beds.

This relationship between the conservation of groundwater through reuse and spring flows may additionally allow the beneficial reuse of wastewater to indirectly contribute to expected instream flows. In reducing the drawdown of groundwater, spring flows may increase, contributing to expanded instream flows (McCarl et al., 1999; Water Science School, 2019). With this cycle—beneficial reuse of wastewater, reduced aquifer drawdown, increased spring flow, increased stream flow—the direct discharge of wastewater may not be as necessary to the maintenance of expected instream flows.

As early as 1990, TWDB recommended the adoption of conservation and reuse programs "to provide for more limited pumping of groundwater and the protection of area spring flows" for the Southern Edwards Aquifer Region, which included Bexar County and neighboring counties (TWDB, 1992, p. 93). In the 1992 update to the 1990 Texas Water Plan, TWDB outlined the stream flow benefit of using recycled water. The update also highlighted that it may be more cost-effective for a community to use recycled water and stormwater for outdoor irrigation "than to treat additional water to potable levels for that purpose. This would be particularly true if users downstream benefitted by having additional water of higher quality for use in limited flow periods" (TWDB, 1992, p. 25).

State-wide Case Studies

Communities large and small across Texas have implemented water reuse systems to provide a sustainable supplemental water supply to their residents, including San Antonio, Big Spring, Boerne, El Paso, Round Rock, Lakeway, and Fredericksburg. These case studies provide examples of how to implement a more comprehensive water reuse system within Comal County to reduce demand that would otherwise be placed on the existing water supplies, primarily the vulnerable Edwards and Trinity aquifers.

San Antonio, Texas

Comal County's neighbor to the southwest, San Antonio, represents likely the most imitable example of a water reuse district. With SB 1667 in 1989, enacted by the 71st Texas Legislature after a request from the City of San Antonio, the Alamo Water Conservation and Reuse District (AWCRD) became the state's first municipal district charged with "controlling, conserving, protecting, preserving, distributing, and reusing wastewater" (SB 1667, 1989, p. 2). SB 1667 did not amend the Texas Water Code, but it did grant the new district the powers and duties applicable to municipal utility districts (MUDs) under Chapter 54 of the Texas Water Code, unless otherwise stated. The AWCRD was created as a conservation and reclamation district pursuant to Article XVI, Section 59, of the Texas Constitution and was deemed essential to accomplishing the purposes of this section of the constitution (SB 1667, 1989). The district operated under special legislation that gave it greater flexibility to operate in addition to and between different jurisdictions.

The AWCRD laid the foundation for San Antonio's current reuse system, and its brief history provides a helpful blueprint for the establishment of other water reuse districts within Texas (San Antonio Water System [SAWS], 2019). As enumerated by SB 1667, the AWCRD had the power to:

1. Contract for the acquisition of wastewater from various parties, including individuals, private corporations, municipalities, and political subdivisions;
2. Accept wastewater from within and without the district boundaries;
3. Process and treat wastewater;
4. Sell treated wastewater as non-potable water to any individual, municipality, political subdivision, and private corporation within and without the district boundaries;
5. Construct, buy, own, lease, sell, and operate facilities to transport, store, and treat wastewater; and
6. Use banks and beds of any surface stream in the state to convey wastewater owned or controlled by the district.[2]

The legislation did not give the AWCRD the power to exclude any other party from using, controlling, or reusing wastewater within the district boundaries. The AWCRD was not allowed to deal in potable water in any manner, levy or collect taxes, or engage in solid waste collection and disposal. SB 1667 did, however, give the AWCRD authority to exercise the power of eminent domain within its boundaries for land, easements, and rights-of-way considered necessary, incident, or helpful to accomplish any of the purposes of the district (SB 1667, 1989).

In 1992, San Antonio's city council decided to dissolve the City Water Board, the City Wastewater Department, and the AWCRD and merge the three water-related utilities within its boundaries into a single utility: SAWS (SAWS, 2019; SAWS,

[2] The sixth provision, "Use banks and beds of any surface stream in the state to convey wastewater owned or controlled by the district," should not be replicated for a water reuse district or system operating in Comal County (SB 1667, 1989, p. 4).

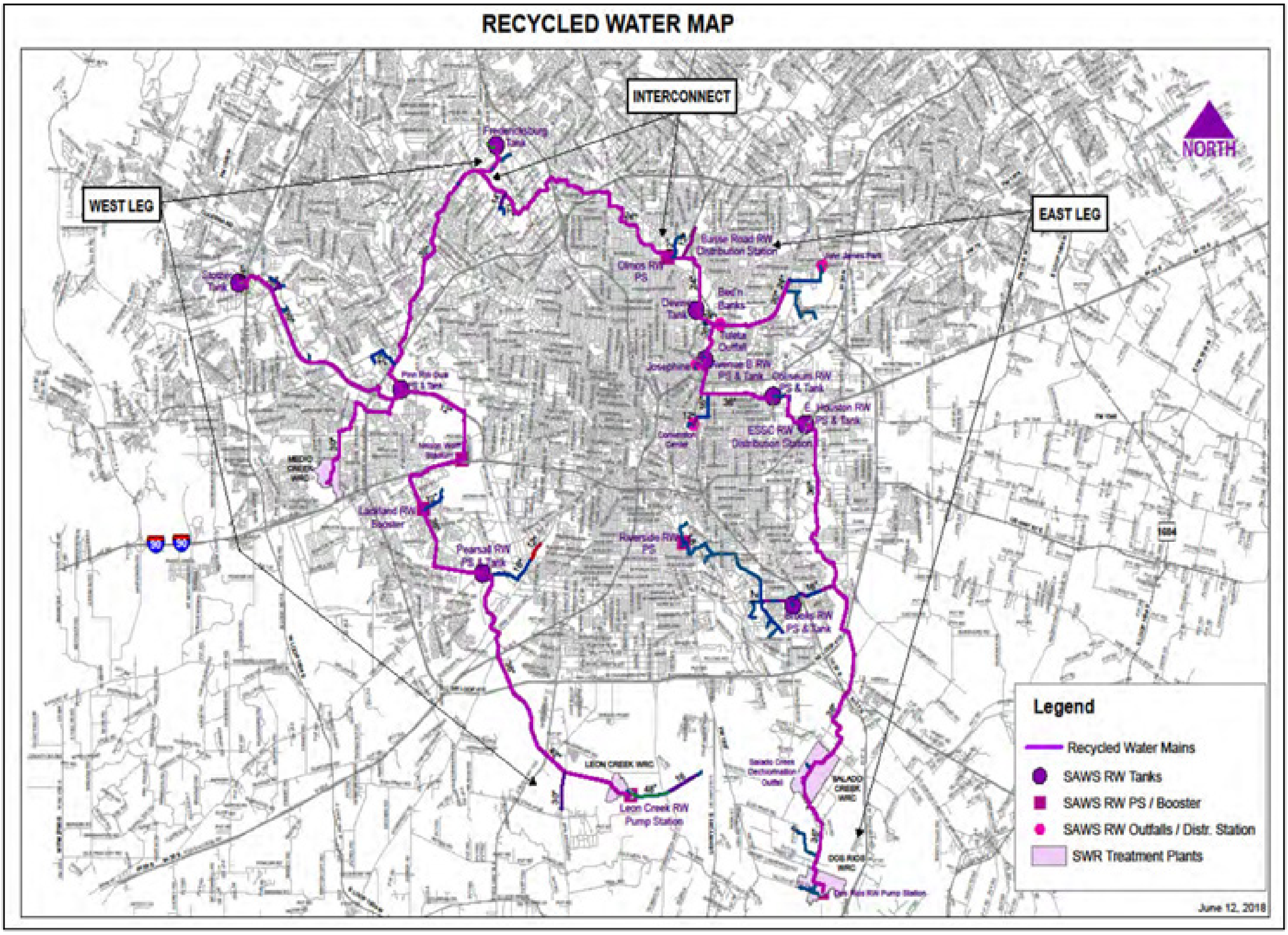

Figure 11. Map of San Antonio Water System's (SAWS) water recycling system and purple pipe system (Eckhardt, n.d.-b).

2021). At the time, the city saw an opportunity to integrate the three utilities into one system that could be funded by all rate-payers in the city, which a water consolidation report to the city council had recommended 2 years earlier (G. Eckhardt, personal communication, January 5, 2024; A. Peace, personal communication, January 16, 2024; Water Consolidation Study Panel, 1990). Though the merger dissolved the AWCRD, the district set the stage for San Antonio's water reuse success; reclaimed water is an integral part of San Antonio's water supply today.

In 1993, a federal district court ruled in *Sierra Club et al. v. Babbitt et al.* that, under the Endangered Species Act, minimum spring flows are required to protect listed endangered species in Comal and San Marcos springs. If the Legislature did not adopt a management plan to limit withdrawals from the Edwards Aquifer by the end of that year's session, the court ruled the plaintiffs could request additional relief (Votteler, 2023).

The Legislature adopted SB 1477, the Edwards Aquifer Authority (EAA) Act, in 1993. This act tasked the newly created EAA with regulating groundwater withdrawals using a permit system for water users in the counties in its jurisdiction (Votteler, 2023). After solidifying its historical pumping rights under the EAA permit scheme, SAWS realized it did not have enough water to meet demand over the following 20 years. The water service took steps to both conserve water and build one of the largest recycling programs in the United States (Texas Stream Team, 2021).

Twenty-seven years after committing to build the nation's largest direct recycled water system in 1996, SAWS has proven that water recycling is integral to its water diversification and conservation efforts. Through over 130 miles of purple pipe, SAWS delivers treated recycled water to customers who use the water for landscaping, golf course irrigation, electrical generation, cooling towers, dust suppression, manufacturing, and for augmenting flows on San Antonio's River Walk (Figure 11). Through these efforts, 16.9% of water distributed by SAWS

Table 2. Table showing the total cost to SAWS customers for the first 1000 gallons/month for reclaimed water service is roughly on par with the total cost to customers for irrigation water service inside and outside city limits. Cheaper cost totals per 1000 gallons/month are shown in green, and more expensive totals are shown in red (SAWS, 2023).

San Antonio Water System service rate schedule	$/month customer fee	$/1000 gallons volume charge	Total cost to customer (1000 gallons/month)
Residential water service inside city limits			
5/8" Meter	$ 9.00	$ 0.907	$ 9.91
Residential water service outside city limits			
5/8" Meter	$ 11.70	$ 1.180	$ 12.88
Irrigation water service inside city limits			
5/8" Meter	$ 12.70	$ 3.475	$ 16.18
Irrigation water service outside city limits			
5/8" Meter	$ 16.00	$ 4.518	$ 20.52
Reclaimed water service*			
5/8" Meter	$ 16.92	$ 0.446	$ 17.37

*Based on recommendations by the Rates Advisory Committee, beginning in 2023, recycled water rate increases will begin to close the cost recovery gap over the next five years while still providing an affordable alternative to potable water.

in 2022 was recycled water, around 115 MGD (SAWS, 2021; Ameresco, 2020).

In addition to treating and recycling wastewater, SAWS recycles the byproducts of its water recycling process. Biosolids generated during the treatment of wastewater are used to generate compost and are sold commercially at local retailers and nurseries, while the biogas generated is transferred to an energy company for sale on the natural gas market. Taking advantage of all aspects of the wastewater treatment and recycling process allows SAWs to offset part of the cost of its recycled water services (SAWS, 2022).

As a policy matter, SAWS has historically kept recycled water rates below the cost of service as a way to incentivize customers to use recycled water for non-potable purposes (D. Burton, personal communication, January 25, 2024). Customers using recycled water reduce demand for potable supplies, which offsets the "the need to identify new water supply sources that are costly to produce and transport into the service area" (Carollo Engineers, Inc., 2022, p. 3-21).

Reclaimed water service rates are roughly on par with potable irrigation water service rates inside the San Antonio city limits and are lower than these rates outside the city limits (Table 2; SAWS, 2022). SAWS recycled water customers do not pay the water supply fee or EAA fee paid by potable water customers. While recycled water rates are slated to increase over the next 5 years, recycled water will continue to be offered at a rate meant to incentivize its use (D. Burton, personal communication, January 25, 2024).

Big Spring, Texas

In Big Spring, Texas, between Odessa-Midland and Abilene, the Colorado River Municipal Water District (CRMWD) is considered a pioneer in recycled water use. The district constructed the nation's first direct potable reuse facility after two of its three reservoirs were declared effectively empty after a severe drought in 2011. Beginning operation in 2013, the Raw Water Production Facility reclaims and cleans water previously used for municipal use, producing around 1.5 MGD of recycled potable water, which is around 2.6% of CRMWD's average daily water deliveries. CRMWD and TCEQ monitor the drinking water quality levels, and the plant is considered highly effective in treating the water (CRMWD, 2022).

CRMWD supports over 600,000 residents in West Texas. Unlike the SAWS system, the recycled water produced by CRMWD can be used for potable purposes, such as drinking water (Table 3). Water from the Raw Water Production Facility in Big Spring is added to a raw water pipeline that mixes surface water from local reservoirs in a 50–50 mix and is then distributed to five water treatment plants in the region to be treated again before distribution to customers (CRMWD, 2018).

Table 3. Table showing the total cost to customers for the first 1000 gallons/month for water service inside and outside Big Spring city limits. Cheaper cost totals per 1000 gallons/month are shown in green, and more expensive totals are shown in red (City of Big Spring Water Department, 2023).

Big Spring water service rate schedule	$/month customer fee	$/1000 gallons volume charge	Total cost to customer (1000 gallons/month)
Residential water service inside city limits			
5/8" Meter	$ 30.00	$ 1.50	$ 31.50
Residential water service outside city limits			
5/8" Meter	$ 30.00	$ 3.00	$ 33.00
Commercial water service inside city limits			
5/8" Meter	$ 30.00	$ 3.98	$ 33.98
Commercial water service outside city limits			
5/8" Meter	$ 30.00	$ 7.96	$ 37.96

Reclaimed water in Big Spring is a direct potable reuse water sources and is not differentiated from other potable water supplies.

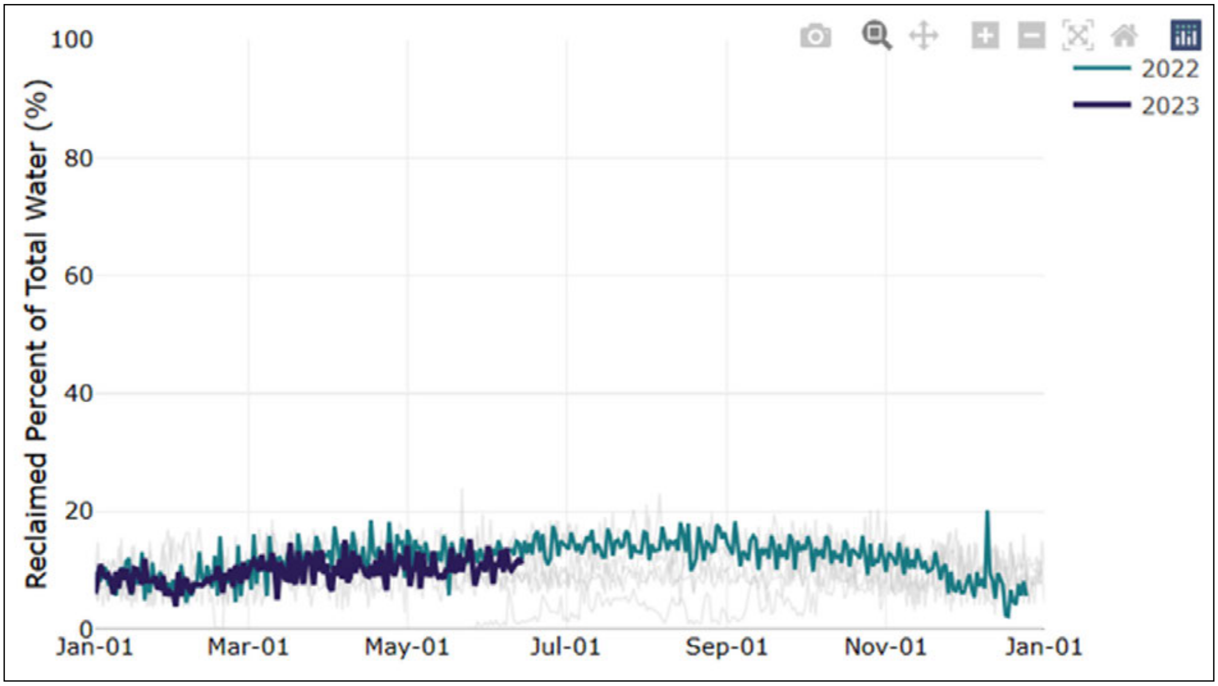

Figure 12. Graph showing the percent reclaimed water makes up of the total water supply delivered by Boerne Utilities, around 10% (City of Boerne, 2023b).

Boerne, Texas

Boerne, Texas, around 20 miles west of Comal County, has been using reclaimed water since 2016. Reclaimed water supplied by Boerne Utilities hovers around 10% of the daily total water supplied and is distributed through a separate purple pipe system (Figure 12). Recycled water in the city is used for outdoor irrigation, soil compaction and dust control, and maintenance of off-channel water bodies (City of Boerne, 2023b; Boerne Utilities, n.d.). The water utility's wastewater recycling system is permitted to produce around 1.4 MGD of reclaimed water at its wastewater treatment and recycling center.

Table 4. Table showing the total cost to customers for the first 1000 gallons/month is much less for reclaimed water service than it is for residential and commercial water service inside and outside Boerne city limits. Cheaper cost totals per 1000 gallons/month are shown in green, and more expensive totals are shown in red (City of Boerne, 2023a).

Boerne Utilities water service rate schedule	$/month customer fee	$/1000 gallons volume charge	Total cost to customer (1000 gallons/month)
Residential water service inside city limits			
5/8" Meter	$ 28.11	$ 2.14	$ 30.25
Residential irrigation water service inside city limits			
5/8" Meter	$ 28.11	$ 8.34	$ 36.45
Commercial irrigation water service inside city limits			
5/8" Meter	$ 28.11	$ 5.90	$ 34.01
Residential water service outside city limits			
5/8" Meter	$ 33.72	$ 2.57	$ 36.29
Residential irrigation water service outside city limits			
5/8" Meter	$ 33.72	$ 10.01	$ 43.73
Commercial irrigation water service outside city limits			
5/8" Meter	$33.72	$ 7.08	$ 40.80
Reclaimed water service			
5/8" Meter	$ 11.50	$ 1.75	$ 13.25

Table 5. Table showing the cost to customers for 500 cubic feet of water inside and outside El Paso city limits. The total cost for reclaimed water service inside and outside city limits is cheaper than commercial water service. Cheaper cost totals per 500 cubic feet/month are shown in green, and more expensive totals are shown in red (El Paso Water [EPW], n.d.-a).

El Paso Water service rate schedule	$/month customer fee	$/5 ccf* volume charge	Total cost to customer (1000 gallons/month)
Residential water service inside city limits			
<1" Meter	$ 9.48	$ -	$ 9.48
Residential water service outside city limits			
<1" Meter	$ 10.91	$ -	$ 10.91
Commercial water service inside city limits			
<1" Meter	$ 9.48	$ 15.350	$ 24.83
Commercial water service outside city limits			
<1" Meter	$ 10.91	$ 23.025	$ 33.94
Reclaimed water service inside city limits			
<1" Meter	$ 9.48	$ 14.350	$ 23.83
Reclaimed water service outside city limits			
<1" Meter	$ 10.01	$ 14.350	$ 24.36

*1 ccf is 100 cubic feet of water, which is equivalent to 748 gallons. The volume charges shown here are for 500 cubic feet.

Table 6. Table showing the total cost to customers for the first 1000 gallons/month is cheaper for reclaimed water service than it is for residential and commercial water service in Round Rock, Texas. Reclaimed water users also face no water use restrictions. Cheaper cost totals per 1000 gallons/month are shown in green, and more expensive totals are shown in red (Round Rock Texas, n.d.-b).

Round Rock Utilities water service rate schedule	$/month customer fee	$/1000 gallons volume charge	Total cost to customer (1000 gallons/month)
Residential water service			
5/8" Meter	$ 16.52	$ 2.56	$ 19.08
Commercial water service			
5/8" Meter	$ 16.52	$ 2.80	$ 19.32
Irrigation water service < 15,000 gallons			
5/8" Meter	$ 16.52	$ 2.56	$ 19.08
Irrigation water service > 15,000 gallons			
5/8" Meter	$ 16.52	$ 3.20	$ 19.72
Reclaimed water service			
5/8" Meter	$ 16.52	$ 1.92	$ 18.44

Boerne Utilities advertises that the benefits of customers using reclaimed water supplies are as follows:

1. "Save on your monthly water bill by not paying potable water prices for irrigation water;
2. Conserve precious drinking water supplies by reducing the amount of ground water pumped out of an aquifer for irrigation;
3. Reduce the costs associated with obtaining new sources of drinking water due to lessening demands on the drinking water supply" (Table 4; City of Boerne, 2023c, p.1).

El Paso, Texas

El Paso, Texas, located in the Chihuahuan Desert in West Texas, has been delivering reclaimed water for reuse since 1963 through its water utility El Paso Water (EPW). The city now supplies nearly 6 MGD of reclaimed water. The water utility operates four reclamation plants and distributes the reclaimed water through a roughly 40-mile purple pipe network. EPW's reuse water is distributed to parks, schools, golf courses, construction sites, industrial sites, and electric power plants (Table 5). According to EPW, in their recycled water system, "every gallon of reclaimed water used to irrigate…or for construction or industrial use is one gallon of potable water that is saved. This means less pumping and preservation of our aquifers" (EPW, n.d.-b, About water reclamation). The city also uses treated wastewater to augment its underlying aquifer, helping to stabilize aquifer levels (Alley & Alley, 2022). It is important to emphasize that in the Edwards Aquifer region, treated wastewater should not be used to augment the aquifer.

EPW piloted an advanced water purification facility—a direct potable reuse facility—in 2016. At this pilot facility, treated wastewater goes through an additional advanced water purification process to supplement El Paso's drinking water supply. Preliminary designs on the full-scale facility are complete, and EPW expects the new facility will be completed and online sometime in 2024, producing up to 10 MGD. State and federal funding sources are expected to lessen the financial impact on ratepayers of constructing and operating the new completed advanced water purification facility (EPW, 2019).

Round Rock, Texas

Round Rock, north of Austin, has been using reuse water for irrigation since 1998, when it began supplying the Forest Creek Golf Club. Round Rock's Water Reuse Program attempts to reduce potable water use by supplying reuse water for non-potable purposes, mainly irrigation. The city provides reuse water to sport complexes, golf clubs, educational campuses, parks, homeowner associations, and developments. Round Rock plans to supply reuse water to an athletic complex, two high schools, and two elementary schools for irrigation by the end of 2025 (Round Rock Texas, n.d.-a).

Round Rock implements a cost-efficient reuse program by using abandoned wastewater force mains and locating new reuse projects near currently operational wastewater facilities. The program allows the city to conserve potable water supplies, delay surface water rights acquisitions—thereby saving millions of dollars—and optimize resources in the wastewater treatment process. Reuse water is a lower cost source of water for both the city and users, and customers who use recycled water face no restrictions on their use even during drought and water rationing (Table 6; Round Rock Texas, n.d.-a).

Table 7. Table showing the total cost to customers for the first 1000 gallons/month is cheaper for reclaimed water service than it is for potable water in Lakeway, Texas. Cheaper cost totals per 1000 gallons/month are shown in green, and more expensive totals are shown in red (Lakeway MUD, 2024).

Lakeway Municipal Utilities District water service rate schedule	$/month customer fee	$/1000 gallons volume charge	Total cost to customer (1000 gallons/month)
Retail water service			
5/8" Meter	$ 24.00	$ 2.50	$ 26.50
Wholesale water			
Meter size not specified	$ -	$ 5.03	$ 5.03
Retail reuse service			
Meter size not specified	$ -	$ 2.50	$ 2.50
Wholesale reuse water			
Meter size not specified	$ -	$ 1.50	$ 1.50

Wholesale services means services provided by the District to a public water or wastewater supplier on terms and conditions set forth in a written contract between the District and said entity allowing said entity to provide retail water service to its customers.

Lakeway, Texas

Lakeway, located 20 miles west of Austin, through the Lakeway MUD, was one of the first utilities in Texas to implement a water reuse system. The district began supplying the Yaupon Golf Course with reuse water for irrigation purposes in 1975 and became the first water provider in the state to use recycled water in a residential area for irrigation in 1994. The Lakeway MUD considers reuse water a safe and cost-effective way to expand the district's supply of non-potable water and is able to provide reuse water even during times of drought (Table 7; Lakeway MUD, n.d.).

Lakeway pulls its water from Lake Travis, one of the Texas Highland Lakes. In the 1980s, TCEQ issued the Highland Lakes discharge ban rule, prohibiting TPDES discharges into the lakes and leaving land application the only option for wastewater discharges for the district. Today, the Lakeway MUD stores more than 90 million gallons of reclaimed water and provides it for the irrigation of medians, city parks, golf courses, various commercial locations, and some residential locations, including the Estates of Lakeway Hills (Foster, 2021; Lakeway MUD, n.d.).

Fredericksburg, Texas

Fredericksburg, Texas, located within the Hill Country region, has a successful and imitable water reuse program that augments the city's water supply by easing demand on the potable water system. Fredericksburg's water and wastewater department provides non-potable water to the nearby Boot Ranch Development and the Lady Bird Johnson Golf Course for irrigation. The city is authorized by the state to provide reuse water for the irrigation of golf courses, greenbelts and common areas, landscapes, public fields, and campuses (Table 8; Freese and Nichols, Inc., 2017). Reclaimed water may also be used for fire assistance and construction of roads and buildings.

Current peak hour demand for all water sources in the city is 9–10 MGD. Fredericksburg's wastewater treatment plant can supply around 1 MGD of reclaimed water and distributes to the current two users through a 16-mile purple pipe system (Figure 13). In a report produced in 2017, the City of Fredericksburg was analyzing options to expand its reuse water system to decrease demands placed on its potable water system and defer the need for an additional supply source (Freese and Nichols, Inc., 2017). Fredericksburg has instituted multiple incentives for reuse water users: 1) there is no volume restriction on recycled water use; and 2) monthly fixed customer fees do not apply in months when no recycled water is used.

Table 8. Table showing the total cost to customers for the first 1000 gallons in Fredericksburg, Texas. The reclaimed water service charges were provided by a utility department representative. Cheaper cost totals per 1000 gallons/month are shown in green, and more expensive totals are shown in red (The City of Fredericksburg Texas, 2019).

Fredericksburg water service rate schedule	$/month customer fee	$/1000 gallons volume charge	Total cost to customer (1000 gallons/month)
Residential water service			
5/8" Meter	$ 11.60	$ 2.45	$ 14.05
Commercial water service			
5/8" Meter	$ 11.60	$ 2.40	$ 14.00
Industrial water service			
5/8" Meter	$ 294.40	$ -	$ 294.40
Reclaimed water service			
5/8" Meter	$ 20.00	$ 1.50	$ 21.50

For reclaimed water service users, the monthly customer fee does not apply during months in which no water is used.

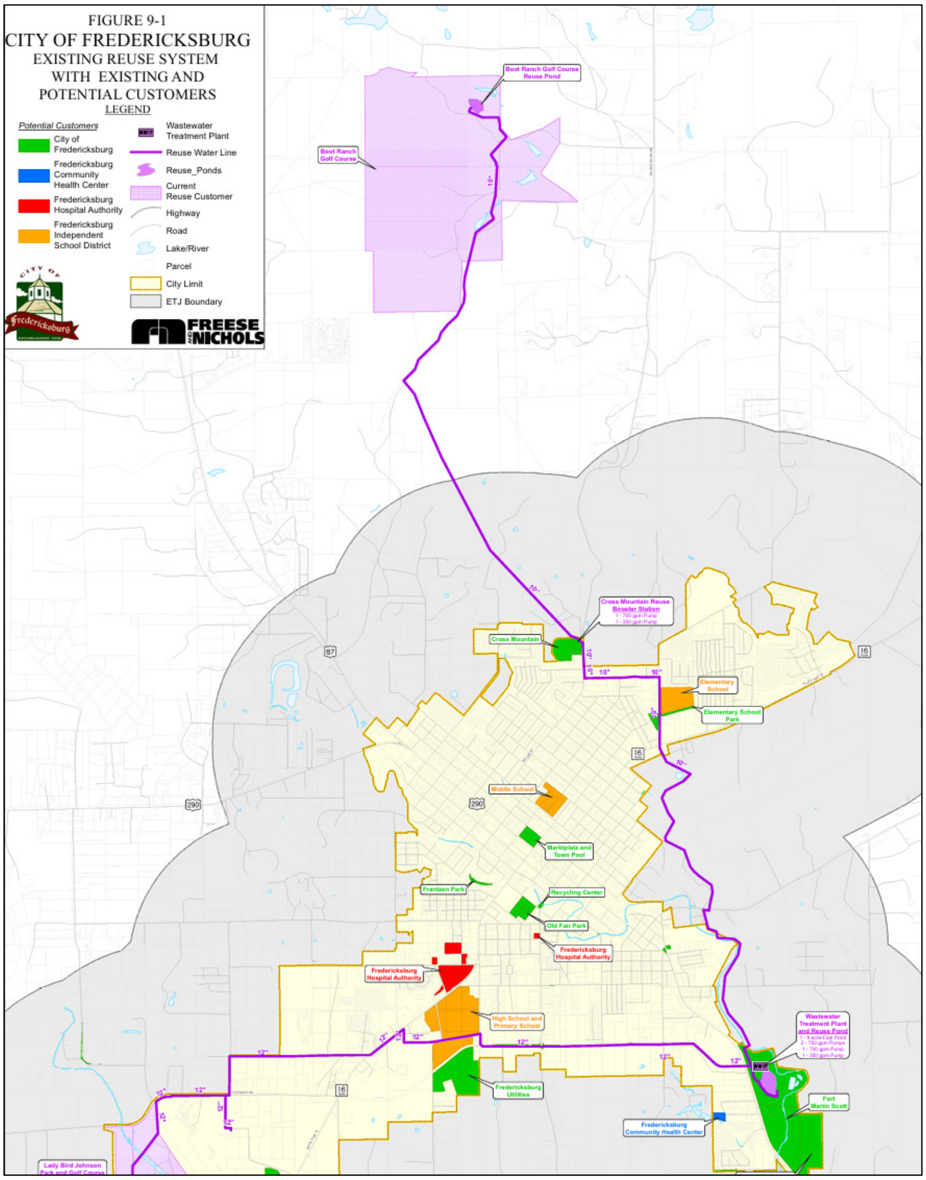

Figure 13. The city of Fredericksburg's purple pipe system in 2017 (Freese and Nichols, Inc., 2017).

Case Studies' Framework for Success

Reuse districts implemented in Comal County or throughout the rest of the Hill Country region could benefit from adopting some of the measures that led to the case studies' success. While each reuse district should meet the specific needs of its determined service area, the new districts could adopt some of the case studies' financial, infrastructure, incentives, and public messaging measures.

In addition to the revenue SAWS generates from selling recycled water to its end users, the utility recycles and sells the byproducts of its water recycling process, helping to offset the costs of treatment. EPW is using state and federal funding to help offset the cost to ratepayers of the new direct potable reuse facility. Round Rock uses existing infrastructure, such as abandoned wastewater force mains, to help keep costs more affordable. Implementing recycled water systems is not cheap, and adopting these measures could help the new district or districts keep costs down.

To plan the layout of reuse infrastructure, a prospective Comal County district could look to Round Rock, San Antonio, or Fredericksburg. Round Rock locates their reuse projects near existing wastewater treatment plants, which a reuse district in Comal County could emulate with the numerous wastewater treatment plants present in the county. San Antonio and Fredericksburg both have relatively simple layouts of their reuse infrastructure (Figures 11 and 13). San Antonio's purple pipe infrastructure runs in a loop around the service area, with both ends of the system connected to treatment plants. Fredericksburg's simpler but effective system starts at a single point, a treatment plant, and runs in two directions towards its distribution points, similar to the hands on a clock. Planning to take advantage of existing wastewater treatment plants and implement simple layouts of the purple pipe infrastructure could help determine which areas of Comal County would best support a reuse district.

Lakeway, Round Rock, Boerne, and Fredericksburg all work to incentivize customers to use reclaimed water for non-potable purposes and do so in a manner any new district could emulate. Recycled water in Lakeway, Round Rock, and Boerne is provided at a lower cost than the potable water supply. There are no restrictions placed on recycled water use in Lakeway, Round Rock, and Fredericksburg during times of drought or shortage, unlike potable water use. Fredericksburg does not charge reuse water customers the monthly fixed customer fee charged to all other water uses during months in which the recycled water is not used. These imitable measures encourage customers to use recycled water for non-potable uses, lessening pressures on potable supplies.

This report strictly provides recommendations for the implementation of non-potable reuse systems. The adoption of direct potable reuse systems, like in Big Spring and El Paso, is outside the scope of this report. Because there is not currently widespread adoption of either potable or non-potable reuse in the county or region, and there are multiple potable supply sources, adoption of direct potable reuse could face greater hurdles than non-potable reuse. El Paso residents were receptive to direct potable reuse due to trust built through the city's "history with safely implementing other forms of water reuse" and effective public relations (Alley & Alley, 2022, p. 148).

Big Spring residents were receptive to direct potable reuse after officials made television show appearances, hosted public meetings for residents, spoke on radio shows, and spoke at civic meetings (Alley & Alley, 2022). The officials made clear there was no good alternative; CRMWD "had fully tapped the area's surface water and fresh groundwater surfaces," and desalination was considered too expensive (Alley & Alley, 2022, p. 143). Any new reuse district in the Hill Country can learn from El Paso's and Big Spring's effective trust building and public messaging and can use these strategies to further acceptance, at least initially, of non-potable reuse.

Limitations

It is important to note that there are several limitations to the creation and implementation of water reuse systems in Texas, especially over the Edwards Aquifer. Beneficial use of reclaimed water in Texas is regulated by TAC Rule 210, *Use of Reclaimed Water*. For reuse water used for irrigation within the recharge zone, plans and specification for the disposal system must be submitted to TCEQ's executive director for approval prior to construction. Holding ponds containing reclaimed water in the recharge zone must adhere to a variety of requirements outlined in TAC Rule 210 to prevent groundwater contamination. The irrigation of food crops and general irrigation practices using reclaimed water and the design of reclaimed water systems are also regulated by parameters set forth in this rule (30 TAC § 210.1–210.85).

Various cities and authorities in the region have restrictions or guidelines on how reclaimed water can be used over the recharge and transition zones of the aquifer (Figure 14):

- EAA: To ensure groundwater quality, the use of reclaimed water on the Edwards Aquifer recharge zone is discouraged. Reclaimed water is, however, considered an alternative source of water and may be used without restriction during critical periods in other areas outside the recharge zone (EAA, 2014).
- San Antonio: Within the SAWS boundaries, recycled water may not be used over the Edwards Aquifer recharge and transition zones (Plants and Major Projects Department, 2020).

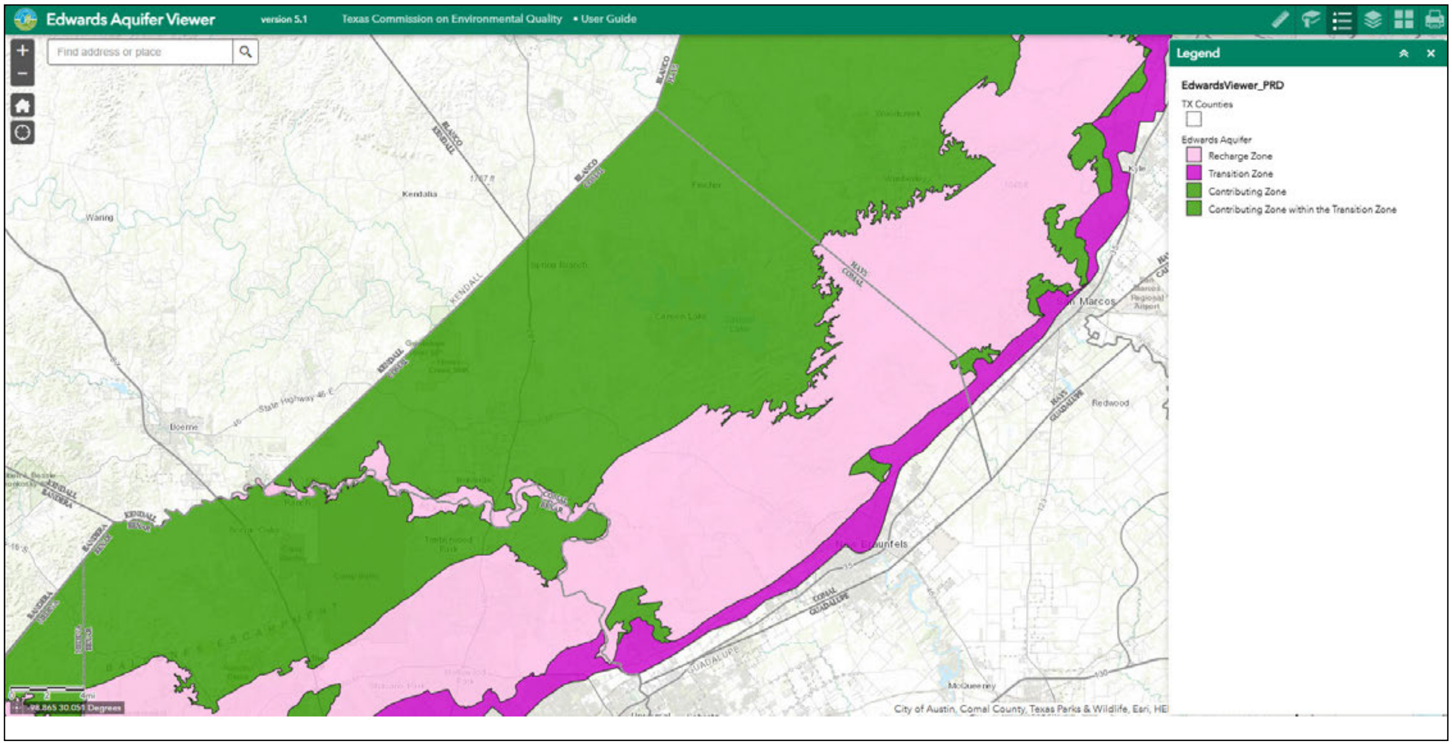

Figure 14. Texas Commission on Environmental Quality (TCEQ) map showing the zones of the Edwards Aquifer in Comal County ([TCEQ, n.d.-b](#)).

- Austin: If a wastewater treatment plant is going to discharge treated effluent over the recharge zone, it must instead dispose of the reclaimed water through irrigation ([Austin, Tex. Land Dev. Code ch. 25-9 art. 4](#)).
- San Marcos: The city proposes that reclaimed water used in future irrigation projects should be limited to the transition zone and should not be used in the recharge zone. Reclaimed water is currently used at a power generating plant and a cement manufacturing plant in San Marcos ([TWDB, 2014](#)).

Any reuse water provider should consider the location of their reuse treatment sites, infrastructure, and delivery points in relation to the Edwards Aquifer. If a provider decides to distribute reclaimed water within the recharge or transition zones, that water should be held to higher treatment and water quality standards than reclaimed water distributed outside of these sensitive areas.

OPPORTUNITIES FOR ADVANCEMENT

Authority

Distinct Water Reuse Districts

Perhaps the most obvious route for the creation of water reuse districts in Comal County is to model the authorization of the districts after the AWCRD. The Legislature could authorize the creation of one or more water reuse districts within Comal County using a bill similar to SB 1667 in 1989. Doing so would allow the new district the authority to buy or collect wastewater, treat it, and then distribute it for reuse through a purple pipe network, selling it to any person, private corporation, city, town, municipal corporation, or political subdivision inside or outside the district's boundaries. This would not prevent other corporations or political subdivisions from implementing a reuse system within Comal County but would allow the district to operate independently from and coordinate with other utility districts or political subdivisions.

A similar authorizing legislation to that which authorized the AWCRD would allow the new water reuse districts to construct their own facilities for the transportation, storage, and treatment of wastewater or allow them to lease or buy such facilities and would grant the districts the power of eminent domain. The district could construct, and later operate, purple pipe networks in the fast-growing areas of Comal County and the Hill Country before those areas are built up. The district could also locate its reuse infrastructure near large water-demand industries, such as aggregate production operations. These scenarios would allow for the more responsible utilization of water sources to respond to and manage current and future growth.

As the Legislature has authorized such a district before, there is legislative precedent for the creation of a water reuse district in the region. Logistical issues may create challenges to the implementation of such a district, but funding opportunities and specific opportunities for implementation are outlined in section IV.B.

Guadalupe-Blanco River Authority Reuse Systems

An alternative route for the creation of water reuse systems is to have the Guadalupe-Blanco River Authority (GBRA) implement more comprehensive reuse systems within its boundaries, for irrigation in fast-growing areas or for industrial sites. Established by Section 59, Article 16 of the Texas Constitution in 1933 and reauthorized by an act of the Legislature in 1935, the GBRA is a 10-county statutory district that includes the entirety of Comal County (GBRA, n.d.-a). The GBRA has prior experience in water reuse and could have support for a broader water reuse system.

The GBRA already operates multiple wastewater treatment plants, including one that produces reuse water for the city of Buda for irrigation of parks and city property. In its 2023–2028 strategic plan, the GBRA calls for the implementation of the first direct reuse facility in the Guadalupe River Basin, signaling existing support for water reuse within the GBRA's boundaries (GBRA, 2022). Here too, logistical issues may pose many of the challenges facing the creation or expansion of a water reuse system, but funding and implementation opportunities are outlined in section IV.B.

Practicalities

A water reuse district authorized to plan for and coordinate the treatment and distribution of recycled water in a region would allow for the more practicable and sustainable utilization of water sources. If recycled water systems are implemented in the Hill Country through one or more water reuse districts, the new districts could either operate outside of the boundaries of existing operators or could overlap at least in part with existing agencies and work to incentivize collaboration and coordination between itself and existing operators.

Just under a third of Comal County is covered by neither a water nor a sewer utility certificate of convenience and necessity. There are many different and sometimes overlapping water and wastewater jurisdictions—MUDs, water agencies, city water departments, etc.—few of which provide or use recycled water on a wide-scale basis (Figure 15). The districts could fill this gap in recycled water use and facilitate water reuse by coordinating wastewater treatment and distribution across these various jurisdictions.

The water reuse district could buy wastewater and lease existing treatment and storage facilities from current operators; undertake treatment costs; and undertake the planning and construction of recycled water infrastructure and delivery. This manner of operations could allow wastewater providers to continue to operate with a revenue stream without taking on the burden of coordinating wastewater reuse treatment or reuse infrastructure planning and construction, which the district would be authorized to handle.

Regardless of how the reuse system is implemented, the operator must ensure there is clear and consistent communication and coordination among partner agencies and separate jurisdictions, as applicable. The authorizing legislation for the reuse district could help facilitate the necessary coordination by outlining distinct powers and limits of the district in relation to other agencies or utilities.

Funding

State and Federal Grants and Loans

There are a variety of state and federal funding opportunities that could be available to supplement the funds needed for the creation of new water reuse districts or additional water reuse systems. Some of these funding opportunities may not be suitable for every iteration of a water reuse district or system. While this section should not be treated as an exhaustive list, it provides a broad overview of some of the potential options:

- The Clean Water State Revolving Fund (CWSRF): The CWSRF provides financial assistance for planning, acquisition, design, and construction of wastewater, reuse, or stormwater projects. Cities, counties, districts, river authorities, designated management agencies, and public and private entities are eligible to apply for below market interest rate loans and principal forgiveness after submitting a completed project information form (TWDB, 2022c).
- The State Water Implementation Fund for Texas (SWIFT): The SWIFT provides financial assistance for projects in the state water plan, including conservation, reuse, desalination, and new pipelines, and specifically encourages the funding of reuse projects. Cities, counties, river authorities, special law districts, groundwater conservation districts, and nonprofit water supply corporations are eligible to apply for a variety of loans and terms. Critically, the project must be a recommended water management strategy in the regional water plan included in the most recently adopted state water plan prior to the project review year (TWDB, 2022e).
- The State Participation Program (SPP): The SPP allows for the development of regional projects by funding excess capacity for future use where the development would be unaffordable without state participation. Eligible projects include planning design, acquisition, and construction for the right sizing of regional projects for water supply and wastewater to prepare for future

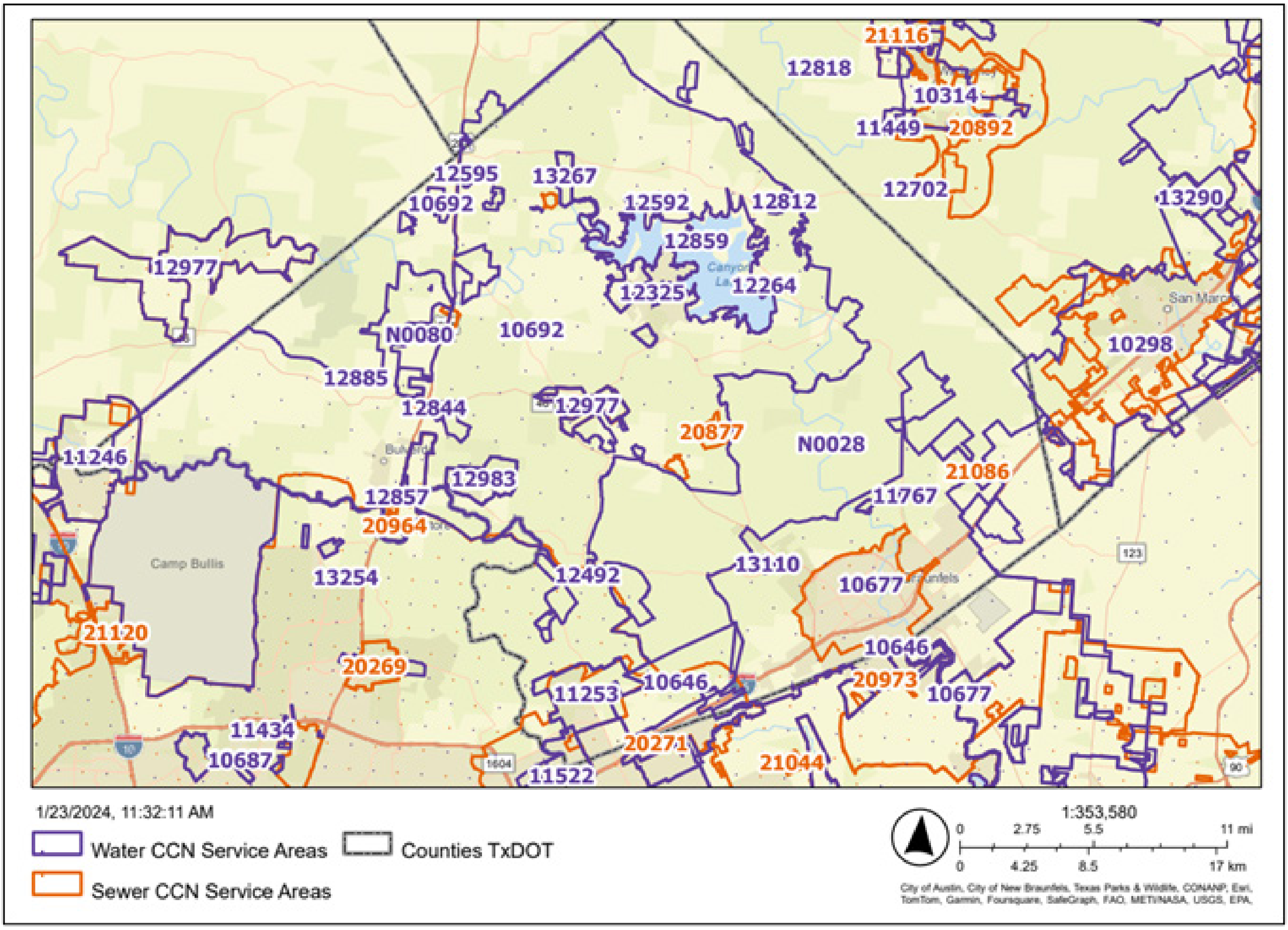

Figure 15. Map of water and sewer certificate of convenience and necessity (CCN) service areas in Comal County. All space not outlined by purple or orange and not filled in with the same color dots is geography not covered by either type of service area. Counties boundaries are Texas Department of Transportation (TxDOT) boundaries (Public Utility Commission of Texas, 2023).

use. Cities, counties, districts, river authorities, and nonprofit water supply corporations are eligible to apply for financing through a temporary TWDB ownership interest in the regional facility with a 34-year repayment term (TWDB, 2022d).

- The Texas Water Development Fund (DFund): The DFund provides financial assistance for planning, design, acquisition, and construction of water supply, conservation, and wastewater projects. Cities, counties, districts, river authorities, and nonprofit water supply corporations are eligible to apply for market interest rate loans after scheduling a pre-application conference with the relevant regional project implementation team (TWDB, 2022f).
- The Title XVI Water Reclamation and Reuse Program Grants of the U.S. Bureau of Reclamation (USBR): Under the authority of Title XVI of Public Law 102-575, USBR provides grant funding opportunities for the planning and design of water recycling and reuse projects in partnership with local government entities. According to the September 2023 funding solicitation, funding Group 1 applicants may request up to $1 million in federal funding for projects under $500 million, with a federal cost share of 50%. Funding Group 2 applicants may request up to $5 million in federal funding for projects over $500 million, with a federal cost share of 25%. Funding categories may vary in future solicitations. Critically, projects are eligible to compete for these grants once USBR has reviewed the feasibility study submitted by the project sponsor (USBR, 2023c).
- USBR's Large-Scale Water Recycling Program Grant: Under the authority of the Bipartisan Infrastructure Law, USBR provides grant funding opportunities for projects that advance water recycling and reuse. The grant targets local government authorities or "water management agencies considering or planning larger water reuse

projects as part of strategies to address projected water supply shortages" (USBR, 2023a, paragraph 5). There is no cap on the project size for which an applicant can request funding, and the federal cost share will be no more than 25%, up to $180 million in federal funds. The final round of applications for the FY24 funding opportunity are due September 30, 2024. $450 million will eventually be made available through this program (USBR, 2023b).

- The Water Infrastructure Finance and Innovation Act (WIFIA) Loans: WIFIA loans are administered by EPA and may be used for eligible water and wastewater infrastructure projects. Local and state government entities, partnerships and joint ventures, and corporations and trusts may apply for planning, design, acquisition, rehabilitation, replacement, and construction activities. Wastewater conveyance and treatment projects, alternative water supply projects, and water recycling projects may be eligible for WIFIA loans with a maximum federal cost share of 49% (EPA, 2023).

Rates and Taxes

If modeled after the AWCRD, the governing board of a prospective Comal County reuse district would be able to "establish and collect rates, charges, and fees for the sale of wastewater that are necessary to produce gross revenue that together with any other revenue is sufficient to: 1) pay all current operation and maintenance expenses of the district; and 2) produce an amount of revenue during each fiscal year at least equal to the principal and interest requirements for that fiscal year…" (SB 1667, 1989, p. 12). Under the AWCRD model, a district would be able to issue bonds but would not be able to levy or collect taxes. The water reuse district would be authorized to enter into contracts for the purchase of wastewater and sale of the reclaimed wastewater.

If created under a political subdivision such as the GBRA, the GBRA could use fees and funds from the sale of water, the treatment of water and wastewater, hydroelectric power generation, and recreation to implement the reuse system. The sale of reclaimed water would also then contribute to its revenues. The GBRA could not, however, levy or collect taxes (GBRA, n.d.-b).

In addition to establishing and collecting rates, charges, and fees for the sale of reuse water, the ability to levy and assess taxes could be instrumental in providing the districts or authority with the financial flexibility to implement a reuse system. The ability to levy and assess taxes is often politically difficult to achieve. However, it could still be worth analyzing the impact that amending the GBRA's authorizing legislation to include this ability or granting the new districts this authority in their authorizing legislation would have on the implementation and maintenance of any reuse system. For the GBRA, this could be similar to the San Antonio River Authority's ability to levy and assess taxes (San Antonio River Authority, 2023).

Recycled water is a water supply that can be provided even in the midst of a drought. During periods of drought, when other supplies may be restricted, supplying reuse water for non-potable purposes could result in revenue that without this supply would not exist. If the reuse system operator—whether that be a new reuse district or a different agency—can provide this recycled water at a lower cost than the regular water supply, the operator can incentivize its use in place of the regular water supply. This could provide a three-fold benefit. The reuse system operator could see an increase in revenue compared to supplying strictly regular water sources, consumers can avoid using potable water for non-potable purposes while also saving money, and scarce groundwater and surface water supplies would be conserved.

Byproduct Sales

SAWS utilizes the byproducts of its wastewater treatment process to help provide more affordable water services. Biosolids are used to generate compost and are sold commercially through local retailers and nurseries, while biogas is treated and sold by a partner energy company on the open market (SAWS, 2022). Following this example could help any new water reuse district or system offset costs or provide subsidized water rates to customers to influence the uptake of recycled water.

Implementation

Aggregate Production Operations

There are many different manners in which water reuse districts or systems can be implemented within Comal County, as evidenced by the seven case studies presented earlier in this report. In addition to these useful examples, there is another opportunity present for a water reuse district or system within the county. Due to the number and location of aggregate production operations (i.e., quarries) present within Comal County, there is a unique opportunity to implement a system wherein reclaimed wastewater can be provided to these quarries for their water use, thereby replacing groundwater use.

A 2015 policy proposal recommended oil and gas operators—considered mining operators by TWDB—use less fresh groundwater and instead substitute this source with other supplies, including municipal treated wastewater. The proposal was geared toward operators in the Eagle Ford Shale region and noted that the limited supplies of municipal treated groundwater in that region and the high cost of recycling produced water would make brackish groundwater the least-cost choice (Steadman et al., 2015). However, in Comal County, using this framework, recycled wastewater would likely be the least-cost choice: brackish groundwater use is not prevalent; there are no available oil and gas produced water volumes; and municipal treated groundwater is not in short supply, especially as the population increases (USGS, 2017; Reedy & Scanlon, 2022).

Comal County has around 40,000 acres of aggregate production operations, roughly 11% of the county's entire landmass. Eleven of these quarries are clustered along a 30-mile stretch of I-35 that runs through Comal County; this stretch is referred to as Quarry Row (Public Citizen, 2018). Comal County is one of the top three counties for water use by the aggregate mining industry in Texas (Figure 16). These quarries use water—in Comal County, this water is solely groundwater—primarily for dust suppression and for washing the aggregate to clean and sort it (Reedy & Scanlon, 2022). A typical 800 ton-per-hour crusher uses the annual equivalent of the water used by around 1,920 single family homes (Texans for Responsible Aggregate Mining, 2019). While quarries make up 11% of Comal County's land area, they use around 21% of the county's groundwater, and annual water use by this industry is expected to increase around 10% per decade over the next 50 years (Reedy & Scanlon, 2022).

Recycled water use is not a new concept for aggregate production operations; many quarries recycle much of the water used in their operations (Texas Aggregates & Concrete Association, 2020). TCEQ does not require them to do so, however, and the original water source in Comal County is still pumped groundwater (Chasnoff, 2021). This initial use of groundwater, though potentially recycled in later stages, represents a significant opportunity for the implementation of a water reuse district to immediately protect the groundwater supply by instead providing recycled water as the original water source. For the quarries, replacing the initial pumped groundwater with recycled water could also mean they would not be subject to drought restrictions, and it would provide them with a certainty of supply.

EPA recommends the construction of intuitive projects with strong potential for reuse and highlights both large water demand industries located next to a wastewater treatment plant and concentrations of reuse customers in an area (Camp Dresser & McKee, Inc., 2004). Most of the quarries in Comal County are linearly clustered along Quarry Row and some are already located next to existing wastewater treatment plants. These quarries use large amounts of groundwater and may have experience using recycled water in their operations (Figure 17). Aggregate production operations should be examined as a path forward for the development of a purple pipe network in the county.

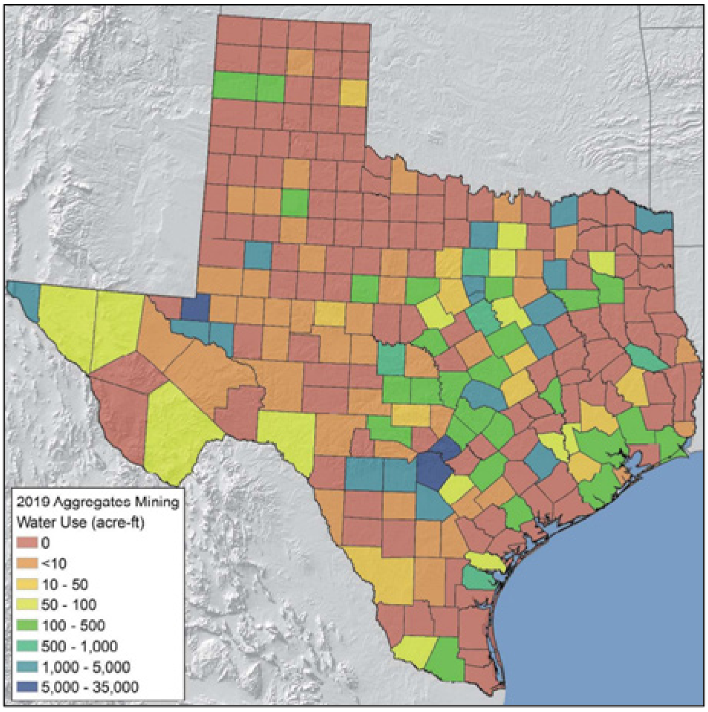

Figure 16. Texas Water Development Board map showing water use by county by the aggregate mining industry, with Comal County in the highest category of use (Reedy & Scanlon, 2022).

Outdoor Irrigation

Another prime opportunity for implementing greater reuse in the county is to supply recycled water for outdoor irrigation. Across the state as a whole, between 2004 and 2011, 31% of municipal residential water use was estimated to be for outdoor water consumption. Around 90% of this outdoor water consumption was dedicated to purposes such as maintaining lawns and gardens (Hermitte & Mace, 2012). Though these are estimates, in Comal County, this percentage would translate to around 6,680 acre-feet dedicated each year to residential irrigation based on 2020 water use.

While conservation should be the first measure for protecting water supplies in the Hill Country, with increasing population growth in the county and the creation and expansion of residential developments, there will continue to be non-potable outdoor water use. Implementing a reuse district or expanding existing reuse systems in the county to supply recycled water for these non-potable outdoor water uses can protect existing supplies as development increases. New residential developments, specifically, could benefit from the implementation of reuse districts, as the implementation will involve the construction and operation of new infrastructure rather than the replacement or retrofitting of old infrastructure. Providing recycled water to new developments for outdoor water uses could help alleviate the strains placed on existing water supplies, even as population and water demands increase.

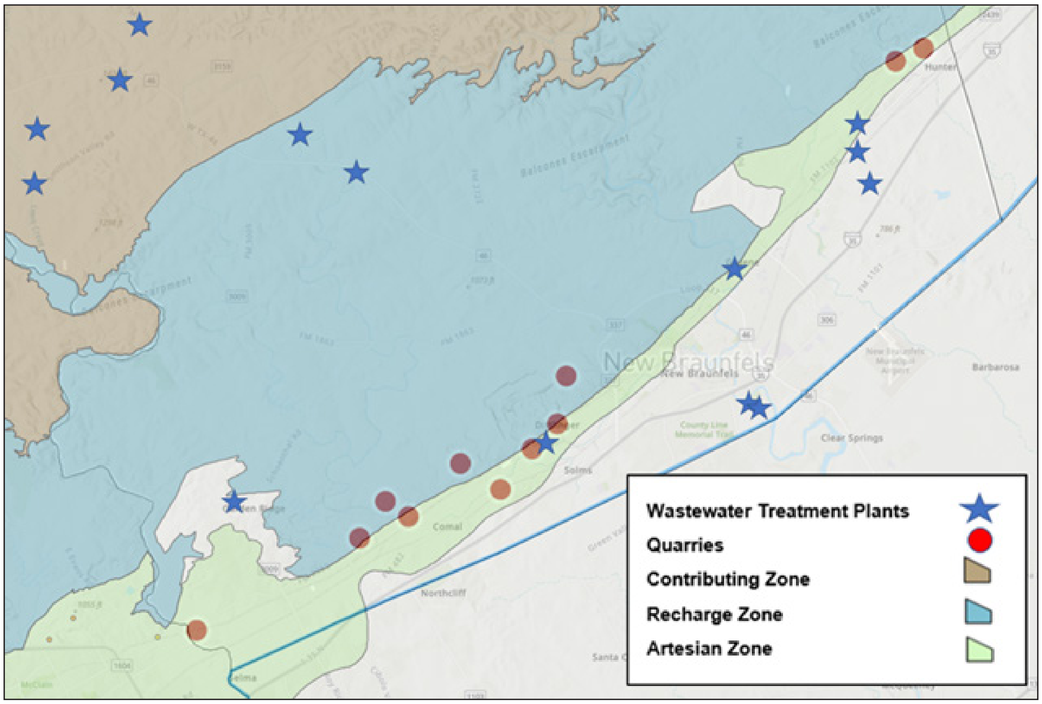

Figure 17. Map of wastewater treatment plants and limestone aggregate production operations (quarries) along Quarry Row in Comal County overlaid on the three layers of the Edwards Aquifer (see Figure 9; Texas Hearst Data Visualization Team, 2021; Greater Edwards Aquifer Alliance, 2023).

Between mining water use and estimated outdoor municipal water use, roughly 10,600 acre-feet of water use in Comal County could potentially be served by non-potable recycled water, over one-third of the county's total water use in 2020.

CONCLUSION

Water reuse is considered one of the leading solutions for safeguarding water supplies in the Hill Country (Siglo Group, 2022). Using reclaimed water allows for the conservation of potable water, thereby reducing the demand placed on groundwater and surface water while allowing communities to diversify and expand their water supplies at the same time (Boerne Utilities, n.d.). Water reuse is integral to ensuring that Texas will have the water supplies it needs to safeguard the health, safety, and quality of life of its residents in the future by providing alternatives to existing water supplies.

RECOMMENDATION

The Greater Edwards Aquifer Alliance recommends that, in preparation for the 2025 legislative session, the Texas House of Representatives Committee on Natural Resources conducts an interim study for the creation of wastewater reuse districts for irrigation use in the fast-growing areas of Comal County and the Hill Country and for industrial use at sites such as aggregate production operations. The study should analyze the possibility of implementing multiple water reuse districts with flexible boundaries throughout the study area, where deemed practicable, given variations at different locations in the volume of potential reuse water generation and the need for that water. Water reuse districts should be examined as a tool to fill existing gaps in water management and planning in the region and to encourage full beneficial use of water supplies. As evidenced by the state of water reuse in Comal County, this source of water is vastly underutilized in the efforts to manage the Hill Country's water supplies in the face of prolonged drought and presents a clear opportunity to better preserve the region's natural resources for the generations to come.

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