INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

Safeguarding Texas' Wastewater Infrastructure:

Key Threats and Imperatives

Institute for Homeland Security

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Abstract

Wastewater infrastructure stands as a critical yet vulnerable component of Texas' essential services, and cities and towns in the state must be aware of several key threats to these systems. Though other utilities receive considerable political, media, and scholarly attention, it is crucial to also understand the pivotal role of wastewater systems as a dimension of critical infrastructure in the realms of public health and environmental protection. The aim of this report is to provide an overview of the problems and challenges that presently face Texas' wastewater infrastructure, which demand renewed attention from both public and private spheres. Specifically, three primary threats endanger the integrity of Texas' wastewater systems, each of which has far-reaching implications. First, Texas cities and towns must confront the problem of aging wastewater infrastructure, as many facilities have long surpassed their intended lifespans and are susceptible to failures and inefficiencies. Second, the state of Texas is uniquely vulnerable to natural disasters that pose a significant risk to the efficacy of wastewater systems and threaten to disrupt these services. Finally, the persistent issue of inadequate funding hampers efforts to modernize and fortify wastewater infrastructure, leaving these systems ill-prepared to meet current and future demands. By prioritizing infrastructure improvements, ensuring disaster mitigation, and locating mechanisms to secure funding, Texas cities can fortify their wastewater systems and ensure that they remain reliable, resilient, and responsive to the needs of their communities.

Keywords: wastewater systems, critical infrastructure, septic tanks, infiltration and inflow, SSO, critical infrastructure funding

Author Biography

Sofia Lehmann received a B.A. in Economics and Asian Studies from Furman University. She has more than 10 years of governmental experience working for state, county, and local governments. She currently works as a Grant Application Specialist for Grantworks, Inc., helping small Texas communities acquire federal funding for infrastructure projects in the areas of water, wastewater, flood mitigation, and communications. Sofia has acquired more than $36 million in federal funds to aid communities with these projects.

Introduction

Over 29 million people throughout the state of Texas rely on the functionality and reliability of the various wastewater systems (United States Census Bureau, 2022). Wastewater systems collect residential and commercial wastewater through a network of pipes and lift stations to ultimately be treated at a wastewater treatment plant. After the wastewater has been cleaned, it is then released back into rivers, bayous, and other bodies of water. Widely overlooked, wastewater systems play a crucial role in realms such as public health, economic development, and environmental protection.

This report aims to provide an overview of the challenges currently facing Texas' wastewater infrastructure. First, Texas state and local governments must address the problem of the state's aging wastewater infrastructure as many facilities have long surpassed the intended lifespan and are nearing or over their designed capacity. Additionally, Texas experiences a variety of natural disasters that pose risks to the already stressed wastewater systems throughout the state. Finally, inadequate funding further hinders local efforts to harden and remediate wastewater infrastructure. By prioritizing infrastructure upgrades, ensuring disaster preparedness, and expanding mechanisms to secure funding, Texas cities can fortify their wastewater systems and ensure that they remain reliable, resilient, and responsive to the needs of their communities.

Challenges of Aging Infrastructure

Wastewater infrastructure throughout the United States has surpassed its designed lifespan and is operating over its intended capacity. According to the American Society of Civil Engineers 2021 Infrastructure Report Card, the country's wastewater system infrastructure earned a D+ rating. The report goes on to state that "more than 16,000 wastewater treatment plants are functioning, on average, at 81% of their designed capacity, while 15% have reached or exceeded it" (American Society of Civil Engineers, 2021, p. 152).

Over 1,300,000 miles of pipeline comprise the nation's wastewater systems (American Society of Civil Engineers, 2021). These pipes have a lifespan between 50 to 100 years (American Society of Civil Engineers, 2021). However, that depends on the type of pipe material, soil type, climate, depth of active zone, installation, and many other factors. Nationwide, the wastewater pipeline currently in use has an average age of 45 years pushing towards the maximum lifespan of the pipes (American Society of Civil Engineers, 2021). This means that the average wastewater line was installed around 1979, but since this is an average, there are wastewater pipes currently in use that were installed prior to the 1970s. These aging pipelines suffer from a wide range of corrosion based on the type of pipe material. Some of the most common materials include cast iron/ductile iron, concrete, clay, PVC, and others.

Most of the time, the pipe material is correlated with the age of the pipe. Older pipes installed before 1990 tend to be cast iron, concrete, or clay while newer pipes are PVC or some other type of plastic. Cast iron, concrete, and clay pipes have higher strength levels and good resistance to pressure surges (Vahidi et al., 2013). However, cast iron, concrete, and clay pipes tend to be heavier leading to shorter lengths, an increased number of joints, and corrosion (United States Environmental Protection Agency, 2000; Vahidi et al., 2013). Cast iron, in particular, is prone to corrosion. The cast iron pipes corrode over time as the iron reacts to the oxygen and moisture in its surroundings creating corrosion pits on the pipe. According to Singh. Kanvinde, Narasimhan (2021), the depth of these corrosion pits in combination with the soil is correlated to the probability of failure and a pipe break. Additionally, the greater the number of joints used in a pipeline increases the probability of the joints shifting and allowing water and other substances to enter the system, referred to as inflow and infiltration (I&I). Inflow and Infiltration, whether caused by gaps in joints or faulty manhole cover, increase the total volume of inflow going into the wastewater treatment plant overwhelming the wastewater plant and causing sanitary sewer overflows. Complete or partial pipe breaks allow untreated wastewater to escape and flood exposing residents in the surrounding area to raw sewage.

Wastewater treatment plants have "an average lifespan of 40 to 50 years" (American Society of Civil Engineers, 2021, p. 153). As stated above, most wastewater treatment plants are currently performing close to or exceeding their designed capacity. Consequently, the technology used to build these plants in the 1970s or 1980s is outdated and prone to failure. Unlike pipelines, if a wastewater treatment plant experiences failure, the specific parts may not be manufactured any longer causing communities to perform greater infrastructure upgrades than are needed in addition to service disruption to customers.

The Texas Commission of Environmental Quality (TCEQ), the agency responsible for wastewater treatment in Texas, has over 3,100 active septic sewer system permits per the Texas Section of the American Society of Civil Engineers (2021). Septic systems are highly used in rural areas where centralized wastewater collection systems do not usually exist. Additionally, as cities and towns expand outside the boundaries of the centralized wastewater system, the only option becomes septic tanks. Sixty percent of rural residents use on-site septic systems to treat their sewage (Maxcy-Brown et al., 2021). The responsibility shifts to the individual homeowner to maintain. This creates a huge problem, especially in rural and economically disadvantaged areas. According to the American Society of Civil Engineers (2021), septic systems have a 20 to 30-year lifespan. Septic tank maintenance is costly, and low-income individuals forgo the maintenance expense not knowing the potential health hazards of septic system malfunctions. Some poorer rural residents are left with no alternative to onsite wastewater management choosing to discharge raw sewage "directly into streams, trenches, or onto the ground" (Maxcy-Brown et al., 2021, p. 2). This practice of straight piping can be done by individual homes or collected by a community line that then discharges the wastewater into bodies of water. Like aging pipelines and wastewater treatment plants, older unkept septic systems can break or overflow due to capacity issues exposing the homeowner to raw sewage as well as potentially contaminating the groundwater in the area. Due to the decentralized nature of on-site septic systems, local and state entities have very few resources to manage each septic system in Texas depending on the homeowner to maintain the system. Consequently, poorer rural communities are at an increased risk of exposure to untreated wastewater due to septic system failures (Fizer et al., 2018; Maxcy-Brown et al., 2021).

Resilience to Natural Disasters

Texas is uniquely susceptible to a wide variety of natural disasters due to its large size. According to the NOAA Office of Coastal Management (2024), Texas has approximately 3,359 miles of coastline. Disaster events experienced by Texas residents range from hurricanes and tropical storms to riverine and flash flooding to droughts and wildfires (NOAA National Centers for Environmental Information, 2024). Between 1980 and 2024, there have been 183 confirmed weather events with losses exceeding $1 billion dollars (NOAA Office of Coastal Management, 2024). Additionally, the NOAA notes that the amount of extreme weather events has increased in frequency from an annual average of 3.9 events (1980-2023) to 11 events (2019-2023) (NOAA Office of Coastal Management, 2024). The increased frequency of events overtaxes and tests the resilience of Texas' aging wastewater systems.

Flooding poses the largest threat to Texas' wastewater systems. The expansive clay soil throughout Texas is sensitive to swells and shrinkage in response to the amount of moisture in the soil. This fluctuation in the soil can create pipe breaks and dislodge or misalign joints. Consequently, during flooding events, the soil becomes inundated with water and can shift the pipelines underneath the soil. This not only can expose the surrounding area to raw sewage, but the system can experience infiltration and inflow of water and other particulates. Additionally, I&I can also lead to sewage backflow in residential and commercial properties causing significant property damage. These types of damages can also cause economic damages as businesses cannot open and residents of the affected community cannot return to work leading to lost wages.

Wastewater treatment plants, when inundated with heavy rainfall events and/or coastal flooding, can become overwhelmed and intake a higher volume of wastewater and stormwater than the plant has the capacity to treat. Thus, the overcapacity wastewater plants experience sanitary system overflows (SSO), where the wastewater plants are forced to discharge untreated wastewater into nearby bodies of water such as rivers, streams, and bayous. According to the Texas Section of the American Society of Civil Engineers (2021), TCEQ recorded 2,500 SSO events in 2016 and almost 6,000 SSO events in 2019. Whether these overflow events are due to the system performing close to its maximum capacity or increased extreme weather events, localities throughout Texas are left to deal with this escalating problem.

In 2004, TCEQ created the Sanitary Sewer Overflow Initiative "to address an increase in SSOs due to aging collection systems throughout the state and encourage corrective action before there is harm to human health and safety or the environment" (Texas Commission on Environmental Quality, n.d.). As of 2021, the Sanitary Sewer Overflow Initiative was comprised of 140 voluntary participants (Texas Section of the American Society of Civil Engineers, 2021). By participating in the initiative, municipalities are not subject to violations and penalties when overflows occur but instead can redirect that cost to making corrective actions to their wastewater systems. The state of Texas and the Texas Commission on Environmental Quality acknowledge that the wastewater systems throughout the state are deficient and are actively coming up with programs to assist communities to upgrade and modernize their wastewater systems.

Septic systems are also highly susceptible to flooding events. If not maintained properly and monitored, sewage can escape the septic systems and contaminate the ground surface, and it can potentially contaminate the groundwater. This is especially prevalent during extreme rainfall events such as storms and hurricanes. Flood water and excessive rainfall can penetrate septic tanks that are not well-maintained and can discharge raw sewage through the drainfield. The untreated wastewater rises to the surface or can penetrate deeper into the ground depending on the topography and drainage in the area. If the untreated wastewater penetrates deeper into the ground, it can make contact with the water table and contaminate this source of water.

System Capacity and Growth

Texas state and local officials also need to take into consideration the systems' capacity and population growth. As many of the systems throughout the state are near or over capacity, long-term planning is crucial to accommodate the growing Texas population. Between 2022 and 2023, Texas became the second-most-populous state in the U.S. (Wilder, 2023). With over 30 million people, the state of Texas is projected to continue increasing its population in the foreseeable future. This continuously growing population will continue to burden the already overtaxed wastewater infrastructure systems throughout the state.

Some state agencies such as TCEQ, have implemented methods to cope with this growth problem. The Texas Administrative Code, used by TCEQ, offers guidance for wastewater treatment plant operations in regard to system capacity stating:

> Whenever flow measurements for any sewage treatment plant facility in the state reaches 75% of the permitted average daily or annual average flow for three consecutive months, the permittee must initiate engineering and financial planning for expansion and/or upgrading of the wastewater treatment and/or collection facilities. Whenever the average daily or annual average flow reaches 90% of the permitted average daily flow for three consecutive months, the permittee shall obtain necessary authorization from the commission to commence construction of the necessary additional treatment and/or collection facilities. (30 TAC §305.126, 1986)

As shown, TCEQ has created guidance for wastewater treatment plant operators and communities to begin planning and implementing upgrades to their wastewater systems before the systems reach overcapacity and experience sanitary sewer overflows.

Additionally, on-site sewage facilities, or sewer systems, "account for approximately 20% of new wastewater treatment capacity in Texas" (Texas Section of the American Society of Civil Engineers, 2021, p. 77). As towns and cities expand, septic systems are the sole option for newly developed areas outside the boundaries of a centralized wastewater system. Septic systems are more cost-efficient than extending the wastewater pipeline to serve new areas.

Limited Funds and Lack of Resources

As previously discussed, due to the age of both wastewater pipelines and wastewater treatment plants throughout Texas and the growing demand for service from its growing population, Texas local governments will need to fund replacements of existing infrastructure and upgrades to increase capacity. These types of infrastructure projects are expensive not only to construct but to maintain. Large components needed for lift stations and wastewater treatment plants have long lead times, creating financial and logistical problems for communities. Industry trends show an average of four percent increase in operational and maintenance costs from 1993 to 2017 (American Society of Civil Engineers, 2021). Local government officials also must consider the affordability of the services as the wastewater infrastructure and maintenance is funded by customers' fees and local taxes. The American Society of Civil Engineers (2021) states that service rates for wastewater customers have been trending upward averaging 24% from 2008 to 2016.

New environmental regulations create further increased costs as cities and towns must upgrade their systems to meet the new regulations or be fined, increasing the financial burden shouldered by these communities (Elliott et al., 2023). According to a U.S. Environmental Protection Agency (EPA, 2023) press release, more than 50 new rules were adopted in 2023. Some of these rules included more stringent water quality standards. As these new rules begin to be implemented, local governments will be obligated to upgrade their systems to comply with the new EPA standards, increasing the financial burden on communities.

Septic systems experience the same cost problems as public wastewater systems. The costs of maintenance and upgrades are shifted to the homeowners. According to the American Society of Civil Engineers, average operational and maintenance costs ranging from $250 to $500 are expected every three to five years (2021). If proper maintenance is not performed, system failures can cost homeowners “between $3,000 and $7,000” (American Society of Civil Engineers, 2021, p. 154). Due to the decentralized nature of the septic systems, most septic systems reside in rural areas, which tend to have lower incomes than urban areas. Thus, the maintenance costs of septic system upkeep are proportionally a greater financial burden to these rural communities. By their nature, septic tanks are private property, and government entities both local and federal cannot perform any upgrades without the landowner's consent, increasing the complexity. As stated in previous sections, septic sewage maintenance is hindered by cost and the homeowner's knowledge of the maintenance and potential risks. Additionally, local entities can run into resident buy-in to decommission septic systems and connect to a centralized public wastewater system. While some funding exists to help landowners rehabilitate or replace their septic systems, a large gap exists when it comes to knowledge and resources to aid septic system owners. Most federal and state grant and loan programs are aimed at local government entities.

Due to the stagnation of wastewater service fees, local governments must turn to alternative funding and financing for large capital projects. These can come from state or federal grants, loans, and other financing mechanisms (American Society of Civil Engineers, 2021). Even with these alternative funding sources and increases in customer rates, a funding gap persists. State governments have tried to step in to close this gap, but the costs of much-needed capital projects have pushed local governments to look for federal options.

Federal agencies such as the U.S. Department of Agriculture (USDA), the U.S. Department of Housing and Urban Development (HUD), and the U.S. Environmental Protection Agency (EPA) have created grant programs and other financial mechanisms to alleviate gaps in wastewater infrastructure funding. The EPA's Clean Water State Revolving Fund provides low-interest loans for infrastructure projects. EPA's Water Infrastructure Finance and Innovation Act Program also provides low-cost loans to "regionally and nationally significant projects" costing $20 million or more (American Society of Civil Engineers, 2021, p. 155). HUD's Community Development Block Grant provides grant funding to economically disadvantaged areas.

The biggest problem with the federal and state programs previously discussed is that the agencies receive more applications than can be funded yearly, making them very competitive. In 2019, entities throughout Texas submitted applications amounting to $786 million in needs to the

Texas Clean Water State Revolving Fund but were only able to award $525 million (Texas Section of the American Society of Civil Engineers, 2021). This leaves $261 million worth of needs that were not able to be awarded. As stated by the Texas Section of the American Society of Civil Engineers (2021):

> Most projects were wastewater-focused and included rehabilitating and capacity increases of large wastewater treatment plants, replacing sewer collection pipes composed of outdated materials, and constructing package plants to replace communities' septic tanks. (p. 77)

While not all applications to the Texas Clean Water State Revolving Fund are funded, those that are awarded tackle much-needed improvements to wastewater infrastructure throughout the state. Another thing to consider is that these types of programs are solely focused on capital expenses and not operation and maintenance expenses (Elliot et al., 2023).

Most of these funds are awarded based on competition, creating a disadvantage for small rural communities. Most small rural cities and towns in Texas have small staff working for the local government. It is not uncommon to have a mayor and a city secretary as the only paid city employees. Some small towns only have volunteer positions due to the lack of local funds. It is communities such as these that would receive the most benefit from state and federal funds. However, the applications for these funds are very technical and complicated. Small rural communities do not have the capacity to manage the application process nor the project management of the funds once they are received. Additionally, federal grants and loans must adhere to the Code of Federal Regulation rules, which most communities do not have the expertise to research or implement. If these regulations are not followed, the agencies can ask the communities to repay the funds, creating yet another barrier for small cities and towns to access these state and federal funds. Thus, many small communities do not attempt to access federal and state funding mechanisms, and instead, the funds are awarded to larger entities with more capacity and knowledge of the funding system.

Alternatively, communities can use the services of grant management firms that use their expertise in federal and state laws to guide the communities through the application process as well as manage the funds and projects. The grant management firms bridge the knowledge gap that the grant application process can have for rural Texas towns, allowing them to tap into much needed funds to upgrade their wastewater infrastructure.

Recommendations

While the problem of deteriorating wastewater infrastructure throughout the state of Texas is complex, multiple options exists to mitigate these issues. Federal and state funding mechanisms such as the EPA's Clean Water State Revolving Fund and Water Infrastructure Finance and Innovation Act Program should be expanded to continue to provide communities with "long-term, low-cost funding mechanisms for regionally and nationally significant, large-dollar-value projects" (American Society of Civil Engineers, 2021, p. 159). Grant programs such as HUD's Community Development Block Grant should also be expanded, and new grant programs should be created both by the federal government as well as the state government to meet the operational and maintenance deficit that exists for small rural communities. These programs should also be more accessible to smaller communities that do not have the personnel or capacity to request the funds.

Technological innovation and implementation could also help the problems that the current wastewater infrastructure faces and will continue to face. More and more appliances are created with water conservation mechanisms that "reduce the volume of wastewater entering the system"

(American Society of Civil Engineers, 2021, p. 158). By reducing the volume of water added to the wastewater system, it alleviates the burden faced by near- and overcapacity wastewater treatment plants.

Additionally, many communities could benefit from monitoring systems throughout their wastewater infrastructure to help pinpoint areas within the systems suffering from corrosion or inflow and infiltration (American Society of Civil Engineers, 2021). Software such as SCADA, Supervisory Control And Data Acquisition, gather and analyze real-time data to allow plant operators or public works personnel to monitor the system performance and identify problems before they escalate. However, retrofitting older wastewater systems with monitoring software is costly but would allow them to prioritize operational and maintenance expenses and investment decisions (American Society of Civil Engineers, 2021).

With the increase in extreme weather events, the state of Texas should prioritize increasing the resilience of the state's wastewater system. As mentioned above, the current wastewater systems throughout Texas are aging and corroding leaving the systems vulnerable to the effects of natural disasters such as flooding and hurricanes. State officials should implement programs and initiatives to build the resilience of wastewater systems throughout the state and emergency response to extreme weather events, decreasing the potential health and environmental risks of sanitary system overflows as well as service disruptions. Additionally, Texas officials should expand existing programs such as TCEQ's Sanitary Sewer Overflow Initiative to provide much-needed assistance to rural communities.

Conclusion

While the current wastewater systems throughout the state of Texas are aging and are overburdened by reoccurring extreme weather events, state and local officials can implement various initiatives to curve the anticipated capacity needed to serve Texas' growing population. By making wastewater infrastructure a priority, resources can be developed to aid small communities as they implement improvement plans to better serve their residents. Additionally, resources and funds could be made available to economically disadvantaged rural communities that have septic systems. If the federal, state, and local governments do not begin performing changes, the residents of Texas can expect to experience an increase in I&I, SSO, and service disruptions posing health and environmental risks. Accordingly, the main purpose of this report is to provide an overview of the challenges currently faced by the wastewater systems throughout Texas with the aim of directing the attention of policymakers and stakeholders to these issues.

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